

THIS YEAR, PIONEER DISCOVERED A NEW ART.



Model: PD-M2000
PIONEER
DIGITAL DETECTOR
PUSH-TO-OPEN
ON
PIONEER ELECTRONIC CORP. TORONTO, ONTARIO, CANADA

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DIGITAL DETECTOR
PUSH-TO-OPEN
ON
PIONEER ELECTRONIC CORP. TORONTO, ONTARIO, CANADA

Pioneer goes beyond state of the art electronics to make a major new contribution in human engineering.

In the past 40 years Pioneer has made countless contributions to the state of the art in High Fidelity. Now Pioneer is introducing new components that actually restate the art. We call it High Fidelity for Humans.

This year to a list of audible innovations and incredible specifications we have added human engineering features that give the owner of our equipment a new ability to control it and the quality of the sound it produces.

For example, Pioneer's new CT-9R, three direct drive motor Cassette Deck has a Time Remaining Counter with a digital readout that shows you how much recording time is left on a tape. So you won't run out of tape before running out of music. There's also an Index Scan feature that previews a tape by playing the first five seconds of each piece of music. And to give the CT-9R an incredible signal-to-noise ratio with extended high frequency response, Pioneer's engineers developed RIBBON SENDUST tape heads with laminations 4 to 5 times thinner than conventional Sendust heads. And only Pioneer has them.

Our new Quartz Synthesized F-9 Tuner has a Multipath Indicator that goes so far as to tell you when a signal is being reflected off nearby objects or buildings. So you can adjust

your antenna for the best reception. It can also memorize six of your favorite FM and six AM stations and retrieve them instantly. And to make sure every one always sounds its best, our engineers combined two of our exclusive ID MOSFET transistors in a Push-Pull Front End circuit. When you tune in a weak station there's no worry about stronger stations causing distortion

Pioneer's new components bring tangible as well as audible advances to high fidelity.



due to front end overload. And Quartz-PLL Synthesized tuning makes drift impossible.

Unique features on the new Pioneer A-9 Integrated Amp include a Subsonic Indicator. It lights up only when you need to use the Subsonic Filter to get rid of very low frequency interference caused by record warps and such. Inside, a new DC Servo circuit eliminates all capacitors from the signal path so they can't muddy up the signal.

That gives you a purer signal with superb definition.

Pioneer's SX-7 Receiver brings you precise electronic control of most functions including volume. The Auto Station Scan control pre-



views the entire band and eight FM and eight AM Memory Presets recall the stations you prefer instantly. What's more, Pioneer's patented Non-Switching amp does away with one of the most troublesome and audible forms of distortion — the noise generated when output transistors switch on and off thousands of times a second.

Our new top-of-the-line turntable, the Linear Tracking PL-L800 is another feat of human engineering. It features a linear motor that drives the tonearm across the track by electromagnetic repulsion — another Pioneer innovation. So it's extraordinarily quiet with no noisy belts, worm gears or pulleys and tracking error is virtually non-existent. The tonearm

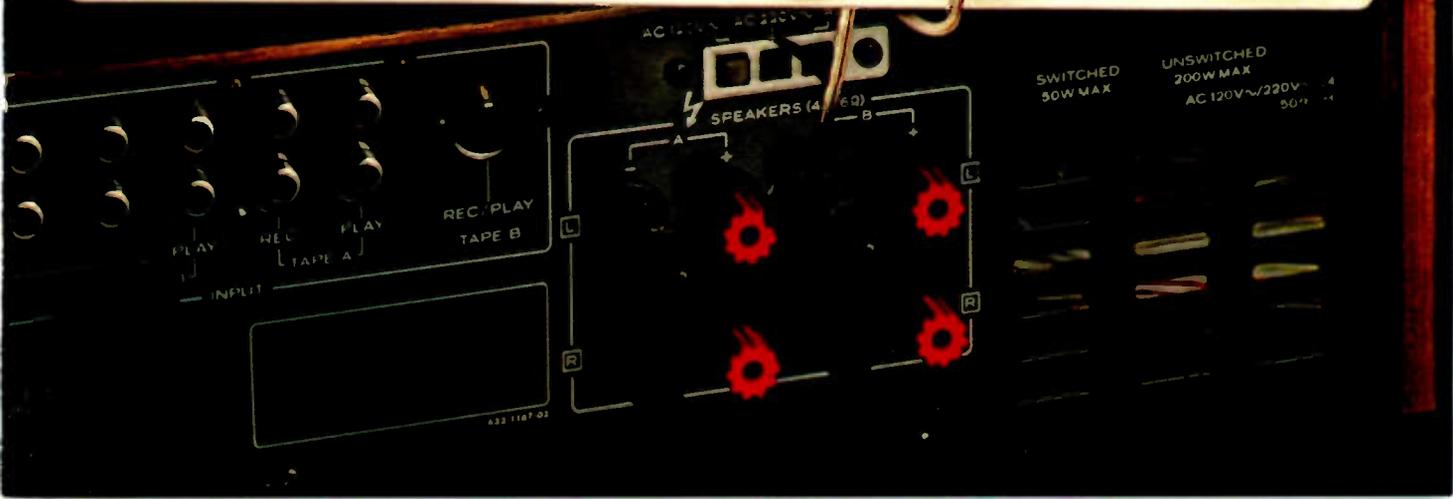
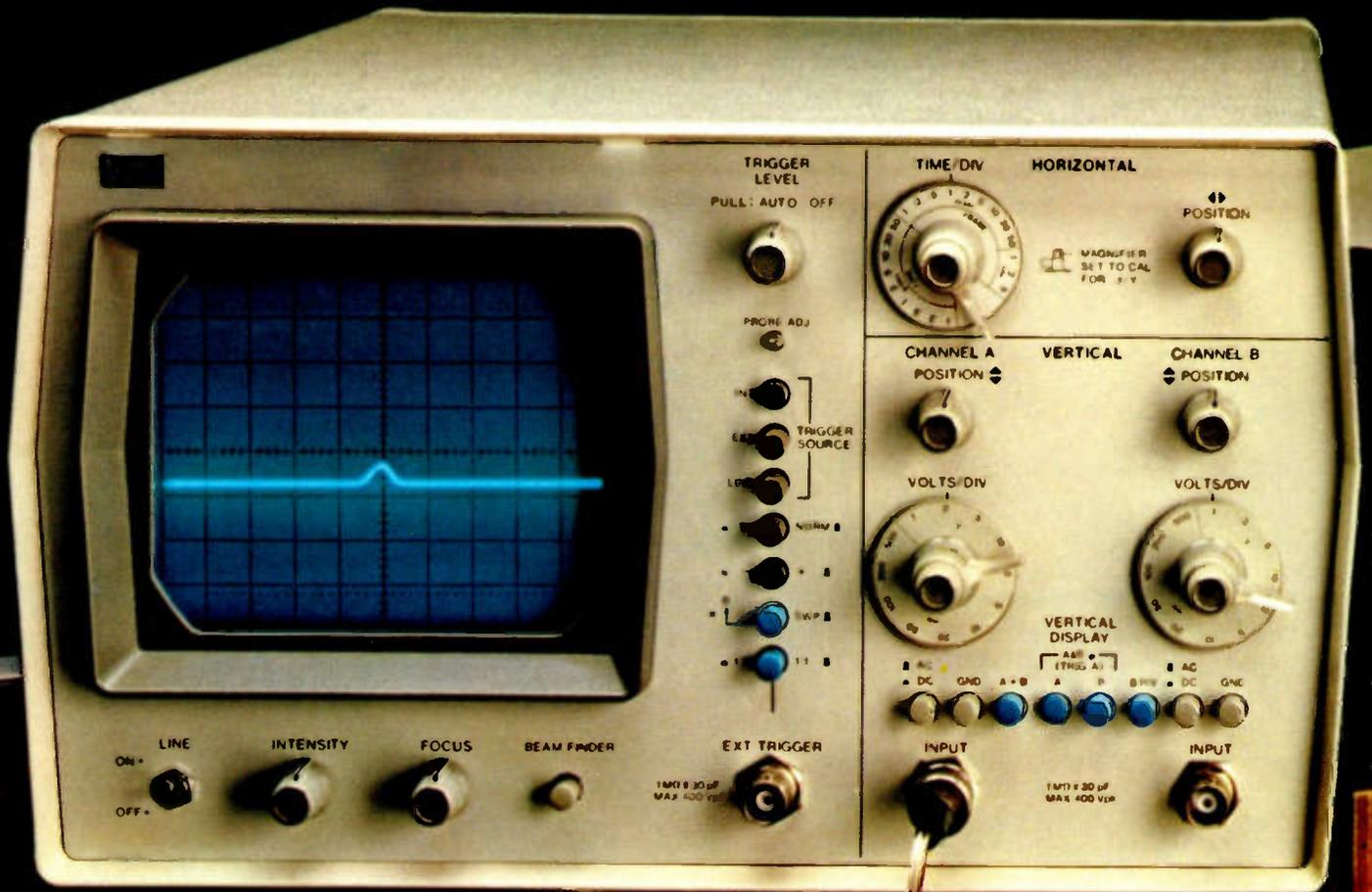
itself is made of Polymer Graphite — an amazing material that dampens resonance. And there's a coaxial suspension system that isolates the platter and tonearm assembly. These features combine to keep what's going on in the room around the turntable from becoming part of the music.

And all this is just the beginning. While the Pioneer concept of human engineering makes our components a pleasure to live with, Pioneer's innovative electronics and technology make them a pleasure to listen to. If you'd like to hear more, visit your nearby Pioneer dealer. You'll see and hear why Pioneer components are #1 with humans who care about music.

 **PIONEER**
WE BRING IT BACK ALIVE



EVERY YEAR, HI-FI COMPANIES MAKE MINOR IMPROVEMENTS IN THE STATE OF THE ART.





A NEW STANDARD OF RECORD CARE

DISCWASHER D4 SYSTEM



NEW D4 FLUID

Inherently more active against record contamination. Inherently safe for record vinyl. Preferentially absorptive formula carries all contamination off the record.

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The Cover Equipment: 1981 Saab Turbo 900 sedan, courtesy of William Baker, Sony car stereo gear includes one XR-70 AM/FM cassette, four XM-1 70-watt amps, two XE-9 equalizers, two XA-21 dual amp controllers, and 10 speakers. Total system value is \$2,519.30 plus installation, which was by Sounds Incredible, Cedarhurst, N.Y. The Cover Photographer: Robert Lewis.

Audio Publishing, Editorial and Advertising Production Offices, 1515 Broadway, New York, N.Y. 10036.

Subscription Inquiries, (800) 525-9511; in Colorado (303) 447-9330.

The best for both worlds

The culmination of 30 years of Audio Engineering leadership — the new Stereohedron®

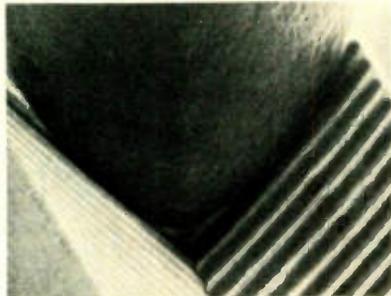
XSV/5000

One of the most dramatic developments of cartridge performance was the introduction of the Pickering XSV/3000. It offered the con-



sumer a first generation of cartridges, combining both high tracking ability and superb frequency response. It utilized a new concept in stylus design — Stereohedron, coupled with an exotic samarium cobalt moving magnet.

Now Pickering offers a top-of-the-line Stereohedron cartridge, the XSV/5000, combining features of both the XSV/3000 and the XSV/4000. It allows a frequency response out to 50,000 Hz.



The Exclusive Stereohedron Tip

The new XSV samarium cobalt magnet accounts for an extremely high output with the smallest effective tip mass. The Stereohedron tip design is the result of long research in extended frequency response for tracing of high frequency modulations. The patented Dustamatic® brush and stylus work hand in hand with the rest of the cartridge assembly to reproduce with superb fidelity all frequencies contained in today's recordings.

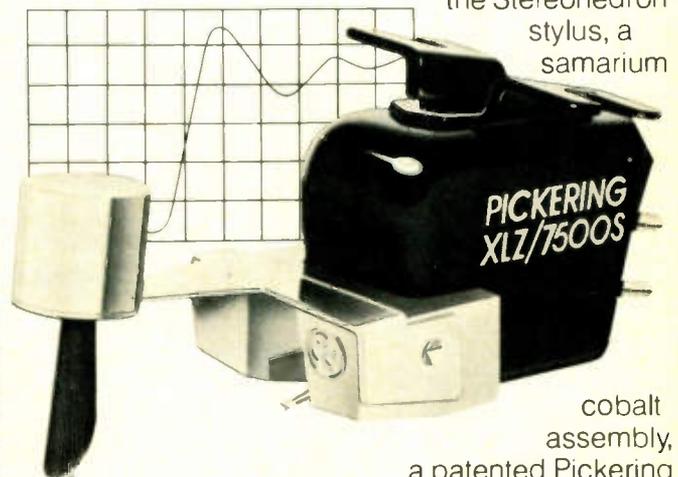
Pickering is proud to offer the XSV/5000 as the best effort yet in over 30 years of cartridge development.

A fresh new breakthrough in cartridge development designed specifically as an answer for the low impedance moving coil cartridge —

XLZ/7500S

The advantages of the XLZ/7500S are that it offers characteristics exceeding even the best of moving coil cartridges. Features such as an openness of sound and extremely fast risetime, less than 10 μ , to provide a new crispness in sound reproduction. At the same time, the XLZ/7500S provides these features without any of the disadvantages of ringing, undesirable spurious harmonics which are often characterizations of moving coil pickups.

The above advantages provide a new sound experience while utilizing the proven advantages of the Stereohedron stylus, a samarium



cobalt assembly, a patented Pickering

Dustamatic brush, with replaceable stylus, along with low dynamic tip mass with very high compliance for superb tracking.

So, for those who prefer the sound characteristics attributed to moving coil cartridges, but insist on the reliability, stability and convenience of moving magnet design, Pickering presents its XLZ/7500S.



"for those who can hear the difference"

Two new sources of perfection!

For further information on the XSV/5000 and the XLZ/7500S write to Pickering Inc., Sunnyside Blvd., Plainview, N.Y. 11803.

from Pickering



How to master tape.

Eventually, you reach a point where you just can't make the kind of quality tapes you want.

Even though your equipment may be the very finest.

If you've reached that point, you're ready for the dbx Recording Technology Series. Noise reduction systems that deliver a quality equal to studio master tapes.

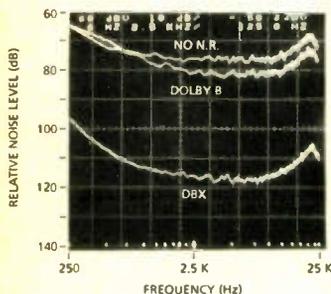
With a dbx Recording Technology Series Model 224 or 222, you can reduce noise by 30 dB across the entire frequency range. Add 10 dB more headroom. And make live recordings with 80 dB or more of dynamic range—remarkably close to a live performance.

There's one final touch. The dbx Recording Technology Series includes a built-in dbx Disc Decoder for playing the revolutionary dbx Discs and Digital dbx Discs, the world's first Full Dynamic Range Recordings.

Hear the dbx Model 224 and 222 at your authorized dbx retailer.

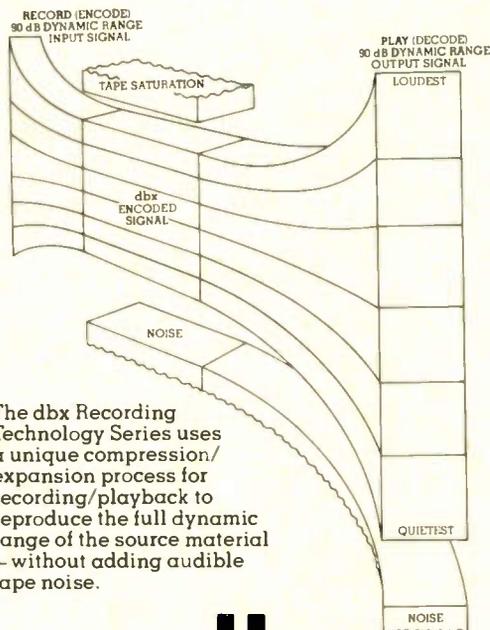
Short of buying your own recording studio, it's the only way to master tape.

dbx, Inc., 71 Chapel St., Newton, Mass. 02195 U.S.A. Tel. (617) 964-3210. Telex 92-2522. Distributed throughout Canada by BSR (Canada) Ltd., Rexdale, Ontario.



Dolby B reduces noise by only 10 dB in the high frequency range. dbx reduces noise by more than 30 dB across the entire frequency range. (Unretouched laboratory photograph. Data for cassette recorder from "The Importance of Dynamic Range," Audio Magazine, January, 1980. For a copy of the article, write dbx.)

*Dolby is a registered trademark of Dolby Laboratories, Inc.



The dbx Recording Technology Series uses a unique compression/expansion process for recording/playback to reproduce the full dynamic range of the source material—without adding audible tape noise.

Making good sound better **dbx**

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AUDIO (ISSN0004-752X) is published monthly by CBS Publications, The Consumer Publishing Division of CBS Inc., 1515 Broadway, New York, N.Y. 10036.

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Dewey Decimal Number 621.381 or 778.5

Editorial Contributions are welcomed but should be accompanied by return postage. Submitters will be handled with reasonable care, but the publisher assumes no responsibility for safety or return of manuscripts, photographs, or artwork.

Printed in U.S.A. at Columbus, Ohio. Controlled circulation postage paid at New York, N.Y. 10001 and additional mailing offices.

U.S. Subscription Rates: 1 year \$13.94, 2 years \$22.94, 3 years \$29.94

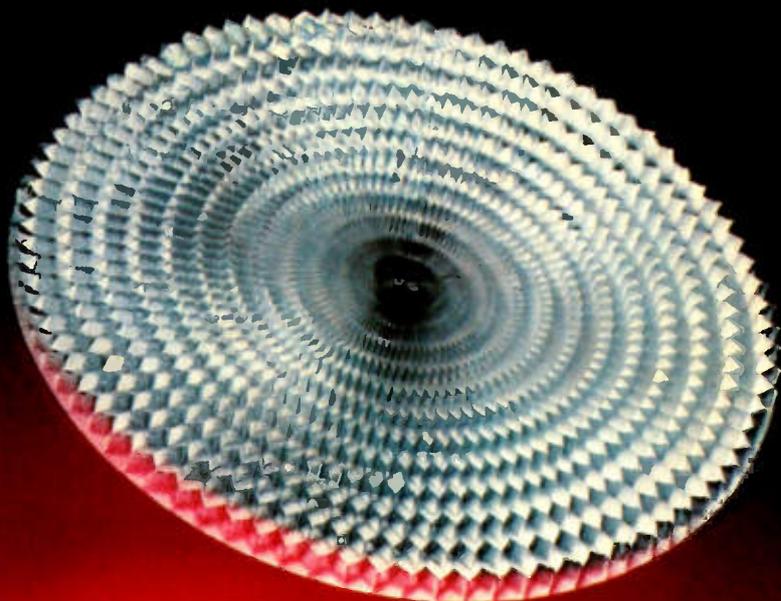
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Back Issues, when available, \$5.00 postpaid.

Audio Publishing, Editorial and Advertising Production offices, 1515 Broadway, New York, N.Y. 10036.

Audio Subscription Offices, P.O. Box 5318, 1255 Portland Place, Boulder, Colo. 80322.

Postmaster: Send Form 3579 to P.O. Box 5316, 1255 Portland Place, Boulder, Colo. 80322.



The anatomy of a breakthrough in sound reproduction. Technics Honeycomb Disc speaker system.

You're looking at the heart of a revolutionary new speaker system—the flat honeycomb drivers of Technics new Honeycomb Disc speakers. A new shape that takes sound beyond the range of traditional cone-shaped speakers to capture the full energy and dynamic range of today's new recording technologies. It's the essence of a true sonic breakthrough.

All conventional cone-shaped drivers have inherent distortion problems due to uneven sound dispersion in the cone cavity. But Technics new axially symmetric Honeycomb drivers are flat. So "cavity effect" is automatically eliminated. And just as important, phase linearity occurs naturally in Honeycomb Disc speakers because the acoustic centers are

now perfectly aligned across the flat driver surfaces.

Technics also added a unique nodal drive system designed to vibrate the speakers in more accurate piston-like motion to reduce distortion even further. The result is an incredibly wide, flat frequency response, broad dynamic range, and amazingly low distortion.

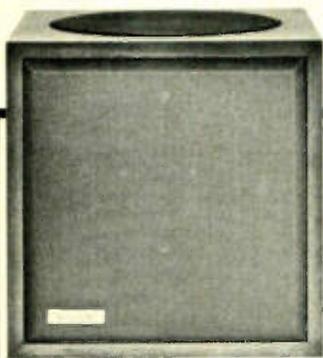
To complete the system, Technics Honeycomb Disc tweeter with special front-mounted acoustic equalizer extends frequency response to a remarkable 35 kHz.

Technics offers a complete new line of Honeycomb Disc speakers, all enclosed in a rich rosewood-grain cabinet.

Now that you've seen what a sonic breakthrough looks like, listen to Technics—and hear what one sounds like.

Technics
The science of sound
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Le Cube.



The **ALLISON:SIX™** is our smallest loudspeaker system. It is an 11-inch cube incorporating the Allison® Room-Matched® design principle.

While compact, the model Six is not a "mini" system in any sense. Its low-frequency output is flat to below 50 Hz with reasonable system efficiency. The highest audible frequencies are reproduced smoothly and dispersed uniformly by the same convex-diaphragm tweeter used in the most expensive Allison models. Allison Sixes are accurate, full-range loudspeaker systems, without allowance for size or price.

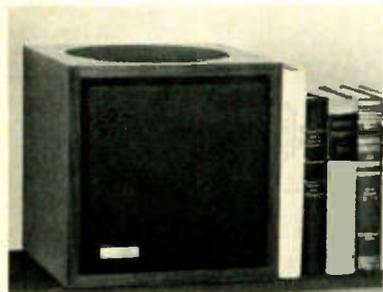
Revue du Son, in a feature review* said "La 'petite' Allison Six est une grande enceinte [loudspeaker]."

Full-range performance is possible from loudspeakers that can be used as bookends on an open shelf. The Allison Six costs \$160 with walnut grained vinyl cabinet and \$172 in black or white lacquer.

Descriptive literature, including complete specifications, is available on request.

For literature and information call (800) 225-4791 [in MA (617) 237-2670] or send coupon.

**Revue du Son*, No. 32 (November, 1979)



ALLISON ACOUSTICS

Seven Tech Circle/Natick, MA 01760, U.S.A.

Name _____

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TAPE GUIDE

HERMAN BURSTEIN

Limited Limiter

Q. My cassette deck has a limiter switch for recording. Am I better off using this switch and not worrying about recording level (assuming that I set it higher than I would otherwise), or should I always take the time to set the recording level accurately and leave the limiter switch off? — Name withheld.

A. For best results in recording, it is usually desirable to avoid use of a limiter and to carefully set recording level so that you will get maximum signal without noticeable distortion. However, if you are recording live material with strong transients, such as a guitar, you might obtain better results, in terms of a high signal-to-noise ratio without appreciable distortion, by using a good limiter. The real answer lies in experience. Try making recordings with and without the limiter. Some limiters do a fine job, while others make their presence felt.

Ohm Mike Goodness

Q. The instructions for my cassette deck recommend the use of mikes rated at 600 ohms to 10 kilohms, but add that "low impedance mikes with impedance of 150 to 600 ohms will also work satisfactorily." I do not quite know what to make of "satisfactorily." — Timothy Martyn, Glen Rock, N.J.

A. I believe it means that the mike will supply sufficient signal to drive the deck to full recording level. Some decks have a lot of reserve gain for recording from a mike, while others tend to be marginal in this respect. Apparently your deck is one of the former.

Reely Magnetic

Q. I have an open-reel tape deck. With a magnetometer I found an area of magnetism on the deck that is in the path of tape travel, between the heads and the take-up reel; I measured about ½-Gauss there. I also measured about ¼-Gauss at the heads and cannot remove this with a demagnetizer. — Erwin Specht, Cudahy, Cal.

A. So far as I know, it is difficult or impossible by ordinary means to remove all vestiges of magnetism from the heads, guides, or other metallic parts of a tape deck. If nothing else, it is claimed that the earth's magnetic field will produce some magnetism. Accordingly, the measurements you obtained seem relatively low.

Not Up to S/Nuff

Q. I recently bought an open-reel deck which sounds good except for an abundance of hiss. I had the unit tested by the manufacturer's service department, and it did quite well except for the signal-to-noise ratio, which was only 42 dB. I taped a record on my friend's machine of the same model and then played the tape on my deck. It sounded great, with barely noticeable hiss. Can you suggest any ways in which I could improve the S/N ratio? — Keith Bonn, Chappaqua, N.Y.

A. From your description it appears that the problem lies in the recording amplifier of your deck, for otherwise a tape recorded on another deck would not play quietly on yours. Inasmuch as your deck quite obviously does not come anywhere near the S/N ratio specified by the manufacturer, it seems your best and most direct course would be to have the company undertake whatever repair or replacement is required to bring it reasonably near to spec. If for some reason you cannot do this, consider checking the type and quality of transistors, the bias oscillator, the quality of resistors, and possibly the quality of capacitors.

If you are technically knowledgeable, you might try replacing the resistors in the early recording stages with good low-noise types, such as metallic film. Try to find out if there are equivalent but quieter transistors that can be used in the early recording stages.

A quite likely source of noise is distortion in the bias current; this is one of the places where one finds a marked difference between standard and high-quality tape decks. Slight amounts of distortion, too small to be seen on an oscilloscope, become apparent as noise in recording. This source of noise appears not only at the record head but also at the erase head, which is driven by the bias oscillator. A mismatch between resistors and/or between capacitors in the oscillator circuit could be responsible for distortion and noise, the oscillator transformer may be defective, and one final possibility is that magnetized heads and/or guides are producing noise. **A**

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.

WHY SPEND \$200 MORE ON A BETTER TAPE DECK WHEN ALL YOU NEED IS \$2 MORE FOR A BETTER TAPE.



No matter how much you spend on a tape deck, the sound that comes out of it can only be as good as the tape you put in it. So before you invest a few hundred dollars upgrading your tape deck, invest a few extra dollars in a new Maxell XLI-S or XLII-S cassette.

They're the newest and most advanced generation of oxide formulation tapes. By engineering smaller and more uniformly shaped oxide particles, we were able to pack more of these particles onto a given area of tape.

Now this might not sound exactly earth-shattering, but it can help your tape deck live up to its specifications by improving output, signal-to-noise ratio and frequency response.

Our new XLI-S cassettes also have an improved binder system, which helps keep the oxide particles exactly where they're supposed to be. On the tape's surface, not on your recording heads. As a result, you'll hear a lot more music and a lot less distortion.

There's more to our XLI-S tape than just great tape. We've also redesigned our cassette shells. Our new Quin-Lok™ Clamp/Hub Assembly holds the leader firmly in place and eliminates tape deformation. Which means you'll not only hear great music, but you'll also be able to enjoy it a lot longer.

So if you'd like to get better sound out of your tape system, you don't have to put more money into it. Just put in our new tape.

maxell
IT'S WORTH IT.

Maxell Corporation of America, 60 Oxford Drive, Manasquan, N.J. 08078Enter No. 4 on Reader Service Card

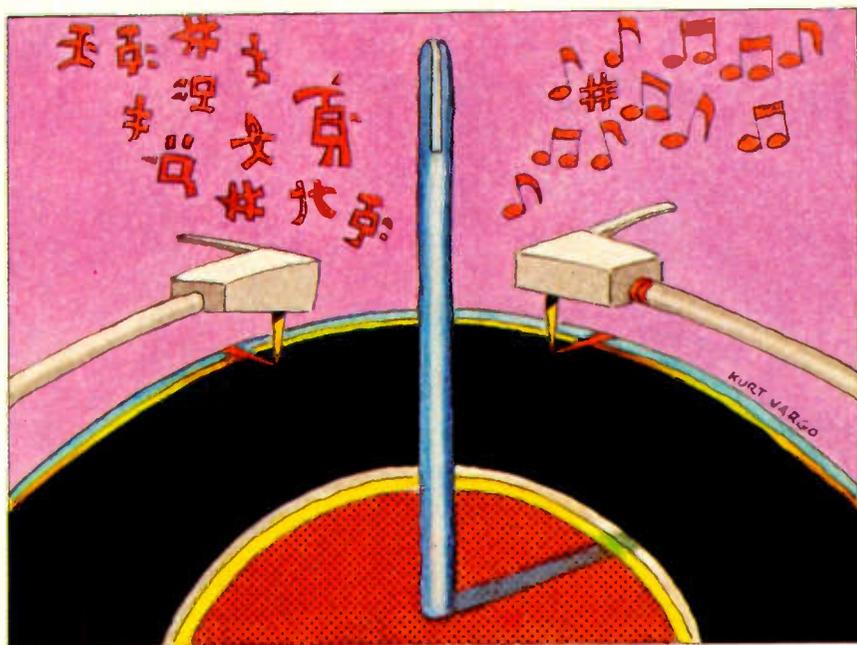
Some leftover business this month, which will lead me, with some pleasure, towards a few observations on the use of our remarkable native language. There's no recession in the growth of this useful commodity! The linguistic GNP continues to expand with astonishing ease, and we can only be glad that language isn't subject to economic conditions even though it is subject to fashion.

Some time back, I put aside the second of two new turntables from Japan, because, very simply, I am merely a music lover and cannot play two tables at once, nor house them. More specifically, the brand new JVC top-of-the-line OL-Y5F turns out to be about an inch deeper front to rear than the Sony PS-X75 of parallel vintage and so would not fit into my equipment cabinet. The Sony made it by a hair, so I started with it.

(For your instant info, the Sony measures 15-11/16 inches from rear to front, along the base of its containing cabinet, whereas the JVC measures a trace over 16 1/8 inches, almost precisely an inch deeper.)

You will remember that I was impressed with the ease and sureness of the Sony operation, in spite of being intimidated by its considerably bulky arm and the complexity of its automatic operations via linear motors. That impression has not changed. The "automatic everything" has not yet settled into easy familiarity (as happened to an earlier automated table I tried — for a brief while), and all is smooth and effective now that I no longer try to set the stylus tip down in mid-record via the automatic up-down and side-to-side arm controls. I just use my fingers.

The JVC OL-Y5F has a leaner, thinner, simpler look than the Sony in spite of the larger depth measurement and a sixteenth of an inch greater width. (Both tables are about the same overall height above their adjustable feet.) The thinner look is largely in the JVC arm which, unlike the Sony arm, does not contain elements of motor drive inside. There are two linear motors in this JVC model, one to the side of the arm at the pivot point and the other beneath the deck. The look is uncluttered, and I like it. Both these tables, being of the newest generation, have characteristics in common, not only the linear motors to do the pushing and pulling and lifting and, more



significantly, the "pressurizing," the downward force at the stylus tip, but also in the outboard controls, ranged along the front shelf-like projection so that they can be reached even when the machine is in operation with the dust cover closed. Lots of simultaneous similarities.

And yet — differences. Once again, this is no lab report, just a musical user's observation, and music listeners tend to ignore the inner technical details so long as the machine works. I gave the JVC table to my brother for a couple of months, and then asked him how had things gone — anything special? "Special?" he asked, "I don't know what you mean. It works. And the sound is wonderful." That's absolutely all I could get out of him. (I'd hoped for at least some sort of revealing problem!) So the differences will have to be my own accounting. They do go beyond the mere dimensions and looks.

JVC, too, has the new automated stylus placement buttons, up/down and side to side, and they work very well, I must say at once.

In the process of shifting these tables around and between cartridges, I discovered something curious. Both tables have the electronically applied skating and tracking force adjustments combined in one control. (On Sony it is outside the dust cover where it can be ad-

justed neatly as the record plays. On JVC it is inside, next to the arm and less convenient, though it still can be adjusted during play.) What has been overlooked, evidently, is that some cartridges require just a bit more anti-skating force, perhaps a quarter gram, than tracking force to produce absolute lowest level of distortion.

Perhaps you see the problem. On "conventional" tracking and anti-skate force adjustments, via weights or spring tension, one merely follows the directions, adjusting each force to optimum. Easy enough. But what if the stylus force and the sidewise skating force are combined in one electronic control? The thought was good: Skating force does normally vary in step with stylus force, and the two can be integrated neatly for a single control. (Remember the early skating force arrangements — still current, I think — via pulleys, cords and dangling weights?) But this does not allow for the different adjustments!

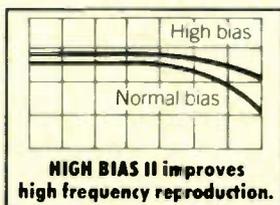
At the moment the JVC has a Shure in it and this, the V15 Type IV, has the small carbon fiber brush out front. It has caused less trouble simply because the adjustment for the brush is less, or so I figure it. But, even so, there is a nagging thought in my mind that JVC is perhaps bearing down a bit too hard on one side of my grooves, if not by much.



If you think "high bias" is discrimination against tall people, you're not ready for New Memorex.

High bias tape is specially formulated to deliver remarkably improved sound reproduction, particularly in the higher frequencies.

And no high bias tape does that better than totally new Memorex HIGH BIAS II.



We've developed a unique new formulation of superfine ferrite crystal oxide particles. And while that's a mouthful to say, it delivers an earful of results.

Singers ring out more clearly. Snare drums snap and cymbals shimmer with startling crispness.

Even quiet passages sound clearer. Because new Memorex

HIGH BIAS II has 4 to 5 dB lower noise. Which means dramatically reduced tape hiss.

And thanks to Permapass™, our extraordinary new binding process, the music you put on the tape stays on the tape. Play after play, even after 1,000 plays.

In fact, new Memorex will always deliver true sound reproduction. Or we'll replace it. Free.

Of course, we didn't stop once we made new Memorex sound better. We also made it work better. By improving virtually every aspect of the cassette mechanism.

We even invented a unique fumble-free storage album.

So trust your next recording to

new Memorex. In HIGH BIAS II, normal bias MRX I or METAL IV.

As a discriminating tape user, you'll have a high opinion of the results.

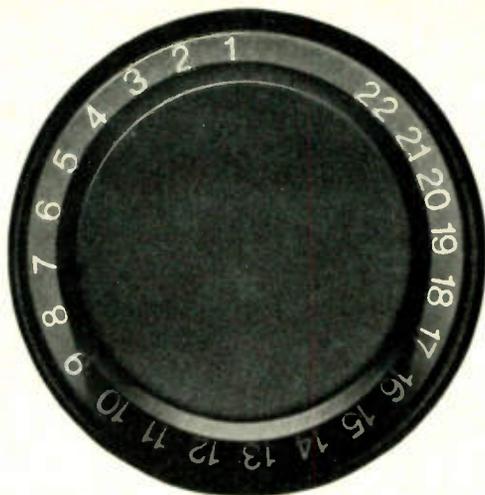
A highly biased opinion, that is.



NOW MORE THAN EVER
WE ASK: IS IT LIVE, OR IS IT

MEMOREX





If If everything were perfect . . . a control unit would consist of a volume control and a program selector switch.

Unfortunately this is not the case as any prospective high fidelity buyer—be he neophyte or hardened campaigner—quickly discovers.

everything He is faced with a choice

He can attempt to sift the vast quantities of conflicting information gathered from high fidelity magazines, retailers and "my friend who is an electronics engineer and knows quite a bit about high fidelity" . . .

were . . . or he can buy a Quad 44.

In the latter case he can be confident that whatever the program sources, he will be able to match them correctly, and apply tonal correction when necessary to obtain optimum results.

perfect... Moreover he can be confident that he need not change his preamplifier to meet future developments.

To learn all about the Quad 44 he only has to write for a brochure and a list of authorized dealers:

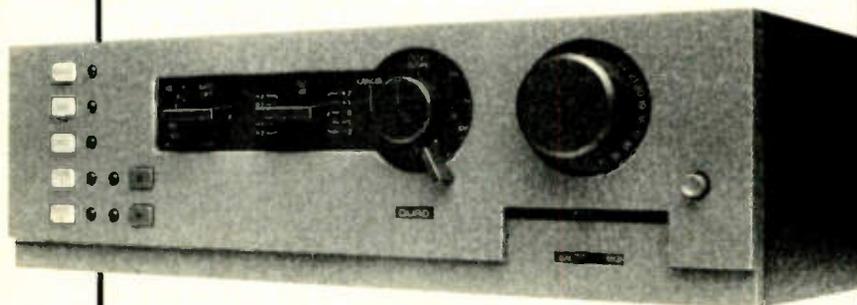
QUAD
425 Sherman Avenue
Palo Alto, CA. 94306

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QUAD 

for the closest approach
to the original sound

QUAD is a registered trademark.



I must publicly admire one JVC technicality, of considerable usefulness in the way of resonance and tracking — "Q damping."

I must publicly admire one JVC technicality, of considerable usefulness in the way of resonance and tracking, incorporating what is called "Q damping." This arm's linear motors actually respond to wows and warps by pushing momentarily harder, up or down, side-wise-in or sidewise-out, in order to resist the inertial tendency of the arm and cartridge to keep on going in the same direction, especially at any resonance point. There is, JVC says, virtually no effective resonance between cartridge stylus and arm mass with this overall electronic system at work, the "Electro-Dynamic Servo Tone Arm," as it is called. So — superb tracking of all irregularities and a smoother, better sound. I'll have to add that, with a different complexity of control, the Sony arm system also tracked and sounded remarkably well, or good, as the case may be. No use my trying to account for these effects in detail, which belong in an Equipment Profile. Just be advised — these tables work, just as my brother said.

I believe in the growth and fluidity of our language, dictionaries or no. They are only self-appointed monitors; they try to pin down usage at a given point and thus are always out of date. (Much more important is the background and derivation of our words that dictionaries give us, so we may judge for ourselves.) Thus, a correspondent recently chided me for my many uses of "via," citing dictionary chapter and verse and the correct substitutions. In almost every case, his version was three or four times longer than my "via" and no clearer. So I will continue "via" whenever it is useful in the context.

Similarly, when I say "stylus" — when you order one at your dealer's — you can assume more than a near-invisible diamond tip or point. "Stylus and cantilever assembly" still does not include the normal slide-in surround elements. So — stylus! Why not? In the appropriate context, we know what is meant. But there can, of course, be confusion. In my discussion of the Micro Acoustics phono cartridge Series II, I spoke of the stylus in the latter sense but also, confusingly, mixed up the action of the beryllium cantilever, the stylus bar, which I said "bent" up into the housing. No, it does NOT bend! It is rigid, but pivoted. *Mea culpa*. Apologies. 

Bob Carver tells you (briefly) how Sonic Holography works. (Others tell you how it sounds.)



Q. Exactly what is Sonic Holography?

A. It's a term I use to point up the similarity of the sonic illusion that enables one to hear a stereo recording in three dimensions and the optical holographic illusion that allows one to see a flat photograph in three dimensions.

Q. What does Sonic Holography sound like?

A. I'll let others answer that for me. Hal Rodgers, Senior Editor of Popular Electronics: "When the lights were turned out we could almost have sworn that we were in the presence of a real live orchestra."

Julian Hirsch of Hirsch-Houck Labs: "The effect strains credibility—had I not experienced it, I probably would not believe it...the 'miracle' is that it uses only the two normal front speakers."

Larry Klein, Technical Director of Stereo Review: "...it brings the listener substantially closer to that elusive sonic illusion of being in the presence of a live performance."

And High Fidelity put it this way: "...seems to open a curtain and reveal a deployment of musical forces extending behind between and beyond the speakers...terrific."

Q. How many speakers are needed for Sonic Holography?

A. Just your usual two. But for optimum Sonic Holography, the speakers *must* be equidistant from the listening position and somewhat closer together than is usually required for stereo.

Q. What do I hear when I'm not in the middle?

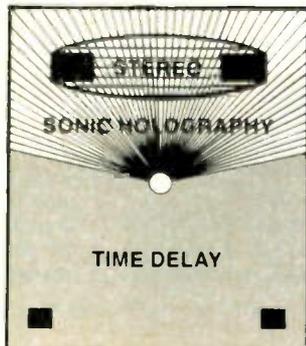
A. We'll let Julian Hirsch describe what he heard: "still noticeably better than normal stereo—particularly in respect to a greater sense of 'warmth' such as is experienced in a concert hall."

Q. How is Sonic Holography achieved?

A. The technology is fairly complex, involving acoustic, psychoacoustic and electronic factors. Using standard stereo program sources—discs, tapes, FM broadcasts—the Sonic Hologram Generator recreates the spatial information of the original recording that is all but lost during normal stereo presentation.

Carefully calculated and controlled psychoacoustic crosstalk cancellation techniques expand the sonic image beyond its normally confined area between the two speakers and deploy instruments and voices naturally in front of the listener over a broad deep arc.

Sonic Holography does not create this illusion artificially, but rather lets the listener hear fully for the first time the phase and timing information on the original recording that up till now could not be heard.



That's why Larry Klein described Sonic Holography in Stereo Review as producing "a far more plausible sonic illusion of space and localization than is produced by normal stereo."

Q. Isn't Sonic Holography something like time delay?

A. No. Sonic Holography takes the normal stereo signal and feeds it through the normal two speakers in a

way that recreates the actual locations of instruments and voices throughout the front hemisphere where they were originally "heard" by the microphones.

Time delay, on the other hand, feeds the stereo signal through additional amplifiers and rear speakers in a way that recreates only the spatial ambience of the original recording environment.



Q. How can I add Sonic Holography to my system?

A. Three different ways.

1. The C-4000 Control Console includes the Sonic Hologram Generator plus a full-function stereo preamplifier, a time-delay system with built-in 40 watt (total) power amplifier for time delay speakers, the Autocorrelator system that reduces noise up to 8 dB with any source material and a peak unlimited downward expander that nearly doubles dynamic range.
2. The C-1 combines the Sonic Hologram Generator with a full-function preamplifier.
3. The C-9 Sonic Hologram Generator allows you to add Sonic Holography to any system, including one with a receiver.

Q. How can I get more information?

A. Easily. Just write to us.

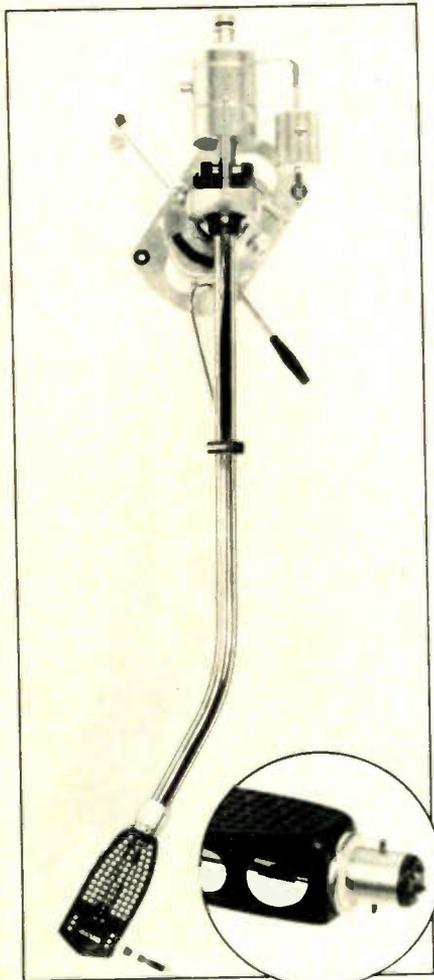
CARVER
CORPORATION

PO Box 664 14034 NE 193rd Place Woodinville Washington 98072

Enter No. 6 on Reader Service Card

SME

MODEL 3012-R



Manufacture of the Model 3012 Series 11 12" (16" US nomenclature) precision pickup arm ended in 1972. In response to many requests to re-introduce it for professional and hi-fi applications we have produced the Model 3012-R. It is basically similar to its classic predecessor but with important refinements including:

- Thin walled stainless steel tone-arm.
- New design lateral balance system.
- Extra rigid low mass shell with double draw-in pins.
- Fine adjustment longitudinal and lateral balance for cartridges weighing from 1½-26 grams or plug-in heads up to 33½ grams.
- Geometry optimised for 12" records.

Distortion caused by lateral tracking error is at least 25% less than is possible with a 9" arm and its effective mass of 14 grams makes it particularly suitable for the many medium and low compliance cartridges now on the market.

The S2-R shell supplied with it is another SME 'first' in heavy gauge aluminium with pin-up and pin-down bayonet for positive locking. The sockets of all SME arms employing detachable shells are double slotted and therefore compatible with this design.

Full details will be sent on request.

Write to Dept 1464
SME Limited, Steyning, Sussex, BN4 3GY,
England

Enter No. 7 on Reader Service Card

AUDIOCLINIC

JOSEPH GIOVANELLI

Encode for Encode

Q. I recently purchased a dbx 224 noise-reduction unit, and I'm quite pleased with its performance. I live in an area where there are two full-time classical radio stations. These stations, however, are not enjoyably poor S/N ratio at my location. Why can't they, or any FM station for that matter, encode their transmitted signal using the dbx II-type noise reduction? The signal-to-noise ratio would improve markedly, and the stations would not have to worry about compressing their signal to stay within the 100-percent modulation limit.

Would there be FCC red tape or problems with systems whose owners do not have the proper decoder device? — Bill Bushnell, Palo Alto, Cal.

A. It would not be practical to encode FM stations with dbx II. The compatibility problem which you have mentioned would be too great. So that you will understand this more fully, I suggest that you listen to an encoded dbx recording, but without decoding it. I think you will see immediately that many listeners who are not equipped with the dbx decoder would find it impossible to listen to such compressed programs.

The FCC is, and rightly so, concerned with compatibility of any device used for the transmission of FM. The majority of FM radios today are not equipped with anything for special decoding of signals, except for stereo and possibly Dolby noise reduction. It would be unthinkable to begin broadcasts which only a relative few could receive. This holds for any new approach to FM broadcasting. *Compatibility must be maintained, regardless of the merits of the system.*

About Phase

Q. I have read that some preamplifiers and power amplifiers invert phase. How significant is this? My preamplifier does invert phase; my power amplifier is unspecified but I suppose it may do so. I have made sure that my loudspeakers are properly connected to the power amplifier. Is my system nevertheless operating out of phase? Why wouldn't the manufacturer see to it that his equipment is built so as not to invert the phase? — Tom Soledad, Maple Shade, N.J.

A. When a piece of equipment is said to have its phase inverted, this means that there is 180 degrees of difference

or phase change between the input and output of the device. This 180-degree phase shift will occur on both the left and right channels of a piece of stereo gear. It would not mean, however, that one channel would be inverted and the other not be inverted. Therefore, the two outputs of a stereo device, while possibly being out of phase with the device's inputs, would nonetheless be in phase with each other.

When speakers are properly connected to a system in which some components contain phase inversion and some do not, the result is that the two loudspeakers are still in phase with each other. However, they may not be in phase with the input, and thus an initial overpressure or "pop" from, for example, a drum may be reproduced as an initial underpressure. Careful listening under double-blind conditions has recently shown that this situation is reliably audible.

Generally, little attention has been paid to this aspect of phase response — keeping a positive-going wavefront at the mike positive-going as it comes from the loudspeaker. In amplifier designs, it is sometimes more desirable to have the unit invert the signal from input to output, while in other designs it is more desirable to have the circuitry be noninverting. One type can be changed to the other by the addition of a pair of transistors and some other components, but generally manufacturers have not seen the need to go to this extra trouble and expense.

One instance where phase relationships might be upset occurs in a biamp or triamp system. Assuming that an inverting stereo amp is used for the mid-range of a triamp system and noninverting amps are used for bass and treble, there would be obvious phase problems, particularly at the crossover points.

Another situation occurs where various pieces of equipment are being combined in a mixer. If some of the devices going into the mixer invert phase and the rest do not, there is a good chance that some of the signals being mixed will be cancelled during the process. ▲

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



TDK brings two new standards to open reel.

Raising sound standards is nothing new to TDK. For years, TDK cassettes have set reference standards in metal and high bias. Now TDK announces two breakthroughs in open reel—GX and LX. Both are formulated to be fully compatible with your present system. You don't have to rebias to appreciate them.

TDK GX Studio Mastering tape handles the most critical demands of live music mastering beautifully. TDK's new ultra refined ferric oxide particle gives GX superior MOL, low distortion and a wide dynamic range. Equally impressive is TDK LX. Its super refined particle gives it high performance with low noise and low distortion throughout an extended frequency range. LX is ideal for both professional and audiophile use.

The refinements don't stop with the

formulations. A unique calendaring and binding process rivets the particles to the tape surface, making dropouts practically a thing of the past. A special graphite and carbon backcoating, found on all GX and most LX tapes, reduces friction for the smoothest possible winding. At the same time, it prevents static discharge and reduces wow and flutter.

These high standards are carried through to the newly designed 10" metal and 7" plastic reels. Each has a separately molded hub and flange to ensure circularity and high strength. If you think open reel has gone as far as it can go, listen to the finest. TDK GX and LX. They could open up a whole new standard of recording excellence.



7th ANNUAL CAR STEREO DIRECTORY

The following specifications, which were provided by the manufacturers listed, indicate that a growing number are following the IHF's A-202 amplifier measurement standard, a method which shows the interrelation of power output, bandwidth, distortion level, and load. For addi-

tional specifications and discussion of features, readers are invited to contact the manufacturer at the address listed. An Addenda will follow in the January 1982 issue, together with the Addenda to the Annual Equipment Directory.

INDEX OF MANUFACTURERS

A

Adcom
9 Jules Lane
New Brunswick, N.J. 08901

ADS
One Progress Way
Wilmington, Mass. 01887

Aiko
See TZL International

Altec Lansing
1515 South Manchester St.
Anaheim, Cal. 92803

American Audio Corp.
Mobile Sound Div.
636 Forbes Blvd.
South San Francisco, Cal.
94080

Avid Corp.
10 Tripps Lane
East Providence, R.I. 02914

B
Blaupunkt
See Robert Bosch Sales

Bon Sonic
See Hanabashiya

Robert Bosch Sales Corp.
2800 South 25th Ave.
Broadview, Ill. 60153

Bose Corp.
100 The Mountain Rd.
Framingham, Mass. 01701

C
Car Tapes Inc.
1000 East Del Amo Blvd.
Carson, Cal. 90746

Cerwin-Vega
12250 Montague St.
Arleta, Cal. 91331

Clarion Corp.
5500 Rosecrans Ave.
Lawndale, Cal. 90260

D

Dahlquist
601 Old Willets Path
Hauppauge, N.Y. 11787

E
EPI
Epicure Products
25 Hale St.
Newburyport, Mass. 01950

Evadin
See TZL International

F
Fujitsu Ten Corp.
19281 Pacific Gateway Dr.
Torrance, Cal. 90502

Arthur Fulmer
122 Gayoso
Memphis, Tenn. 38101

H
Hanabashiya Ltd.
39 West 28th St.
New York, N.Y. 10001

I
Infinity Systems
7930 Deering Ave.
Canoga Park, Cal. 91304

J
Jensen
4136 North United Pkwy.
Schiller Park, Ill. 60176

Jet Sound
See Car Tapes Inc.

JVC
41 Slater Dr.
Elmwood Park, N.J. 07407

K
Kenwood
1315 E. Watsoncenter Rd.
Carson, Cal. 90745

Kraco Enterprises
505 East Euclid Ave.
Compton, Cal. 90224

L

Linear Power
11545 D Ave.
Auburn, Cal. 95603

M
Marantz
20525 Nordhoff St.
Chatsworth, Cal. 91311

Matrex Electronics
805 Woodman Ave.
Winslow, Ill. 61089

Mini-Amp Corp.
10407 Los Alamitos Blvd.
Los Alamitos, Cal. 90720

Mitsubishi
3030 East Victoria St.
Compton, Cal. 90221

Mobile Audio Development
P.O. Box 7338
Arleta, Cal. 91331

N
Numark Electronics
P.O. Box 493
Edison, N.J. 08818

O
Oaktron Industries
1000 30th St.
Monroe, Wisc. 53566

P
Panasonic
One Panasonic Way
Secaucus, N.J. 07094

Peerless Audio
40 Jytek Dr.
Leominster, Mass. 01453

Pioneer
1925 East Dominguez St.
Long Beach, Cal. 90810

Polk Audio
1205 South Carey St.
Baltimore, Md. 21230

Pyle Industries
501 Center St.
Huntington, Ind. 46750

Q
Quam-Nichols
234 East Marquette Rd.
Chicago, Ill. 60637

R
Radio Shack
14001 Tandy Center
Fort Worth, Tex. 76102

Rockford-Fosgate
328 South Rockford Dr.
Tempe, Ariz. 85281

RTR Industries
8116 Deering Ave.
Canoga Park, Cal. 91304

S
Sanyo
1200 West Artesia
Compton, Cal. 90220

Sony
9 West 57th St.
New York, N.Y. 10019

Soundmates
796 29th Ave., S.E.
Minneapolis, Minn. 55414

Sparkomatic Corp.
Routes 6 and 29
Milford, Pa. 18337

T
TZL International
1523 N.W. 79th Ave.
Miami, Fla. 33126

V
Visonik
701 Heinz St.
Berkeley, Cal. 94710

Z
Zapco
Zeff Advanced Products
2135 Stone Ave
Modesto, Cal. 95351



Blaupunkt CR-3001

7TH ANNUAL CAR STEREO DIRECTORY

RADIOS/TAPE PLAYERS

MANUFACTURER	Model	Price, \$	Stereo (S), Mono (M), or L-Channel (L)	FM Sensitivity (µV) (For 30-dB Overloading)	Selectivity, dB	Preamp Output?	Average Watts/Channel, per IEC #202	Amplifier S/N Ratio, dB	% THD at Rated Output	Local/Distance Switch?	Number of Presets	Separate Tone Controls?	Cassette (C), 8-Track (8)	Auto Reverse?	Dolby B/N?	Bias/EO Switch?	Fast Tape Speeds?	4-Speed (U), Under-Drive (UL), Convertible (U/L)	Dimensions, Inches	
AIKO	ACS 4500	79.95	S	7	45	No	6	45	3	Yes	0	Yes	C	No	No	No	Yes	I	6 1/2 x 7 1/2 x 2 1/2	
	ACS 9000	139.95	S	9	50	No	4.5	43	2	Yes	0	Yes	C	No	No	No	Yes	I	1 1/2 x 7 x 6 1/2	
AMERICAN AUDIO CORP.	4700 Geneva	299.95	S	3.162	50	No	16	40	10.0	No	0	EQ	C	Yes	No	No	Yes	I	1 1/2 x 5 1/2 x 7 1/2	
	3705 Munich	199.95	S	3.162	50	No	6	40	10.0	No	5	No	C	Yes	No	No	Yes	I	1 1/2 x 5 1/2 x 7 1/2	
	3600 Vienna	142.95	S	3.162	50	No	6	40	10.0	No	0	No	C	Yes	No	No	Yes	I	1 1/2 x 5 1/2 x 7 1/2	
	3505 San Francisco	188.95	S	3.162	50	No	6	40	10.0	Yes	5	No	C	Yes	No	No	Yes	I	2 x 5 1/2 x 7 1/2	
	2500 Zurich	136.95	S	3.162	50	No	6	40	10.0	No	0	No	C	Yes	No	No	Yes	I	1 1/2 x 5 1/2 x 7 1/2	
	2405 Chicago	159.95	S	3.162	50	No	6	40	10.0	Yes	5	No	C	No	No	No	Yes	I	2 1/2 x 7 1/2 x 4 1/2	
	1705 Seattle	104.95	S	3.162	50	No	6	40	10.0	No	0	No	C	No	No	No	Yes	I	1 1/2 x 4 1/2 x 7 1/2	
	1100 Florence	94.95	S	7.943	50	No	6	40	10.0	Yes	0	No	C	No	No	No	Yes	I	1 1/2 x 4 1/2 x 7 1/2	
	505 St. Louis	37.95	S			No	6	40	10.0				C	No	No	No	Yes	U	2 x 6 1/2 x 4 1/2	
	2255 Atlanta	146.95	S	3.162	50	No	6	40	10.0	Yes	5	No	B				No	I	2 1/2 x 4 1/2 x 7 1/2	
	1655 Dallas	99.95	S	7.943	50	No	8	40	10.0	Yes	0	No	B				No	I	1 1/2 x 4 1/2 x 7 1/2	
	6000	249.95	S	3.162	50	Yes	16	40	10.0	Yes	0	EQ	C	No	No	Yes	Yes	U	Component system.	
5300	159.95	S	3.162	50	No	6	40	10.0	No	5	EQ	C	No	No	No	Yes	U	1 1/2 x 4 1/2 x 6 1/2		
Osaka																				
5100 Kyoto	109.95	S	3.162	50	No	6	40	10.0	No	0	No	C	No	No	No	Yes	I	1 1/2 x 4 1/2 x 8 1/2		
BLAUPUNKT	Berlin 8000	1395.00	S	19dBf	80	Yes	18x4	56		7	Yes	C	Yes	Yes	Yes	Yes	Yes	I	2 x 7 x 5 1/2	
	CR-2000	275.00	S	19dBf	70		14x4	53	1.0	Yes	Yes	C	Yes	Yes		Yes	I	1 1/2 x 7 x 5 1/2		
	CR-3001	630.00	S	19dBf	70	Yes	18x4	53	1.0	Yes	12	C	Yes	Yes	Yes	Yes	I	2 x 7 x 5 1/2		
	Frankfurt	218.00	S	19dBf	70		5	5	1.0	Yes	6	C	Yes	Yes		Yes	I	1 1/2 x 7 x 5 1/2		
	CR-2001	350.00	S	19dBf	70		7 1/2	53	1.0	Yes	5	C	Yes	Yes	Yes	Yes	I	2 x 7 x 5 1/2		
	CR-4000	344.00	S	19dBf	70	Yes	7x4	53	1.0	Yes	5	C	Yes	Yes	Yes	Yes	I	2 x 7 x 5 1/2		
	CR-5001	450.00†	S	19dBf	70	Yes	15x4	54	1.0	Yes		Yes	C	Yes	Yes	Yes	Yes	I	2 x 7 x 5 1/2; †\$30.00 with amp.	
BON SONIC	008		S			No			0.1	Yes		C/B						I/U		
	R560B		S			No			0.1	Yes		C	Yes					I		
	1011		S			No			0.1	Yes	5	C	Yes					I		
	103		S	30		No			0.1	Yes		C	Yes					I		
	6011		S			No	4.5		0.1	Yes		8						I	7 x 2 x 4 1/2	
	201		S			No			0.1	Yes		8						I		
433AF		S			No	6		0.1	Yes		C						I	7 x 2 x 4 1/2		
R455		S			No	7		0.1	Yes		C	Yes					I	7 x 1 1/2 x 5 1/2		
BOSE	CRC	449.95	S	19dBf	55	Yes			0.4	Yes	12	Yes	C	Yes	Yes	Yes	Yes	I	7 x 5 1/2 x 2 1/2	
CLARION	PE959A	899.95	S	14dBf	70	Only			Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I	2 x 7 1/2 x 5 1/2	
	PE751C	299.95	S	15dBf	70	Yes	12	55	5.0	Yes	5	Yes	C	Yes	No	Yes	Yes	I	2 x 7 1/2 x 8 1/2	
	PE785A	224.95	S	15dBf	70	No	2.8	55	5.0	Yes	5	No	C	Yes	No	Yes	Yes	I	2 x 7 1/2 x 5 1/2	
	PE550A	224.95	S	14dBf	70	Yes	2.8	55	5.0	Yes		No	C	Yes	Yes	No	Yes	I	2 x 7 1/2 x 8 1/2	
	PE962A	449.95	S	14dBf	70	Only			Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I	2 x 7 1/2 x 5 1/2	
	PE768A	249.95	S	15dBf	70	Yes	2.8	55	5.0	Yes	5	No	C	Yes	No	Yes	Yes	I	1 1/2 x 7 x 5 1/2	
	PE572A	199.95	S	15dBf	70	No	2.8	55	5.0	Yes		No	C	Yes	No	No	Yes	I	1 1/2 x 7 x 5 1/2	
	PE869A	249.95	S				10	55	5.0			Yes	C	Yes	Yes	Yes	Yes	I/U	2 x 5 1/2 x 8 1/2	
EVADIN	CR 3010	119.95	S	7	50	No	6	45	3	Yes	0	Yes	C	Yes	No	No	Yes	I	1 1/2 x 7 x 5 1/2	
	CR 6000	159.95	S	9	50	No	8	50	1.5	Yes	5	Yes	C	Yes	No	No	Yes	I	7 x 2 1/2 x 8 1/2	
FUJITSU TEN	DP-1000	129.95	S	22 dBf	64	No	4			Yes	0	No	C	No	No	No	Yes	I	1 1/2 x 4 1/2 x 8 1/2	
	DP-1008	149.95	S	22 dBf	64	No	4			Yes	0	Yes	C	No	No	No	Yes	I	1 1/2 x 4 1/2 x 8 1/2	
	GP-1010	189.95	S	22 dBf	64	No	4			Yes	5	No	C	No	No	No	Yes	I	1 1/2 x 4 1/2 x 8 1/2	
	DP-7872	175.00	S	20 dBf	64	No	5			No	0	No	C	Yes	No	No	Yes	I	1 1/2 x 5 1/2 x 7	
	DP-7874	169.95	S	20 dBf	64	Yes				No	0	No	C	Yes	No	No	Yes	I	1 1/2 x 5 1/2 x 7	
	GP-7881	250.00	S	20 dBf	64	Yes	5			Yes	5	Yes	C	Yes	Yes	No	Yes	I	2 1/2 x 5 1/2 x 7 1/2	
	CR-1030	239.95	S	20 dBf	64	No	5			No	5	No	C	Yes	No	Yes	Yes	I	1 1/2 x 5 1/2 x 7	
	CR-1130	299.95	S	20 dBf	64	No	16			No	5	Yes	C	Yes	Yes	Yes	Yes	I	1 1/2 x 5 1/2 x 7	
	EP-820	599.95	S	20 dBf	64	Yes				Yes	10	EQ	C	Yes	Yes	Yes	Yes	Yes	I	2 1/2 x 8 1/2 x 7
	DP-620	150.00	S	20 dBf	64	No	5			No	0	No	C	Yes	No	No	Yes	I	1 1/2 x 5 1/2 x 7	
	DP-640	184.95	S	20 dBf	64	No	5			No	0	No	C	Yes	No	No	Yes	I	1 1/2 x 5 1/2 x 7	
	DP-644	229.95	S	20 dBf	64	No	16			No	0	Yes	C	Yes	No	Yes	Yes	I	1 1/2 x 5 1/2 x 7	
	SP-600	110.00				No	5			No		No	C	No	No	No	No	U	2 x 5 1/2 x 4 1/2	
	SP-572	120.00				No	5			No		No	C	No	No	No	No	U	2 x 5 1/2 x 5 1/2	
	CP-J-81	120.00	S			No	5			No	0	No	C	Yes	No	No	No	U	2 x 6 1/2 x 5 1/2	
AT-7831	239.40	S	20 dBf	64	Yes				No	0	Yes	C	No	No	No	Yes	I	1 1/2 x 5 1/2 x 5 1/2		

RADIOS/TAPE PLAYERS



Mitsubishi CZ747

MANUFACTURER	Model	Price \$	Stereo (S) Mono (M) or 4-Channel (C)	FM Sensitivity μ V (For 30-dB Quieting)	Selectivity dB	Preamp Output?	Average Rate/Channel, per IHP #A-202	Amplifier S/A Ratio, dB	% THD at Rated Output	Local/Distance Switch?	Number of Presets	Separate Tone Controls?	Cassette (C), B-Track (B)	Auto Reverse?	Dolby B/P?	Bias/EG Switch?	Fast Tape Spools?	In-Dash, Uses Dash (D), Consoles (U)	Dimensions, inches	
FUJITSU TEN (Continued)	SP-711	171.00				Yes													2x5x5 1/2	
	CA-100	82.50				Yes													1 3/4x4x5 1/2	
	RT-130	149.50				Yes													1 3/4x5x4 3/4	
	AT-7801	53.95	M	20dBf	64	No	4		No	5	No								1 3/4x4x7 1/4	
	AT-7811	110.00	S	20dBf	64	No	4		No	5	No								1 3/4x4x7 1/4	
	AT-3700	135.00	S	20dBf	64	No	4		No	5	No								1 3/4x4x7 1/4	
ARTHUR FULMER	16-6800	499.95	S			Yes		1.0	Yes	14	Yes	C	Yes	No	No	Yes	I		2 1/2x7x5 1/2	
	16-6100	149.95	S			No	6	5.0	Yes	5	Yes	C	No	No	No	Yes	I		2 1/2x7x4 3/4	
	16-6300	149.95	S			No	6	5.0	Yes	5	Yes	B	No	No	No	No	I		2 1/2x7x5 1/2	
	16-5600	118.95	S			No	5.8	4.0	Yes	0	Yes	B	No	No	No	No	I		1 3/4x7x4 3/4	
	16-5000	89.95	S			No	5.0	10.0	No	0	Yes	C	No	No	No	No	I		1 3/4x6 1/2x4 3/4	
	16-5080	99.95	S			No	5.0	10.0	Yes	0	Yes	C	No	No	No	Yes	I		1 3/4x6 1/2x4 3/4	
	16-5200	129.95	S			No	5.0	6.0	Yes	0	Yes	C	No	No	No	Yes	I		1 3/4x6 1/2x4 3/4	
	16-5700	159.95	S			No	5.8	2.0	Yes	0	Yes	C	Yes	No	No	Yes	I		1 3/4x6 1/2x4 3/4	
	15-0737	44.95	S				2.5	1.0	No	0	Yes	B	No	No	No	No	U		2 1/2x5 1/2x7	
	15-0738	49.95	S				2.5	1.0	No	0	Yes	C	No	No	No	Yes	U		1 3/4x4 3/4x6 1/2	
	15-0739	49.95	S				2.5	1.0	No	0	Yes	B	No	No	No	No	U		2 1/2x5 1/2x6 1/2	
	16-6500	189.95	S				5	1.0	Yes	5	No	B	No	No	No	No	I		2 1/2x7x6	
	16-8600	499.95	S				5.8	3.0	Yes	5	No	B	No	No	No	No	I		2x7x7	
	16-8400	399.95	S				5.2	3.0	Yes	5	No		No	No	No	No	I		2x7x6	
	16-4200	99.95	S				4	1.0	Yes	5	No		No	No	No	No	I		1 3/4x6 1/2x4 3/4	
	16-3200	69.95	M				4	1.0	Yes	5	No		No	No	No	No	I		1 3/4x4 3/4x6 1/2	
JENSEN	RE518	399.95	S	2.5	60	No	4	50	2.5	Yes	10	Yes	C	Yes	Yes	No	I		7x1 1/2x4 3/4	
	RE512	369.95	S	2.5	60	No	4	50	2.5	Yes	10	Yes	C	Yes	No	No	I		6 3/4x1 1/2x4 3/4	
	T415	299.95	S	2.5	60	Yes		55	No	5	Yes	C	Yes	Yes	No	No	I		7x2x5 1/2	
	R406	289.95	S	2.5	60	No	2	50	1.0	No	5	Yes	C	Yes	No	No	No	I		7x1 1/2x6
	R401	259.95	S	2.5	60	No	3.5	55	2.5	5	Yes	C	No	No	No	No	I		7x2x5 1/2	
	R210	199.95	S	5.0	60	No	2.5	50	1.0	No	5	No	C	No	No	No	No	I		6 3/4x1 1/2x4 3/4
	R200	149.95	S	5.0	60	No	2.5	50	1.0	No	5	No	C	No	No	No	No	I		6 3/4x1 1/2x4 3/4
	JET SOUND	JS-8250	99.95	S	1.8	50	No	8	60	5	Yes	0	No	B	No	No	No	No	I	
JS-9351		109.95	S	1.4	50	Yes	8	60	5	Yes	0	No	C	No	No	No	Yes	I		1 3/4x6 1/2x4 3/4
JS-9401		149.95	S	1.4	50	Yes	8	60	5	Yes	0	No	C	Yes	No	No	Yes	I		1 3/4x6 1/2x4 3/4
JS-8002		169.95	S	1.5	60	No	8	65	5	Yes	0	No	C	Yes	No	No	Yes	I		1 3/4x7x5 1/2
JS-8004M		189.95	S	1.5	60	No	8	65	5	Yes	0	No	C	Yes	Yes	No	Yes	I		1 3/4x7x5 1/2
JS-9700		209.95	S	1.5	60	No	8	65	5	Yes	5	No	C	Yes	No	No	Yes	I		2x7x5 1/2
KENWOOD	KRC-1022	649.95	S	1.5	65	Yes			Yes	12	Yes	C	Yes	Yes	Yes	Yes	I		7 1/4x2x6 1/2	
	KRC-922	549.95	S	1.5	65	Yes			Yes	10	Yes	C	Yes	Yes	Yes	Yes	I		7 1/4x2x5 1/2	
	KRC-722	499.95	S	1.5	65	Yes			Yes	10	Yes	C	Yes	Yes	Yes	Yes	I		7 1/4x2x5 1/2	
	KRC-322	369.95	S	1.7	65	Yes			Yes	10	Yes	C	Yes	Yes	Yes	Yes	I		7 1/4x2x5 1/2	
	KRC-312	329.95	S	1.7	65	Yes	15	92	1	Yes	10	Yes	C	Yes	No	No	Yes	I		7 1/4x2x5 1/2
	KRC-511	439.95	S	1.5	65	Yes	5	92	1	Yes	10	Yes	C	Yes	No	Yes	I		7 1/4x2x5 1/2	
	KRC-711	499.95	S	1.5	65	Yes	5	92	1	Yes	10	Yes	C	Yes	No	Yes	I		7 1/4x2x5 1/2, 1 1/2x2 and 15x2	
	KRC-311	279.95	S	1.7	65	Yes	5	92	1	Yes	10	No	C	Yes	No	No	Yes	I		7 1/4x2x5 1/2
KRACO	KHP-3085	299.95	S	2	30	No	15	10	Yes	0	Yes	C	No	Yes	Yes	Yes	Yes	I		4 1/4x4x5 1/2
	KHP-1087	279.95	S	2	30	No	15	10	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I/U		2x5 1/2x7
	KHP-1085	239.95	S	2	30	No	15	10	No	0	Yes	C	Yes	Yes	Yes	Yes	Yes	I/U		2x5 1/2x7
	KID-597	199.95	S	2	30	No	5	10	No	5	No	C	Yes	No	No	No	Yes	I		2x5 1/2x7
	LED-501	249.95	S	11	45	No	3.6	47	No	0	Yes	C	No	No	No	No	Yes	I		2x7 1/2x6
	KGE-801	239.95	S	10	50	No	10	48	No	0	Yes	C	No	No	Yes	Yes	I		2x7x5	
	KID-588	159.95	S	13	45	No	3.6	46	Yes	0	Yes	C	Yes	No	No	No	Yes	I		2x7 1/2x5 1/2
	KX1-87	169.95	S	12	45	No	45	45	Yes	6	Yes	C	No	No	No	No	Yes	I		2x4 3/4x6 1/2
	KX1-85	129.95	S	12	45	No	45	45	Yes	0	Yes	C	No	No	No	No	Yes	I		1 3/4x4 3/4x6 1/2
	KID-587	169.95	S	12	45	No	3.6	45	No	10	Yes	C	No	No	No	No	Yes	I		2x7 1/2x5 1/2
	MARANTZ	CAR-427	625.00	S	1.5	65	Yes		58	0.5	Yes	10	Yes	C	Yes	Yes	No	Yes	I	
CAR-400		500.00	S	2.0	60	Yes	4	58	0.9	Yes	12	Yes	C	No	Yes	No	Yes	I		2 1/2x7 1/2x5 1/2
CAR-410		395.00	S	1.1	60	Yes	4	58	0.9	Yes	12	Yes	C	No	No	No	No	I		1 3/4x7 1/2x6
CAR-302		350.00	S	5.0	60	Yes	4	58	0.9	Yes	5	Yes	C	No	Yes	No	No	I		2 3/4x7 1/2x4 3/4
CAR-300		235.00	S	1.8	60	Yes	4	58	0.9	Yes	5	No	C	No	No	No	No	I		2 3/4x7 1/2x5 1/2
CAR-330		290.00	S	2.2	60	Yes	4	58	0.9	Yes	5	Yes	C	No	No	No	No	I		
MITSUBISHI	CZ747	499.95	S	24dBf	80	Yes			Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	CZ692	299.95	S	22dBf	80	Yes			Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	CZ725	269.95	S	22dBf	80	Yes			Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	RX2	399.95	S	23dBf	80		4.8	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	RX791	379.95	S	22dBf	86		14	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	RX79	289.95	S	24dBf	70		9	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	Rx691	269.95	S	22dBf	86		4.5	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	RX752	259.95	S	22dBf	86		5	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	RX73	169.95	S	27dBf	60	Yes	4.8	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	RX723	159.95	S	17dBf	68		3.5	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I		
	GX101	99.95	S			Yes	3.5	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	U		
GX102	169.95	S			Yes	3.5	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	U			
RX103	169.95	S	17dBf	70	Yes	3.5	5	Yes	5	Yes	C	Yes	Yes	Yes	Yes	Yes	U			

RADIOS/TAPE PLAYERS



Pioneer KE-5100

MANUFACTURER	Model	Price, \$	Stereo (S), Mono (M), or 4-Channel (O)	FM Sensitivity (mV)	(For 20-dB Quieting)	Selectivity, dB	Preamplifier?	Average Watts, Channel	per IEC #202	Amplifier S/N Ratio, dB	% THD at Rated Output	Local/Distance Output	Number of Presets	Separate Tone Controls?	Cassette (C), 8-Track (8)	Auto Reverse?	Dolby NR?	Bias/EO Switch?	Fast Tape Speeds?	in-Dash (I), Under-Dash (U), Converter (U)	Dimensions, inches
PANASONIC	CQ-S900	449.95	S	19dBf	55	Yes	7.5	60	1.0	Yes	12	Yes	C	Yes	Yes	Yes	Yes	Yes	I	2 1/2 x 5 1/4 x 7	
	CQ-S820	349.95	S	19dBf	55	No	7.5	50	1.0	Yes	10	No	C	No	No	Yes	Yes	Yes	I	2 1/2 x 5 1/4 x 7	
	CQ-S791	319.95	S	15dBf	55	Yes	7.5	60	3.0	No	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I	2 1/2 x 5 1/4 x 7	
	CQ-S761	289.95	S	15dBf	55	No	7.5	60	3.0	No	5	Yes	C	Yes	Yes	Yes	Yes	Yes	I	2 1/2 x 5 1/4 x 7	
	CQ-S750	269.95	S	15dBf	55	No	7.5	60	3.0	No	5	No	C	Yes	Yes	Yes	Yes	Yes	I	2 1/2 x 5 1/4 x 7	
	CQ-S686	199.95	S	15dBf	55	No	7.5	50	3.0	No	0	No	C	No	No	No	No	Yes	I	2 1/2 x 5 1/4 x 7	
	CQ-S661	199.95	S	15dBf	55	No	7.5	50	3.0	No	0	No	C	No	No	Yes	No	Yes	I	2 1/2 x 5 1/4 x 7	
	CQ-S646	169.95	S	15dBf	55	No	7.5	50	3.0	No	0	No	C	No	No	No	No	Yes	I	2 1/2 x 5 1/4 x 7	
PIONEER	KEX-20	299.95	S	19.2 dBf	74	Yes				No	15	Yes	C	No	No	Yes	No	I	2x7 1/2 x 7 1/2		
	KPX-9500	249.95	S	14.3 dBf	74	Yes				No	5	Yes	C	No	Yes	No	No	I	3x7 1/2 x 7 1/2		
	KPX-9000	219.95	S	14.3 dBf	74	Yes				No	5	Yes	C	No	No	No	No	I	2x7 1/2 x 7 1/2		
	KP-707G	199.95	S			Yes				No		Yes	C	Yes	No	Yes	No	U	2x6x6		
	KPX-600	139.95	S	14.3 dBf	74	Yes				No		Yes	C	No	No	No	No	U	2 1/2 x 7 1/2 x 6 1/2		
	KP-66G	109.95	S			Yes				No		Yes	C	No	No	No	No	U	2x4 1/2 x 6 1/2		
	KP-77G	139.95	S			Yes				No		Yes	C	Yes	No	Yes	No	U	2x6x6		
	KE-2100	249.95	S	14.3 dBf	74	No	3.2		5.0	Yes	10	No	C	No	No	No	No	I	2x7 1/2 x 7 1/2		
	KP-7500	259.95	S	19.2 dBf	74	No	2.9		5.0	No		No	C	Yes	No	Yes	No	I	2x7 1/2 x 7 1/2		
	KP-6500	219.95	S	19.2 dBf	74	No	2.9		5.0	No	5	No	C	No	No	No	No	I	2x7 1/2 x 7 1/2		
	KP-8500	199.95	S	14.3 dBf	74	No	3.0		5.0	Yes	5	No	C	No	Yes	No	No	I	2x7 1/2 x 7 1/2		
	KP-5500	189.95	S	14.3 dBf	74	No	3.0		5.0	No	5	No	C	No	No	No	No	I	2x7 1/2 x 7 1/2		
	KP-1500	129.95	S	20.7 dBf	50	No	2.5		5.0	No		No	C	No	No	No	No	I	1 1/2 x 6 1/2 x 5 1/2		
	KP-2500	149.95	S	19.2 dBf	50	No	3.2		5.0	No		No	C	No	No	No	No	I	2x7 1/2 x 7 1/2		
	KP-4500	169.95	S	19.2 dBf	50	No	3.2		5.0	No		No	C	Yes	No	No	No	I	2x7 1/2 x 7 1/2		
	KP-8000	199.95	S	14.3 dBf	74	No	3.0		5.0	No	5	No	C	No	No	No	No	I	2x7 1/2 x 6 1/2		
	KP-4502	199.95	S	19.2 dBf	50	No	3.2		5.0	Yes		No	C	Yes	No	No	No	I	1 1/2 x 7 1/2 x 6 1/2		
	KP-3500	179.95	S	23.2 dBf	50	No	3.0		5.0	Yes		No	C	No	No	No	No	I	2x7 1/2 x 6 1/2		
	KP-575	129.95	S			No	3.0		5.0	No		No	C	Yes	No	No	No	U	2x6 1/2 x 4 1/2		
	KP-500	189.95	S	14.3 dBf	74	No	3.0		5.0	No		Yes	C	No	No	No	No	U	3x7 1/2 x 7 1/2		
	KP-373	114.95	S			No	3.0		5.0	No		No	C	No	No	No	No	U	2x4 1/2 x 6 1/2		
	TP-6006	129.95	S			No	3.0		5.0	Yes		No	B	No	No	No	No	I	2x7 1/2 x 7 1/2		
	TP-727	104.95	S			No	3.0		5.0	No		Yes	B	No	No	No	No	U	2 1/2 x 6 1/2 x 6 1/2		
	TP-900	179.95	S	14.3 dBf	74	No	3.0		5.0	No		Yes	B	No	No	No	No	U	3x7 1/2 x 7 1/2		
	KP-202G	139.95	S			Yes						Yes	C	No	No	Yes	No	U	5 1/2 x 2 x 5 1/2		
	KP-404G	159.95	S			Yes						Yes	C	No	Yes	Yes	No	U	5 1/2 x 2 x 5 1/2		
	GEX-60	219.95	S	19.2 dBf	70	Yes				No	15	Yes	Yes	C	No	Yes	Yes	No	U	5 1/2 x 2 x 5 1/2	
	KE-5100	299.95	S	19.2 dBf	70	No	2.9		5	No	15	No	C	No	No	No	No	I	7 1/2 x 2 x 7		
UKP-2200	169.95	S	23.2 dBf	50	No	3.2		5	No	0	No	C	No	No	No	No	I	7 1/2 x 1 1/2 x 5 1/2			
UKP-4200	189.95	S	23.2 dBf	50	No	3.2		5	No	0	No	C	Yes	No	No	No	I	7 1/2 x 1 1/2 x 5 1/2			
UKP-5200	209.95	S	23.2 dBf	50	No	3.2		5	No	5	No	C	No	No	No	No	I	7 1/2 x 2 x 5 1/2			
UKP-5600	249.95	S	19.2 dBf	70	No	3.2		5	No	5	Yes	C	No	No	No	No	I	7 1/2 x 2 x 5 1/2			
UKP-7200	239.95	S	23.2 dBf	50	No	3.2		5	No	5	No	C	Yes	No	No	No	I	7 1/2 x 2 x 5 1/2			
RADIO SHACK	12-1889	179.95	S	3	68	No	7	50	10	No	0	No	C	No	No	No	Yes	I/U	7x1 1/2 x 5 1/2		
	12-1886	179.95	S	3	50	No	12	45	10	No	0	Yes	C	No	No	No	Yes	I/U	2 1/2 x 7 x 6 1/2		
	12-1887	179.95	S	3	50	No	12	45	10	No	0	Yes	B	No	No	No	No	I/U	2 1/2 x 7 x 6 1/2		
	12-1890	159.95	S	5	50	No	6	45	10	No	0	No	C	Yes	No	No	Yes	I/U	1 1/2 x 7 1/2 x 5 1/2		
	12-1891	129.95	S	2	68	No	4	45	10	No	5	No	C	No	No	No	Yes	I	7x2 1/2 x 5 1/2		
	12-1884	99.95	S	2	53	No	4	45	10	No	0	No	C	No	No	No	Yes	I/U	1 1/2 x 7 1/2 x 5 1/2		
	12-1885	99.95	S	3	59	No	4	50	10	No	0	No	B	No	No	No	No	I/U	2x7x4 1/2		
	12-1892	99.95	S	3	68	No	4	50	10	No	0	No	C	No	No	No	Yes	I	2 1/2 x 6 1/2 x 4 1/2		
	12-1880	79.95	S	3	45	No	4	53	10	No	0	No	C	No	No	No	Yes	I	7x1 1/2 x 4 1/2		

7TH ANNUAL CAR STEREO DIRECTORY

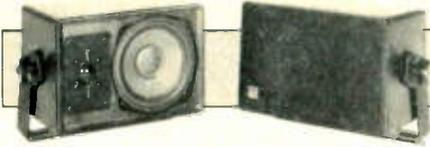
RADIOS/TAPE PLAYERS



Sanyo FT590

MANUFACTURER	Model	Price \$	Stereo (S), Mono (M), or 2-Channel (C)	FM Sensitivity (uV) (For 30dB Coupling)	Selectivity, dB	Preamp Output?	Average Watts/Channel, per IMAF A-202	Amplifier S/N Ratio, dB	% THD at Rated Output	Local/Distance Switch?	Number of Presets	Separate Tone Controls?	Cassette (C), B-Track (B)	Auto Reverse?	Dolby NR?	Bass/EC Switch?	Fast Tape Speeds?	In Dash (D) Under Dash (U) Converter (V)	Dimensions Inches	
SANYO	FTC2	79.95	S	26.2 dBf	35	No	3.8	10.0	Yes		Yes	C	No	No	No	Yes			6 1/4 x 4 x 1 1/4	
	FTC4	89.95	S	21.6 dBf	55	No	3.5	10.0	Yes		Yes	C	No	No	No	Yes			6 1/4 x 4 x 1 1/4	
	FTC5	99.95	S	26.2 dBf	35	No	3.8	10.0	Yes		Yes	C	Yes	No	No	Yes			6 1/4 x 4 x 2	
	FTC6	109.95	S	21.6 dBf	55	No	3.5	10.0	Yes		Yes	C	Yes	No	No	Yes			6 1/4 x 4 x 1 1/4	
	FTC8	139.95	S	21.6 dBf	55	No	3.5	10.0	Yes		No	C	Yes	No	No	Yes			6 1/4 x 4 x 2	
	FTC26	139.95	S	20.2 dBf	60	No	9.5	1.0	Yes		No	C	Yes	No	No	Yes			6 1/4 x 4 x 2	
	FTC12	149.95	S	20.2 dBf	60	No	2.4	5.0	Yes		Yes	C	Yes	No	No	Yes			6 1/4 x 4 x 2	
	FTC13	159.95	S	21.6 dBf	55	No	4.0	10.0	Yes	10	Yes	C	Yes	No	No	Yes			6 1/4 x 4 x 2	
	FTC15	179.95	S	21.6 dBf	55	No	4.0	10.0	Yes	10	No	C	Yes	No	No	Yes			6 1/4 x 4 x 2	
	FTC16	199.95	S	18.2 dBf	65	Yes	3.5	10.0	Yes		No	C	Yes	Yes	Yes	Yes			6 1/2 x 5 x 2	
	FTC18	229.95	S	21.6 dBf	60	Yes			Yes	10	No	C	Yes	Yes	Yes	Yes			6 1/4 x 4 x 2	
	FT2200	279.95	S	18.2 dBf	70	Yes			Yes	10	No	C	Yes	Yes	Yes	Yes			6 1/2 x 5 x 2	
	FT526	109.95	S	21.6 dBf	60	No	2.4	5.0	Yes		Yes	C	No	No	No	Yes			7 1/2 x 4 x 2	
	FT7	129.95	S	21.6 dBf	55	No	4.0	10.0	Yes		Yes	C	Yes	No	No	Yes			7 x 5 x 2	
	FT482	159.95	S	21.6 dBf	55	No	4.0	10.0	Yes		No	C	Yes	No	No	Yes			7 x 5 x 2	
	FT510	159.95	S	30.0 dBf	60	No	9.5	1.0	Yes		No	C	Yes	No	No	Yes			7 1/2 x 5 x 2	
	FT645	179.95	S	25.0 dBf	60	No	3.5	10.0	Yes		Yes	C	Yes	No	No	Yes			7 1/2 x 6 x 2	
	FT240	179.95	S	21.6 dBf	60	No	3.5	50	Yes		Yes	C	Yes	Yes	No	Yes			7 x 5 1/2 x 2	
	FT9	189.95	S	21.6 dBf	55	No	4.0	10.0	Yes	10	Yes	C	Yes	No	No	Yes			7 x 5 x 2	
	FT20	199.95	S	18.2 dBf	65	No	2.4	5.0	Yes		No	C	Yes	Yes	Yes	Yes			7 1/2 x 5 1/2 x 2	
FT30	249.95	S	21.6 dBf	60	Yes	4.0	10.0	Yes	10	No	C	Yes	Yes	Yes	Yes			7 x 5 1/2 x 2		
FT590	379.95	S	20.2 dBf	60	Yes			Yes	10	No	C	Yes	Yes	Yes	Yes			7 x 5 1/2 x 2		
SONY	XR-77	449.95	S	1.2	75	Yes	12	86	0.5	Yes	10	Yes	C	No	Yes	Yes	Yes	Yes	I	2 1/2 x 7 1/2 x 6
	XR-70	389.95	S	1.2	75	Yes				Yes	10	Yes	C	No	Yes	Yes	Yes	Yes	I	1 1/2 x 7 1/2 x 6
	XR-55	359.95	S	1.1	75	Yes	10	84	1.0	Yes	6	Yes	C	Yes	Yes	Yes	Yes	Yes	I	1 1/2 x 7 1/2 x 6
	XR-50	289.95	S	1.4	60	Yes	4.5	86	1.0	Yes	0	Yes	C	No	No	Yes	Yes	Yes	I	1 1/2 x 7 1/2 x 6
	XR-35	279.95	S	1.6	65	Yes	4	84	1.0	No	0	EQ	C	Yes	Yes	Yes	Yes	Yes	I	1 1/2 x 6 1/2 x 5 1/2
	XR-25	229.95	S	1.6	65	Yes	4	84	1.0	No	0	EQ	C	Yes	No	Yes	Yes	Yes	I	1 1/2 x 6 1/2 x 4 1/2
	XT-1	329.95	S	1.1	92	Yes				No	10								I/U	5 1/2 x 1 1/2 x 7
	XT-22	159.95	S	2	65	Yes				No									I/U	5 1/2 x 1 1/2 x 7
	XK-23	259.95	S			Yes						Yes	C	Yes	Yes	Yes	Yes	Yes	I/U	5 1/2 x 1 1/2 x 7
	XK-21	199.95	S			Yes						Yes	C	Yes	No	Yes	Yes	Yes	I/U	5 1/2 x 1 1/2 x 7
	XK-M-11	249.95	S			Yes	4.5		0.8			Yes	C	Yes	Yes	Yes	Yes	Yes	I/U	5 1/2 x 1 1/2 x 7
SPARKOMATIC	SR303	149.95	S	2.0	50	No	6.0	85	10	Yes	0	Yes	C	Yes	No	No	No	Yes	I	7 x 1 1/2 x 4 1/4
	SR302	149.95	S	2.0	50	No	6.0	85	10	Yes	5	Yes	C	No	No	No	Yes	I	7 1/2 x 2 1/2 x 4 1/4	
	SR301	119.95	S	2.0	50	No	6.0	85	10	Yes	0	Yes	C	No	No	No	Yes	I	6 1/2 x 1 1/2 x 4 1/4	
	SR300	89.95	S	2.0	45	No	6.0	85	10	Yes	0	Yes	C	No	No	No	Yes	I	7 x 1 1/2 x 4 1/4	
	SR2400	269.95	S	2.0	55	No	20	85	10	Yes	0	Yes	8	No	No	No	No	I	7 x 1 1/2 x 5 1/2	
	SR2100	216.95	S	2.0	55	No	20	85	10	Yes	0	Yes	8	No	No	No	No	I	7 x 1 1/2 x 5 1/2	
	SR240	239.95	S	2.0	55	No	6.0	85	10	Yes	0	Yes	8	No	No	No	No	I	7 x 1 1/2 x 5 1/2	
	SR210	189.95	S	2.0	55	No	6.0	85	10	Yes	0	Yes	8	No	No	No	No	I	7 x 1 1/2 x 5 1/2	
	SR305	149.95	S	2.0	50	No	20	85	10	Yes	0	Yes	C	No	No	No	Yes	I	7 x 1 1/2 x 5 1/2	
	SR304	119.95	S	2.0	50	No	6.0	85	10	No	0	Yes	C	No	No	No	Yes	I	6 1/2 x 1 1/2 x 4 1/4	
	SR3400	269.95	S	2.0	55	No	20	85	10	Yes	0	Yes	C	No	No	No	Yes	I	7 x 1 1/2 x 5 1/2	
	SR3300	249.95	S	2.0	55	No	20	85	10	Yes	0	Yes	C	Yes	No	No	Yes	I	7 x 1 1/2 x 5 1/2	
	SR3100	219.95	S	2.0	55	No	20	85	10	Yes	0	Yes	C	No	No	No	Yes	I	7 x 1 1/2 x 5 1/2	
	SR340	239.95	S	2.0	55	No	6.0	85	10	Yes	0	Yes	C	No	No	No	Yes	I	7 x 1 1/2 x 5 1/2	
	SR330	219.95	S	2.0	55	No	6.0	85	10	Yes	0	Yes	C	Yes	No	No	Yes	I	7 x 1 1/2 x 5 1/2	
	SR310	189.95	S	2.0	55	No	6.0	85	10	Yes	0	Yes	C	No	No	No	No	I	7 x 1 1/2 x 5 1/2	
	SR202	149.95	S	2.0	50	No	6.0	85	10	Yes	5	Yes	8	No	No	No	No	I	7 1/2 x 2 1/2 x 4 1/4	
	SR201	119.95	S	2.0	50	No	6.0	85	10	Yes	0	Yes	8	No	No	No	No	I	6 1/2 x 1 1/2 x 5 1/2	
	SR200	89.95	S	2.0	45	No	6.0	85	10	Yes	0	Yes	8	No	No	No	No	I	7 x 1 1/2 x 4 1/4	

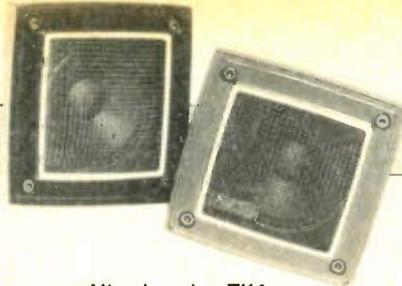
SPEAKERS



ADS 300C

MANUFACTURER	Model	Price \$ (If Sold Individually)	Price \$ (If Sold in Pairs)	Recommended Max. Power Watts	Woofer Size, Inches	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	Whizzer (W), 2-Way (2), 3-Way (3), 4-Way (4)	Flush Mount (F), Surface Mount (S), Crossover (C)	Dimensions, Inches	Notes
ADCOM	ELF-100		229.95	60	4	4	45-20	2	S	5x8x6½	
ADS	200C	129.95		50	4	4	55-22 ±5	2	S	6½x4½x4½	Subwoofer system with active electronic crossover. As above but passive.
	300C	159.95		75	5½	4	40-23 ±5	2	S	8½x5½x5½	
	300I	129.95		100	5½	4	50-20 ±3	2	F	8½x5½x1½	
	CS400A	249.95		100	(2) 7	3.6			F	7x7x3	
	CS400P	249.95		100	(2) 7	4			F	7x7x3	
ALTEC LANSING	TK1	79.95		20	3	4	5-18 ±4		F	3½x3½x2½	†Inc. 40-W amp and cross-overs. Five speakers — two TK1s, two SK1s, one SW1.
	SK1	112.95		35	5		100-10 ±5		F	5½x5½x2½	
	6x9-4A	169.95		40	6x9	4	80-18 ±6	2	F	6½x9½x1½	
	6x9-4B	239.95		100	6x9	4	80-18 ±6	2	F	6½x9½x2	
	6x9-4C	119.95		40	6x9	4	80-18 ±6	2	F/S	6½x9½x2½	
	SK2	79.95		35	5½	4	100-18 ±6	2	F/S	5½x5½x2½	
	SW1	239.95		†	6x9	1k	50-150 ±4		F	6½x9½x2½	
	AL-1	389.95		80	6x9	4	50-180 ±5	3	F/S		
AVID	1	60.00		50	8x9	4	70-16 ±5	W	F/S	6½x9½	Model 1K, with grille kit, 67.50. With sub-surface adaptor. Opt. sub-surface adaptor. †See 10 and RD-5; includes pair of both.
	RD-5	70.00		50	4½	4	60-10 ±5		F/S	5½x5½	
	5	175.00		75	4½	4	60-20 ±5	2	F/S	9½x5½x1	
	10	225.00		100	6½	4	50-20 ±3	2	F/S	11½x7½x1½	
	10 Plus	275.00		100	6½	4	†	3	F/S	†	
BLAUPUNKT	750-001	31.40		15	5	4	125-14		S	5 Dia.	
	532-000	18.60		8	7	4	80-12		F	7½x3½x2½	
	544-000	22.10		8	6½	4	70-16		F	6½x4½x1½	
	545-000	34.30		10	4	4	10-12.5		S	7x5x2½	
	547-000	18.60		8	4	4	70-15		F	4½x4½x1½	
	555-000	22.10		8	4½	4	70-12.5		F	5½x5½x1½	
	639-000	71.40		25	4½	4	70-14	2	S	6½x5½x5½	
	640-000	34.30		10	4	4	100-12.5		S	6½x4½x2½	
	665-000	22.10		8	4	4	140-14		S	4½x4½x2½	
	686-060	26.40		15	4½	4	80-15		F	5½x1½	
	687-000		103.60	25	4½	4	80-16	2	F	5½x5½x2½	
	688-000		134.25	25	6x9	4	40-16	2	F	6x9x3½	
	721-000	41.40		25	5	4	70-16		S	6½x5½x5½	
	723-060	25.00		15	4½	4	80-15		F	4½x1½	
	724-060	34.30		25	5	4	70-15		F	5½x2½	
	725-000		73.50	30	6½	4	80-18	W	F	6½x1½	
	726-000	25.00		15	5	4	80-15		F	5½x5½x1½	
	727-000	34.25		25	5	4	70-15		F	5½x5½x2½	
	728-000		108.30	30	6½	4	80-18	3	F	6½x2½	
	729-000	76.90		30	4½	4	70-20	2	F	8½x5½x3½	
	731-000	76.90		30	4½	4	70-20	2	S	8x5½x5½	
	230-007	26.80		8	6x9	4	70-12	W	F	6x9x3½	
	230-008		31.50	8	4	4	70-12		F	4x1½	
	230-009		39.60	8	4	4	70-12		F	20½x5½x3	
	230-010		34.60	25	4½	4	40-18		F	4½x2½	
	230-011		28.80	25	4x6	4	50-18		F	4x6x1½	
BON SONIC	525C			10	5	8	60-15				
	525P			10	5	8	60-15				
	CRB5			10	5	8	60-15		F		
	Sp50w			50	3	4	20-20	3	F/S	3½x5½x2	
	IS700			30	6x9	8	20-20	3	S	6x9x3½	
	MS69H			30	6x9	8	20-20	3	S	6x9x3½	
BOSE	Direct	97.20	100			0.45	40-17 ±1		F/S	4½ x 1½	†Must be used with 1401 booster/EQ.
	Reflecting† Accessory†	85.20	100			0.45	40-17 ±1		F/S	4½ x 1½	
CERWIN-VEGA	HED CS-7	104.00	40	6x9	4		50-16 ±5	2	F	6½x9½x3	
	HED CS-18	150.00	75	6x9	4		40-20 ±3	2	F	6½x9½x4½	
CLARION	SK111			100	6x9	4		2	F		
	SK110			60	6½	4			F		
	SK108			60	6½	4			F		
	SK89C	65.75	40	6x9	4		50-18	2	F		
	SK45C	60.50	35	6½	4		60-18	2	F		
	SK44C	54.95	30	6½	4		60-18	2	F		
	SK40C	39.95	30	6½	4		70-18	W	F		
	SK42C	34.95	30	5½	4				F		
	SK95C	36.50	30	4	4		80-18	W	F		
	SK20C	24.95	20	3½	4				F		

SPEAKERS



Altec Lansing TK1

MANUFACTURER	Model	Price, \$ (If Sold Individually)	Price, \$ (If Sold in Pairs)	Recommended Max. Power, Watts	Woofer Size, Inches	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	WHizzer (W), 2-Way (2), 3-Way (3), 4-Way (4)	Flush Mount (F), Surface Mount (S), Convertible (C)	Dimensions, Inches	Notes
DAHLQUIST	ALS-3		295.00	40	4	4	45-22	3	S	7½x4½x4	
EPI	LS-70 LS-81 LS-81C CSS	80.00	190.00 225.00 100.00	60 60 60	8 4½ 4½	4 4 4	70-20 ±3 80-20 ±3 90-20 ±3	2 2 2	F/S F/S S F	9½x7x3¼ 7½x4½x2½ 7½x5½x5¼ 6x6x1¼	Subwoofer with level control.
FUJITSU TEN	SG-1003 SSB-8G11 SG-1002 SSB-8G3 SSB-4G24 SG-1301 SSB-8G4 SSB-4G25 SG-1602 SSB-8G5 SSB-4G31 SG-6901		42.50 34.95 59.95 14.95 13.95 54.50 26.95 24.95 57.00 16.50 14.50 139.95	30 20 70 20 10 30 20 10 30 20 10 70	4 4 4 5 5 4 5 4 4 5x7 5x7 6x9	4 8 4 8 4 4 8 4 4 8 4 4	50-17 90-15 90-16 50-15 50-15 60-19 50-20 50-20 50-20 80-15 80-15 70-15		F F F F F W W W W W W 2		
ARTHUR FULMER	15-9696 15-9690 15-9670 15-9470 15-9490 15-9435 15-9430 15-9260 15-9460 15-9660 15-9590 15-9240		79.95 69.95 54.95 46.95 59.95 39.95 26.95 119.95 39.95 44.95 59.95 21.95	35 30 25 25 30 20 10 45 10 10 30 7	6x9 6x9 6x9 5¼ 5¼ 4 4 4 5¼ 6x9 4x10 5	4 4 4 4 4 4 4 4 4 4 4 4		4 3 2 2 3 2 2 3 2 2 3 W	F F F F F W F S F F F F/S	6x9x3¼ 6x9x3¼ 6x9x3¼ 5¼x5¼x2½ 5¼x5¼x2½ 4x4x1¼ 4x4x1¼ 4¼x7¼x4¼ 5¼x5¼x2½ 6x9x3¼ 4x10x6¼ 5¼x5¼x6¼	
INFINITY	I-Car		229.00	50	5	4	55-32 ±3	2	F		
JENSEN	J2000 Mini J1033 Triax I J1242 Quadax I J1201 Coax II J1283 ThinMount J1245 Coax Convertible		239.95 159.95 149.95 109.95 44.95 34.95	55 100 55 50 30 25	4½ 6x9 6x9 6¼ 4 6¼	4 4 4 4 4 4	65-20 ±6 45-20 ±6 40-20 ±6 65-20 ±6 65-20 65-18	2 3 4 2 2 2	S F F F F/S	4¼x10¼x3¼ 6¼x9¼x3¼ 4¼x9¼x4 6¼x6¼x1¼ 4¼x4¼x1¼	
JET SOUND	JS-25 JS50-10AS JS-410 JS-420 JS-580 JS-563 JS-980 JS-1515		14.95 29.95 34.95 39.95 44.95 49.95 59.95 99.95	5 8 20 4 20 50 50 50	5¼ 5¼ 4 4 5¼ 5¼ 8x9 8x9	4 4 4 4 4 4 4 4	100-10 100-10 100-10 80-15 80-20 80-10 70-18 90-18		F W F F F F F F/S	2¼x6¼ 2¼x6¼ 2x5x5 2¼x5x5 2¼x5x5 3¼x6¼ 3x7¼x10¼ 3x7¼x10¼	
JVC	CS-5K CS-50K		200.00 120.00	50 30	4 4	4 4	50-35 50-35	2 2	S F/S	5¼x8x7½ 5x8¼x2¼	
KENWOOD	KFC-161 KFC-162 KFC-692 KFC-103 KFC-83 KSC-501B		89.95 79.95 139.95 65.00 32.00 159.95	35 25 70 25 20 50	6¼ 6¼ 6x9 4 3¼ 4	4 4 4 4 4 4	45-20 ±10 45-20 ±10 40-20 ±10 80-20 ±10 100-20 ±10 60-20 ±10	2 2 3 W W 2	F F F F F S	6¼x2¼ 6¼x2¼ 6x9x3¼ 4x1¼ 3¼x1¼ 8¼x4¼x5	
KRACO	THP-693 THP-543 TRI-369 CX-269-20 TRI-469 TRI-3-410 CX-410-20 TRI-359		129.95 129.95 69.95 44.95 89.95 69.95 49.95 64.95	100 100 50 30 40 30 25 25	6x9 5¼ 6x9 6x9 5¼ 4x10 4x10 6¼	4 4 4 4 8 8 8 8	40-20 ±5 70-20 ±5 60-17 ±5 65-17 ±5 70-19 ±5 150-20 ±5 100-19 ±5 75-17 ±5	3 3 3 2 3 3 2 3	F F F F S S F F	3¼x8½x9½ 3x6¼ 3¼x6¼x9½ 3¼x6¼x9½ 6x9x2¼ 4¼x10¼x2¼ 4x10x3½ 6¼x3¼	
MARANTZ	SS-5000 SS-825 SS-3410 SS-3469 SS-469 SS-140		300.00 90.00 80.00 110.00 110.00 40.00	250 30 20 30 30 10	6¼ 6¼ 4x10 6x9 6x9 4	4 8 8 8 8 4	30-20 50-20 50-20 40-18 40-18 60-14	2 3 2 4 4 4	S F F F F/S F	7¼x11¼x7¼ 6¼x6x2¼ 10x4¼x2½ 9¼x6¼x3¼ 9¼x6¼x3¼ 4x4x1¼	

SPEAKERS



Jensen Coax II

MANUFACTURER	Model	Price \$		Recommended Max. Power Watts	Woofer Size, Inches	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	Wizzer (W), 2-Way (2), 3-Way (3), 4-Way (4)	Mount (F), Surface Mount (S), Convertible (F/S)	Dimensions, Inches	Notes
		(If Sold Individually)	(If Sold in Pairs)								
MATRECS	Domeplex 100	199.95	50	4 1/2 Dia.	4	40-22	2	S	5x6x9	Separate tweeter mounting capability. As above. Removable tweeter.	
	Domeplex 40	189.95	150	6x9	4	30-22	2	F	4x6 1/2 x9		
	Domeplex 30	139.95	75	6x9	4	35-22	2	F	4x6 1/2 x9		
	Domeplex 25	119.95	65	6x9	4	40-22	2	F	4x6 1/2 x9		
	Domeplex 19	119.95	35	4x10	4	50-22	2	F	4x4x10		
	Domeplex 16	119.95	65	6 Dia.	4	40-22	2	F	6 1/2 Dia. x4		
MITSUBISHI	SG-69TB	139.95	100	6x9	4	50-20	3	F			
	SG-69CB	99.95	40	6x9	4	50-20	2	F			
	SG-40CB	99.95	50	4x10	4	50-20	2	F			
	SG-13CD	79.95	30	5 1/4	4	60-15	2	F			
	SG-13WD	59.95	30	5 1/4	4	70-15	W	F			
	SG-12MA	54.95	30	5	4	80-15	W	F			
	SG-10WE	49.95	4	4	4	100-17	W	F			
	SR-35WA	34.95	20	3 1/2	4	120-13	W	F			
NUMARK	MS100A	149.95	50	4	8	40-25	2	S	7 1/2 x4 1/2 x4 1/2		
OAKTRON INDUSTRIES	CABF69T	41.55	40	6x9	4/8	50-14 ±5	2	F	4x6 1/2 x9 1/2		
	CABF53K	31.85	25	5 1/4	4/8	60-16.5 ±5	2	F	2 3/4 x5 1/2 x5 1/2		
	3WBF69K	53.75	25	6x9	4/8	50-20 ±5	3	F	3 1/2 x6 1/2 x9 1/2		
	CAFE410H2	33.70	30	4x10	4/8	50-15 ±5	2	F	3 3/4 x4 1/2 x10 1/2		
	FE69HW	14.20	18	6x9	4/8	80-12 ±5	W	F	2 1/2 x6 1/2 x9 1/2		
	BF53KW	21.25	25	5 1/4	4/8	90-15 ±5	W	F	2 1/2 x5 1/2 x5 1/2		
PANASONIC	EAB-080	179.95	100	8	4	30-20	2	F/S			
	EAB-692	89.95	20	6x9	4	40-25	2	F			
	EAB-911	39.95	20	5	4	70-15		F			
	EAB-063	84.95	25	6 1/2	4	40-25	2	S			
	EAB-411	64.95	25	4x10	4	60-20	2	F			
	EAB-050	52.95	20	5	4	50-16		F			
PEERLESS AUDIO	Lemans	124.95	40	6x9	4	50-20 ±3	2	F	6x9x3 3/4	12-dB/octave x-over, biamped. As above.	
	Monza	119.95	30	5 1/4	4	60-20 ±3	2	F	6x9x3		
PIONEER	TS-X9	199.95	40	3 1/2	4	50-22	2	S	8 1/2 x5 1/2 x7 1/2	Separate brilliance control. For Ford products. For Toyota notchback-type cars. For GM products. One-inch mounting depth. As above. For GM cars.	
	TX-X6	109.95	20	4	4	80-20	2	S	9 1/2 x5 x6 1/2		
	TS-35	44.95	40	4	4	80-13		F/S	7 1/2 x4 1/2 x7 1/2		
	TS-5	29.95	8	4	4	80-13		F/S	6 1/2 x4 1/2 x5 1/2		
	TS-W203	149.95	60	8	4	28-10		F			
	TS-202	179.95	60	8	4	30-20	2	F			
	TS-T3	49.95	60	4	4	250-20		F			
	TS-M2	49.95	20	8	4	450-20		S	3x1 1/2 x4 1/2		
	TS-87	20.95	20	4	4	100-18		F			
	TS-698	169.95	60	6x9	4	30-22	3	F			
	TS-697	139.95	60	6x9	4	30-22	2	F			
	TS-696	119.95	40	6x9	4	30-20	2	F			
	TS-695	149.95	40	6x9	4	30-20	3	F			
	TS-694	85.95	25	6x9	4	35-18	2	F			
	TS-692	63.95	20	4	4	35-16	W	F			
	TS-691	49.95	20	4	4	40-18	W	F			
	TS-681	69.95	20	6x8	4	40-20	2	F			
	TS-585	99.95	20	5x8	4	45-20	2	F			
	TS-571	59.95	20	5x7	4	50-18	2	F			
	TS-411	69.95	20	4x10	4	50-20	2	F			
	TS-1600	169.95	60	6 1/2	4	40-20	2	F			
	TS-168	124.95	40	6 1/2	4	35-20	3	F			
	TS-167	79.95	20	6 1/2	4	30-20	2	F			
	TS-165	69.95	20	6 1/2	4	30-16	2	F			
	TS-164	64.95	20	6 1/2	4	40-16	2	F			
	TS-1620X	55.95	20	4	4	40-16	W	F			
	TS-160	42.95	20	4	4	40-18	W	F	6 1/2 x 1 1/2		
	P-16L	29.95	8	4	4	50-10		F	6 1/2 x 1 1/2		
	TS-121	44.95	20	4	4	80-16		F			
	TS-120	39.95	8	4	4	80-16		F			
	TS-107	54.95	20	4	4	50-20	W	F			
	TS-106	49.95	20	4	4	50-16		F			
TS-100	34.95	8	4	4	50-14		F				
P-10L	26.95	8	4	4	70-12		F				
TS-280	399.95	60	5 1/2	4	70-20	2	S	7 1/2 x10 1/2 x8 1/2			
TS-108	69.95	20	4	4	50-20	2	F				
TS-X11	299.95	60	4 1/2	4	47-25	3	S	11 1/2 x5 1/2 x7 1/2			
TS-462	49.95	20	4x8	4	60-20	W	F				
TS-M6	99.95	40	8	4	350-22	2	S	9 1/2 x5 1/2 x5 1/2			
TS-X5	99.95	20	4	4	80-20	W	S	9 1/2 x5 1/2 x5 1/2			
TS-2000	199.95	60	8	4	30-21	2	F				
POLK AUDIO	Mini-Monitor II	250.00	60	4 1/2	6	60-20.5 ±2	3	S	13 1/2 x6 x4 1/2		

Kraco CX-269-20

MANUFACTURER	Model	Price \$ (If Sold Individually)	Price \$ (If Sold in Pairs)	Recommended Max. Power Watts	Woofer Size, inches	Impedance, Ohms	Frequency Response, Hz to kHz, ±dB	Whizzer (W), 2-Way (2), 3-Way (3), & 4-Way (4)	Flux Horn (F), Surround Mount (S), Connectable (C)	Dimensions, inches	Notes
PYLE INDUSTRIES	F69C200-FC	70.25	156.15	85	6x9	4/8	50-20	2	F	3 1/2 x 6 x 9 1/4	
	F69C290-FC	82.75	183.60	100	6x9	4/8	50-20	2	F	4 x 6 x 9 1/4	
	F69C100-FT	49.90	117.95	55	6x9	4/8	55-20	2	F	3 1/2 x 6 x 9 1/4	
	F69C200-FT	62.45	140.55	85	6x9	4/8	50-20	2	F	3 1/2 x 6 x 9 1/4	
	F69C290-FT	76.50	170.95	100	6x9	4/8	50-20	2	F	4 x 6 x 9 1/4	
	F52C100-FP	42.90	99.95	45	5 1/4	4/8	60-40	2	F	2 1/2 x 5 1/4 x 5 1/4	
	F52C165-FP	49.85	117.10	55	5 1/4	4/8	55-40	2	F	3 1/2 x 5 1/4 x 5 1/4	
	F410C100-FP	43.60	101.50	45	4x10	4/8	60-40	2	F	3 1/2 x 4 1/2 x 10	
	F410C160-FP	51.50	117.10	50	4x10	4/8	55-40	2	F	3 1/2 x 4 1/2 x 10	
	F35C30-WF	19.95		30	3 1/2	4/8	90-18	W	F	1 1/2 x 3 1/2 x 4 1/4	
	F4C99-F	23.35	70.25	35	4	4/8	70-18	W	F	1 1/2 x 4 x 4	
	F5C100-WF	23.35	70.25	45	5	4/8	60-18	W	F	2 1/2 x 5	
	F52C100-WF	23.35	70.25	45	5 1/4	4/8	60-18	W	F	2 1/2 x 5 1/4 x 5 1/4	
	F6C100-WF	24.95		50	6	4/8	60-18	W	F	2 1/2 x 6 1/4	
	F46C55-WF	22.65		35	4x6	4/8	70-18	W	F	1 1/2 x 4 1/4 x 6 1/4	
	F57C100-WF	25.85		45	5x7	4/8	60-18	W	F	2 1/2 x 5 7/8	
	F69C100-WF	26.50	71.90	55	6x9	4/8	55-18	W	F	3 x 6 x 9 1/4	
	F69C180-WF	32.75	82.05	55	6x9	4/8	50-18	W	F	3 1/2 x 6 x 9 1/4	
	F410C100-WF	26.20	68.70	45	4x10	4/8	60-18	W	F	2 1/2 x 4 1/2 x 10	
	WM5C100-F	24.45		45	5	8	50-8.5	F	F	2 1/2 x 5	
	W52C165-F	30.50		55	5 1/4	8	50-8	F	F	2 1/2 x 5 1/4 x 5 1/4	
	W6C200-F	37.95		85	6	8	35-7.5	F	F	3 1/2 x 6 1/2	
	W8C170-F	36.75		100	8	8	30-7	F	F	3 1/2 x 8 1/2	
	W8C200-F	40.55		100	8	8	30-7	F	F	3 1/2 x 8 1/2	
	W8C200-F4	41.15		100	8	4	30-7	F	F	3 1/2 x 8 1/2	
	W8C300-F	54.60		115	8	8	30-4.5	F	F	3 1/2 x 8 1/2	
	W10C170-F	41.40		105	10	8	30-6.5	F	F	4 1/4 x 10 1/4	
	W10C200-F	45.25		105	10	8	25-6.5	F	F	4 1/4 x 10 1/4	
	W10C200-F4	45.85		105	10	4	25-6.5	F	F	4 1/4 x 10 1/4	
	W10C300-F	58.95		120	10	8	20-4.5	F	F	4 1/4 x 10 1/4	
	W12C200-F	51.15		115	12	8	20-6	F	F	5 1/4 x 12 1/4	
	W12C200-F4	51.75		115	12	4	20-6	F	F	5 1/4 x 12 1/4	
	W12C300-F	63.30		130	12	8	20-4.5	F	F	5 1/4 x 12 1/4	
	W69C200-F	41.40		85	6x9	8	40-7	F	F	3 1/2 x 6 x 9 1/4	
	W69C200-F4	42.10		85	6x9	4	40-7	F	F	3 1/2 x 6 x 9 1/4	
	W69C290-F	49.95		100	6x9	8	35-7	F	F	4 x 6 x 9 1/4	
	W69C290-F4	50.80		100	6x9	4	35-7	F	F	4 x 6 x 9 1/4	
	W410C160-F	30.85		50	4x10	8	45-7.5	F	F	3 1/2 x 4 1/2 x 10	
	MSC99-F	24.60		55	5	8	700-14	F	F	2 1/2 x 5	
	MSC160-F	28.50		70	5	8	400-10	F	F	2 1/2 x 5	
	T17C55-X	19.15	38.30	45	1 1/2	8	2.5k-20k	F	F	1 1/2 x 4 1/4	
	T3C24-X	17.15	34.30	65	3	8	3.5k-20k	F	F	1 1/2 x 3 1/2	
	T3PA	16.00	32.00	35	2 1/2		3k-40k	F	F	1 1/2 x 3 1/2	
	T3PAS	14.75	29.50	35	3k		3k-20k	F	F	1 1/2 x 3 1/2	
H35A15-X	24.18	48.35	50	3 1/2	8	2.5k-20k	F	F	2 1/2 x 3 1/2 x 3 1/2		
HT35P	22.65		35	3 1/2		4k-40k	F	F	2 1/2 x 3 1/2 x 3 1/2		
CD4C80-X	28.08	56.15	50	4	8	3k-20k	F	F	1 1/2 x 4 1/4		
QUAM-NICHOLS	20X		59.50	18	6x9	8	45-17	W	F	3 1/2 x 6 x 9 1/4	KIL. As above.
	20C0		94.50	35	6x9	8	40-19	W	F	3 1/2 x 6 x 10 x 9 1/4	
	30C25Z8	9.40		5	3	8	200-12		F/S	1 1/2 x 3 x 3	
	3C328U	10.55		5	3	8	180-9		F/S	1 1/2 x 3 1/2 x 3 1/2	
	5C328	10.35		5	5	8	90-13		F/S	1 x 4 1/2 x 4 1/2	
	52C10Z8	14.70		10	5 1/4	8	125-9		F/S	2 1/4 x 5 1/2 x 5 1/2	
	52C10FEX	19.50		15	5 1/4	8	75-15	W	F/S	2 1/4 x 5 1/2 x 5 1/2	
	68C20FEX	25.65		15	6x8	8	45-17	W	F/S	3 1/2 x 6 x 8	
	69C10FEX	21.40		15	6x9	8	45-17	2	F/S	3 1/2 x 6 x 9 1/4	
	69C30FEX	42.05		50	4x8		35-15	W	F/S	3 1/2 x 6 x 9 1/4	
69C10FECO	36.40		15	6x9	8	45-20	2	F/S	3 1/2 x 6 x 9 1/4		
RADIO SHACK	12-1856		59.95	60	6 Dia.	8	80-16	3	F	6 Dia.	
	12-1853		59.95	40	5 1/4 Dia.	8	120-18	2	S	10 1/2 x 6 1/2 x 4 1/2	
	12-1845		79.95	40	5 1/4 Dia.	8	100-15	3	F	9 1/2 x 6 1/2 x 1 1/2	
RTR INDUSTRIES	4.1		199.95	60	4	4	55-25 ±3	2	S	7 1/2 x 4 1/2 x 4 1/2	
SANYO	SP709		22.98	10	4	4	90-15	W	F		
	SP721		39.95	10	4	4	80-16	2	F		
	SP40		49.95	30	4	4	70-20	2	F		
	SP700		14.98	5	6 1/4	4	100-12		F		
	SP711		32.95	15	6 1/4	4	80-16	W	F		
	SP9035		59.95	30	6 1/4	4	70-17	2	F		
	SP9036		69.95	30	6 1/4	4	70-20	2	F		
	SP9046H		109.95	100	6 1/4	4	60-20	2	F		
	SP758		54.95	30	5x7	4	80-16	2	F/S		
	SP766		69.95	30	6x9	4	50-16	2	F		
	SP772		79.95	30	6x9	4	50-20	3	F		
	SP778		99.95	30	6x9	4	50-20	3	F		
	SP69A		199.95	120	6x9		40-20	3	F		
	SP412		89.95	30	4x10	4	70-20	3	F		
SP90		219.95	120	4		80-20	2	S			



Visonik Alphasonik D3200

MANUFACTURER	Model	Price, \$ (If Sold Individually)	Price, \$ (If Sold in Pairs)	Recommended Max. Power, Watts	Woofer Size, Inches	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	Whizzer (W), 2-Way (2), 3-Way (3), 4-Way (4)	Finish (F), Surface Mount (S), Convertible (C)	Dimensions, Inches	Notes
SONY	XS-1	279.95	100	5	4	90-40 ±6	2	S	10½x5½x7½	Includes 20 W/ch. Internal amp. As above.	
	XS-11	199.95	70	5	4	90-19 ±6	2	S	9x5¼x7¾		
	XS-21	179.95	50	4	4	80-20 ±6	2	S	8¾x5¾x4¾		
	XS-601	149.95	70	6½	4	70-20 ±6	3	F	7¾x7¼x3¾		
	XS-602	129.95	70	6½	4	70-19 ±6	2	F	7¾x7¼x3¾		
	XS-201	79.95	50	5	4	80-17 ±6	W	F	5¾x5¼x2¾		
	XS-611S	49.95	20	6½	4	70-15 ±6	W	F	7½x2½		
	XS-211S	39.95	15	5½	4	85-12 ±6	W	F	6¼x1¼		
	XS-M31	159.95	5	4	4	80-19 ±6	W	F	5¾x5¾x5		
	XS-M33	199.95	6½	4	70-19 ±6	2	F	7¼x7¼x6½			
	XS-202	99.95	50	5	4	80-19 ±6	2	F	5¾x5¾x2¾		
	XS-66	159.95	80	6x9	4	50-19 ±6	3	F	8¾x9¾x4¾		
	XS-63	139.95	40	6x9	4	50-19 ±6	3	F	6¾x9¾x4		
	XS-62	109.95	40	6x8	4	55-18 ±6	2	F	6¾x9¾x4		
	XS-43	139.95	40	4x10	4	65-18 ±6	3	F	4¾x10¾x3¾		
XS-613S	79.95	20	6½	4	70-17 ±6	2	F	7¾x2¾			
SOUNDMATES	S-6	87.50	175.00	75	6x9	8	10-2 ±7	2	F/S	Adjustable tweeter.	
SPARKOMATIC	SK6950	99.95	200	6x9	4/8	50-20	4	S	6¼x9¼x4		
	SK550	89.95	200	5x7	4/8	60-20	4	S	8x6x5½		
	SK650	69.95	200	6	4/8	70-20	4	F	6¼x6¼x2¾		
	SK6900	89.95	80	6x9	4/8	40-18	3	S	6½x10½x3		
	SK525	89.95	50	4	4/8	80-18	3	S	10¼x5½x5		
	SK6922T	69.95	80	6x9	4/8	30-17	3	S	6¼x9¼x3½		
	SK522T	59.95	50	5x7	4/8	60-17	3	S	8x6x5½		
	SK622T	49.95	80	6	4/8	50-17	3	F	6¼x6¼x2¾		
	SK520C	44.95	50	5x7	4/8	60-15	2	S	8x6x5½		
	SK6920C	47.95	50	6x9	4/8	30-15	2	S	6½x9½x3¾		
	SK620C	34.95	50	6	4/8	50-15	2	F	6¼x6¼x2¾		
	SK4120C	47.95	50	4x10	4/8	50-15	2	S	4¾x10¾x3¾		
	SK600	39.95	30	6¼	4/8	70-15	2	F	6¼x6¼x1½		
	SK400	24.95	40	4	4/8	90-15	W	F	4x4x1¾		
	SK410	29.95	40	4	4/8	90-15	W	S	5½x6¼x5		
	SK313	12.95	10	3	4/8	125-8	S	S	4¾x3¾x5½		
	SK355	12.95	10	3¼	4/8	100-10	W	F	4x4x1¾		
VISONIK	D3200	150.00	45	4	4	60-22 ±3	2	F	6¾x4¾x1¾†, 3 Dia. x1††	†Above mounting surface, ††below mounting surface.	
	D3000	188.00	50	4	4	50-20 +4,-8	2	S	6¾x4¾x4¾		
	D4200	180.00	50	4	4	80-22 +4,-8	2	F	7¾x4¾x2†, 3¾ Dia. x1¾††		
	D4000	232.00	50	4	4		2	S	6¾x4¾x4¾		
	D5000	276.00	50	4	4		2	S	6¾x4¾x4¾		
	DMT-1	136.00	50	4	4	800-19 ±3	2	F	5½x3¾x1¼		
	W6920	45.00	60	6x9	4	40-3.5 ±3	2	F/S			
W620	45.00	60	6	4	45-3.5 ±3	2	F/S				

All styli are not created equal.



Round Shank UniRadial



Round Shank BiRadial



Round Shank Line Contact



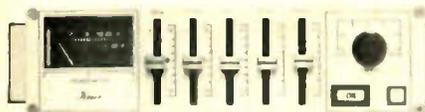
Square Shank Line Contact

When you select a phono cartridge, the cost will be strongly influenced by which stylus design you choose. Least expensive is the UniRadial (spherical or conical). A simple design, simply made. Or you can opt for better high frequency tracing with a BiRadial (elliptical) tip. Its more complex shape takes longer to make, so costs more. Best performance comes with a Line Contact (Shibata) tip whose shape permits the best high frequency tracing, yet whose long, narrow bearing face reduces groove pressure for longer record and stylus life. Add a positively-indexed square shank, plus laser-beam alignment of micro-polished surfaces and you have the finest stylus design available today. Make your choice with Audio-Technica. You'll hear the difference.



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Enter No. 9 on Reader Service Card



Kraco KE-6

AMPS/EQUALIZERS

MANUFACTURER	Model	Price, \$	Amps	EQ=Equalizer	Number of EQ Bands	Separate Controls for Each Stereo Channel?	Boost/Cut Range, dB	S/N Ratio, dB	Watts Into 4 Ohms, per IHF A-202	% THD at Rated Output, per IHF A-202	Dimensions, inches	Notes	
ADS	P100 Power Plate	319.95	Amp					51	0.08	1 1/2 x 12 1/2 x 6 1/4		Adjustable input sensitivity, three-position bass EQ.	
BLAUPUNKT	BEA-50 BEA-100 BEA-200	92.50 143.90 232.70	EQ Both Both	5 5 5	No No No	12 12 12		15x4 15x4	1.0 1.0	5 1/2 x 1 1/2 x 3 1/2 5 1/2 x 1 1/2 x 5 1/2 7 1/2 x 1 1/2 x 5 1/2		Built-in time delay reverberation.	
BON SONIC	AE202B AE207B		Both Both	5 7	No No	12 12		50	0.10 0.10	6 x 5 x 1 1/2 6 x 5 x 1 1/2			
BOSE	1401	217.60	Both		Yes	†	70	50	0.09	10 x 5 x 2 1/2		†Active spatial control — no boost/cut as in passive faders; see "Speakers" section.	
CLARION	300EOB2 150EOB2 100EOB3 EE115B GA302E GA301E	199.95 149.95 99.95 59.95 129.95 56.95	Both Both Both EQ Amp Amp	5 5 5 5 5	No No No No	15 15 15 15		25 13.5x4 13.5	1.0 1.0 1.0	7 1/2 x 1 1/2 x 6 1/2 5 1/2 x 2 x 5 1/2 5 1/2 x 1 1/2 x 6 1/2 5 1/2 x 2 x 6 5 1/2 x 2 x 6 5 1/2 x 1 x 4		Defeat switch, fader. Power switch, preamp, fader. Defeat switch, fader. Defeat switch.	
EVADIN	EQB-160	39.95	Amp			20	45	30	1.0	4 x 1 1/2 x 5		Booster amp.	
FUJITSU TEN	CA-200 PA-130 OA-150 PA-200 PA-160	119.90 75.90 103.95 140.00 259.90	EQ Amp Amp Amp Amp	5	No	12		60 12 70 40 70		1 1/2 x 3 3/4 x 5 1/2 1 1/2 x 5 1/2 x 5 1/2 2 1/2 x 4 3/4 x 5 1/2 2 1/2 x 7 1/2 x 9 1/2 2 1/2 x 5 3/4 x 9 1/2			
ARTHUR FULMER	15-0720 15-0731 15-0732	49.95 79.95 99.95	Amp Both Both	5 7	No No	10 12		24.6 28 29.5	10.0 10.0 10.0	1 1/2 x 4 1/2 x 6 1 1/2 x 3 1/2 x 5 1/2 1 1/2 x 5 1/2 x 6 1/2			
JENSEN	A30 EQ400 EQA3000	99.95 129.95 179.95	Amp EQ Both	15 5				80 90 80	15 0.3 0.05 0.3	2 1/2 x 7 1/2 x 9 1/2 2 1/2 x 6 1/2 x 6 1/2 2 1/2 x 6 1/2 x 6 1/2			
JET SOUND	JS-51 JS-61 JS-71 JS-121	69.95 89.95 119.95 159.95	Both Both Both Both	5 5 8 12	Yes Yes Yes Yes	12 12 12 12		50 60 80 80	20 30 40 50	1 1 0.1 0.1	1 1/2 x 4 1/2 x 5 1/2 1 1/2 x 4 1/2 x 5 1/2 1 1/2 x 7 1/2 x 6 1/2 1 1/2 x 7 1/2 x 6 1/2		
KENWOOD	KGC-737 KGC-747 KAC-727 KAC-887 KAC-801 KAC-901	249.95 164.95 99.95 149.95 249.95 379.95	Both EQ Amp Amp Amp Amp	7 7	No No	12 12		85 85 80 92 80 92	† 15 15x4 50 100	1 1 1 1 1 1	6 1/2 x 2 1/2 x 6 1/2 6 1/2 x 2 1/2 x 6 1/2 6 1/2 x 2 1/2 x 6 1/2 6 x 2 1/2 x 6 11 1/2 x 2 1/2 x 7 11 1/2 x 2 1/2 x 8		†5x2 and 15x2. Adjustable input sensitivity. As above.
KRACO	KE-6 PB-131 KE-7 KE-5 KE-3	89.95 39.95 169.95 79.95 59.95	Both Amp Both Both Both	5 7 5 5	No Yes Yes Yes	12 12 12 12		20 15 20 15 10	10 10 1.0 1.0 1.0	1 1/2 x 6 1/2 x 6 1/2 2 x 5 x 7 2 1/2 x 7 x 8 2 x 5 1/2 x 7 2 x 5 1/2 x 6 1/2			
LINEAR POWER	401 601 901 1501 EQ-1 PA-1	139.95 174.95 229.95 359.95 179.95 99.95	Amp Amp Amp Amp EQ EQ					95 95 95 95	20 30 45 75	0.15 0.15 0.15 0.15	8 1/2 x 5 x 2 8 x 6 1/2 x 2 7 x 6 1/2 x 4 7 x 9 x 4 4 1/2 x 4 1/2 x 1 1/2 7 x 1 1/2 x 4		Variable input sensitivity. As above. As above. As above. As above. High/low level inputs, variable input sensitivity.
MARANTZ	SA-2040	160.00	Amp		Yes			10x4	0.5	2 x 9 1/2 x 9 3/4			
MINI-AMP CORP.	Mini-Mac MX-1000 Dyne-Mac MX-7000 Maxi-Mac MX-3000	99.95 179.95 119.95	Amp Amp Amp			10 10 10		40 150 50	0.07 0.008 0.07	4 1/2 x 2 3/4 x 3 1/2 4 1/2 x 2 7/8 x 3 1/2 (2) 3 1/2 x 4 x 1 1/2 3 1/2 x 4 x 1 1/2 5 x 4 x 1 1/2		Two mono amps for 40-W stereo. Three pieces, 2 amps and 1 power supply.	

FIFTY YEARS. of TV

EUGENE PITTS III and WALTER I. SEIGAL



Television is 50 years old this month. On July 21, 1931, regularly scheduled broadcasts of TV programs were begun by 500-watt experimental station W2XAB in New York City from studios located on the 23rd floor at 485 Madison Avenue. While W2XAB's was the sixth TV transmitter in Manhattan, this was the inauguration of scheduled broadcasting. It was an invitation-only affair, and officials, celebrities and leading entertainers participated in the ten-act program which ran from 10:15 to 11:00 p.m.

With Ted Husing as master of ceremonies, Mayor James J. Walker opened the program. The station's "Television Girl," Natalie Towers, was introduced, and she was followed by Kate Smith, who sang "When the Moon Comes Over the Mountain" and "Making Faces at the Man in the Moon." Comic Henry Burbig did a specially titled "Little Red Riding Hood," after which tenor Ben Alley and contralto Helen Nugent sang "Under Your Window Tonight." The Boswell Sisters sang "Heebie-Jeebie Blues," George Gershwin played "Lisa," and Helen Gilligan and Milton Watson sang "Dream

*Ben Alley and
Helen Nugent sang
"Under Your
Window Tonight."*



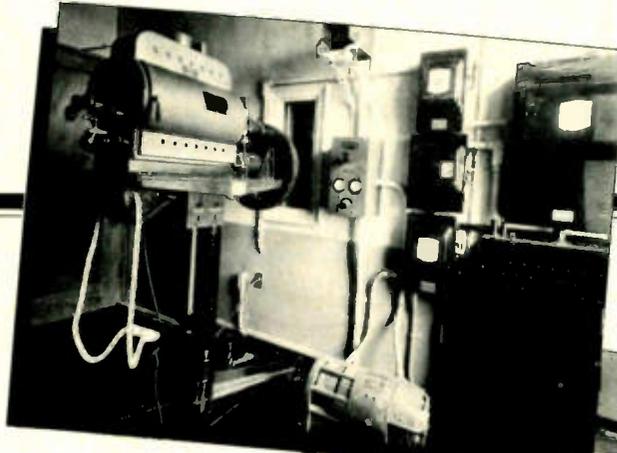
a Little Dream of Me" and "Now You're in My Arms."

In another studio, over 100 guests watched the program on several TV receivers with screens about four inches square. *The New Yorker* magazine, in August of that year, gave its impression of picture quality:

"One night last week Columbia broadcast two prizefighters in action, to give the public some idea of what it will be seeing in a few years. With a dozen other people we watched the shadowy images of Benny Leonard and another boxer on the small screen of a receiving set. Only about two people really can see comfortably into the present set; the others have to bend and duck and crane their necks over the lucky ones' shoulders.

"The fight wasn't very good. The boxers had to stay inside a space about five feet square and you could see them only from their waists up. Now and then there'd be a clear picture; then the pugilists would appear to be groping in a fog or chasing each other in a tank of milk. Faces and arms dilate and contract and look crazy, like images in those trick mirrors at amusement parks.

"Lighting is a major difficulty. For the last round, we went up into the room where the fight was going on. It was about the size of a bathroom and dark. Out of a small glass-enclosed control room a finger of light plays upon



From top, Mayor James J. Walker; views of the studios from in back of and in front of the camera, and engineer Harry Spears makes up TV Girl Natalie Towers; TV department secretary and William Schudt, Jr., Columbia's Television Director.



FIFTY YEARS of TV

the figures of the performers. If it were allowed to come to a full stop, it would be just a spot as big as a thumbnail, but a disc with sixty holes in it whirls in front of the line of light, scattering it. This light, reflected back from the body of whoever is being televised, is registered, after a lot of little miracles, on a screen of a receiving set. Right now it's hard to get more than two persons in a picture. Four

Helen Gilligan and Milton Watson sang "Dream a Little Dream of Me" and "Now You're in My Arms"; Kate Smith did "When the Moon Comes Over the Mountain" and "Making Faces at the Man in the Moon."



or five would have to stand back so far that they wouldn't reflect the light strongly enough. Performers have to be made up like movie actors, with grease paint and lipstick."

Generally, performers during the experimental phase of TV were established stars who were already well known to radio audiences. One interesting exception to this was the "CBS Television Girl," Natalie Towers, whose job it was to act as a sort of living test pattern in front of the TV scanner. Since there was, of course, no history to the medium, everything had to be tested — skin and hair tones, make-up, clothing colors, backgrounds. This inevitably led to some humorous bits in the newspapers — *The Times* for April 24, 1932, reported that a television watcher had telephoned W2XAB to "inquire if television technique permits artists to go on air without neckties." *The Times* went on to explain that "red appears white when televised, so the red tie turned white which blended with the shirt. Incidentally, that is why the performers use black lipstick instead of red, otherwise their lips appear white." Indeed, the *American* for July 30, 1931, reported that "wizards in the laboratories are now deep in conference over what color lipstick is the most suitable for television, how best to present a play, what kind of mechanical props to use





... Director of make-up probably will be one of the biggest jobs in the studios when television is here in a big way. . . ."

By the end of 1931, W2XAB was broadcasting some seven hours of programming a day, seven days a week. The next year, the station reported the results of the Presidential election contest between Roosevelt and Hoover.

Transmission during the early 1930s was on a channel between 2,750 and 2,850 "kilocycles" with 60-line scanning and 20 frames per second; the sound portion of the program was broadcast over W2XE, a shortwave station at 49.02 meters, and a coast-to-coast network of 85 stations linked to WABC in New York. At 500 watts, the video transmitter was expected to do little more than cover Manhattan, but the October 4th Brooklyn *Eagle* carried a note that "dances, silhouettes and visual announcement signs have lately been reported seen by television as far as Indianapolis, Ind., while reports arrive weekly from Toronto, Chicago, Washington, and other distant cities. The sound accompaniment for the visual programs . . . is reported heard almost nightly in many parts of South America, Europe, New Zealand and Australia, in favorable weather conditions."

In July of 1932, William A. Schudt, Jr., Columbia Broadcasting's Director of

On the first broadcast by W2XAB, George Gershwin played "Lisa" and dapper Ted Husing was the master of ceremonies.



FIFTY YEARS. of TV



TV Programs, estimated that there were some 9,000 television receivers in the metropolitan New York City area alone. However, on Feb. 23, 1933, broadcasting was suspended, and management stated:

"We now feel that further operation with the present facilities offers little possibility of contribution to the art of television, and we have, accordingly, decided to suspend temporarily our program schedule. . . . It is our intention to resume our experimental transmission as soon as we are sufficiently satisfied that advanced equipment of broader scope can be installed. Until then our activities will be confined to the laboratory and the maintenance of our close contacts with other organizations in the field."

In 1937, W2XAB's parent company ordered one of the world's most powerful TV transmitters for installation on the Chrysler Tower, together with the then state-of-the-art electronic camera equipment for film and live pickup. This equipment was designed for 343-line images, but even while it was under construction, the order came for modification to a 441-line standard. In 1941, the standard was raised still higher, to the present-day 525 lines.

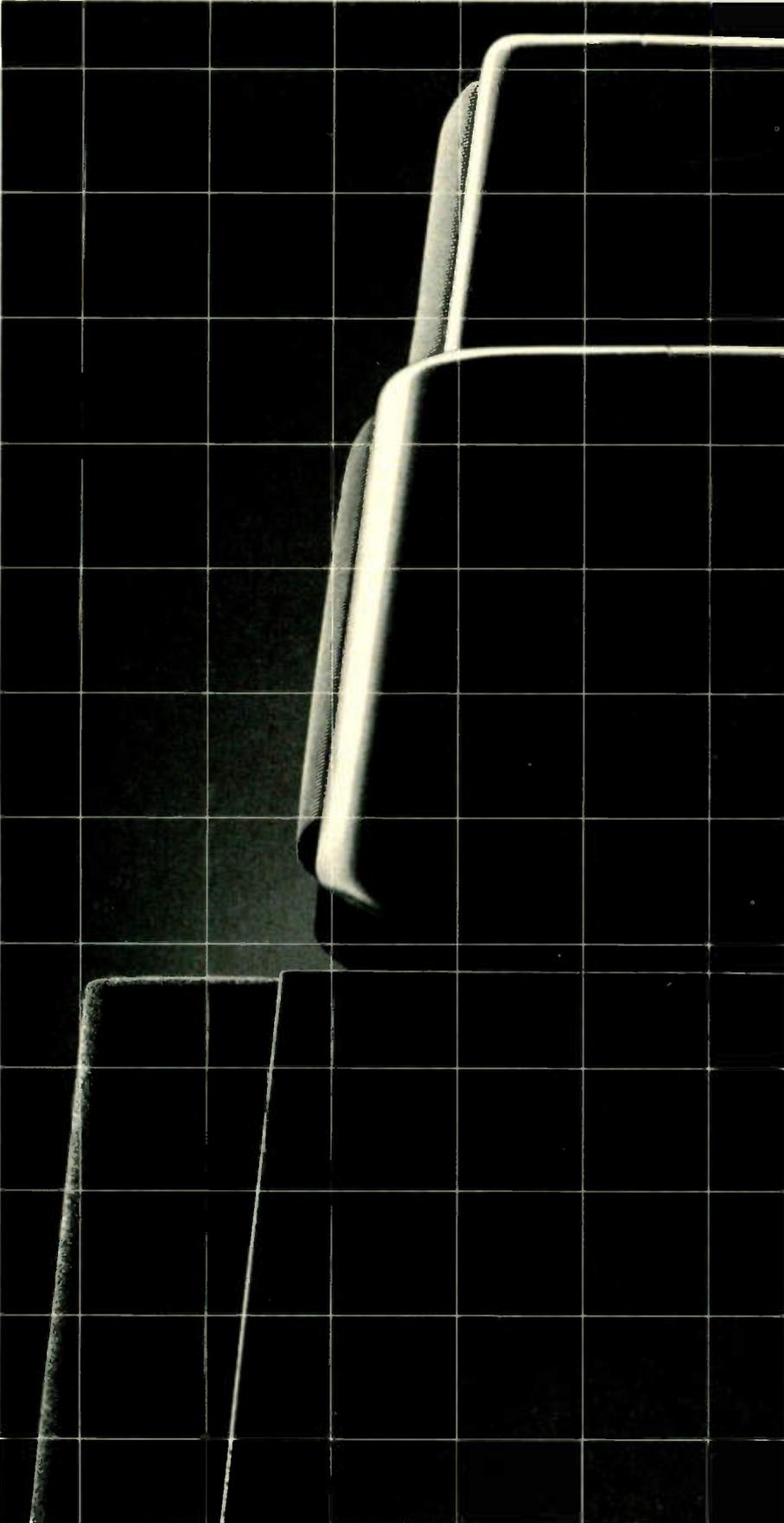
Work began on the installation of the

Chrysler Tower transmitter on September 27, 1938. The equipment weighed some 100,000 pounds and was to be installed 900 feet above street level. Moreover, the equipment had to be moved into the building during the night and on weekends so as not to disturb normal building tenant traffic. Moved up some 60 stories by freight elevator, the final 14 stories were covered by hoist. In addition to the transmitter itself were the electrical transformers and feeders needed to supply some 500,000 watts of power — 300,000 of which were for actual current broadcasting needs, with the remainder being held in reserve for possible expansion or unforeseen requirements. On October 10, 1939, the new transmitter was test operated for the first time.

The Federal Communications Commission gave approval for regularly scheduled commercial TV broadcasting on July 1, 1941, and on that date two stations began such broadcasting. One of them was W2XAB, which changed its call letters that day to WCBW. A 15-hour-a-week schedule remained standard for 11 months until it was curtailed, as was the schedule of other TV stations, to four hours a week to conserve scarce tubes and manpower during wartime.

Henry Burbig, who was later to play "Tinker, the Toymaker" on "Tinker's Workshop," a five-day-a-week show on WABC during the mid-1950s, did his routine, "Little Red Riding Hood."





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BUILD A HIGH PER- FORMANCE THD ANALYZER

PART ONE

ROBERT R. CORDELL

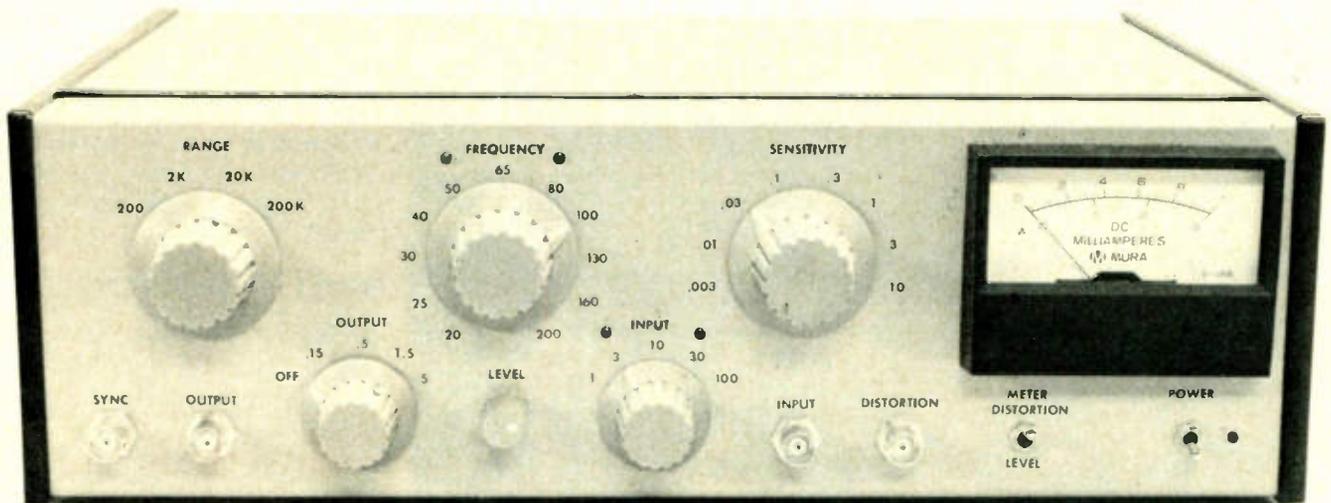
The Total Harmonic Distortion (THD) analyzer is probably the most widely used instrument for evaluation of distortion in audio systems. Unfortunately, those analyzers which are good enough to evaluate contemporary equipment generally cost in the neighborhood of \$2,000. Because of a careful selection of features and a topology which lends itself to realization with low-cost components, the analyzer described in this article can be constructed for a fraction of that cost, while providing a measurement floor on the order of 0.001 percent across the full audio band.

A typical measurement setup of a THD analyzer is shown in Fig. 1. It consists of a low-distortion oscillator feeding the Unit Under Test (UUT) which in turn feeds the THD analyzer, an oscilloscope is optionally used to observe the waveform of the distortion products. (In most high-performance THD analyzers, the oscilloscope and analyzer are in one unit.) It is well known that a nonlinearity

The 'scope photo in Fig. 2 shows the fundamental sine wave in the top trace and a typical distortion waveform in the bottom trace. Viewing the distortion in the "time domain" is very useful in evaluating the nature of the distortion mechanism. Here, the disturbances near the zero crossings of the fundamental imply that crossover distortion exists. As far as audibility is concerned, for a given magnitude of distortion, smooth or "soft" distortion waveforms are preferable to jagged or "harsh" waveforms.

How THD Analyzers Work

We can get a feel for some of the analyzer requirements by seeing what the desired performance specification implies. Here, our goal is a measurement floor of less than 0.001 percent. This means that if we bypass the UUT, that which remains after the fundamental is rejected is less than 0.001 percent, or 100 dB down. The residual will consist of distortion, unrejected fundamental,



in the UUT, when adequately excited by a sine wave (the so-called "fundamental"), will produce at the output harmonics of the sine wave in addition to the fundamental. The principle of the THD analyzer is to remove the fundamental entirely and measure what is left. This removal of the fundamental is usually achieved with an extremely sharp and deep notch filter centered on the fundamental frequency.

noise and hum. Clearly, we need a very good oscillator, one with distortion at least 10 dB down from the floor, or better than 0.0003 percent. In addition, low-noise, low-distortion electronics throughout the analyzer are mandatory.

Similarly, the notch filter should probably have at least 110 dB of rejection, while attenuating the closest harmonic (the second) by less than, say, 0.5 dB. Such a sharp notch is normally difficult

to achieve and even more difficult to tune manually. This problem is dealt with in most high-performance analyzers by automatic tuning circuits, often termed "auto tune" [1]. Notch filters are generally realized by passing the signal through two paths with differing phase and/or amplitude characteristics so that the two resulting outputs are equal and of opposite phase only at the center frequency. When combined, the signals thus cancel each other at the center frequency. It can be seen that an automatic tuning system must exert two types of control: One to assure the proper phase relationship at the notch frequency, and one to assure that the amplitudes of the two signals are exactly equal at the notch frequency so that full cancellation can occur. As we shall see later, these two control circuits each function by examining different characteristics of the output of the notch filter and then adjusting notch filter control elements accordingly. The auto-tune circuits of a THD analyzer are generally responsible for a substantial portion of the overall cost, but they are virtually indispensable. With well-designed auto-tune circuits, rejection of the fundamental is so complete that analyzer internal distortion and noise generally dominate the residual and establish the measurement floor.

To make maximum use of the convenience associated with auto tune, it is best to have the oscillator packaged in the analyzer so that its frequency can be controlled in step with that of the analyzer. This also tends to reduce the control range required of the auto-tune circuits, making them less prone to limit analyzer performance.

An additional feature found in most better analyzers is called "auto set level." In analyzers without this feature, a level-setting calibration adjustment must be made whenever the input level is changed. An auto set level feature permits the input level to the analyzer to change over some range, say ± 10 dB, without affecting the calibration of the distortion meter. It is achieved with a type of a.g.c. circuit which adjusts the gain in the measurement path (after the notch filter) downward in direct proportion to increases in input level.

Finally, many analyzers include high-pass and low-pass filters of varying complexity and flexibility to optimize performance. These distortion product filters are

placed in the measurement path after the notch filter. Generally, a high-pass filter is used to minimize the effect of hum in the UUT on the measurement. Low-pass filters are usually employed to limit the measurement bandwidth (to minimize noise) while passing all of the harmonics of interest (e.g., up to the tenth).

Practical Analyzer Design

My goal here was to provide a THD analyzer design capable of state-of-the-art performance which can be constructed at moderate cost and with readily available parts. At the same time, I felt that retaining the features of a built-in oscillator, auto tune, auto set level, and product filtering was essential. One compromise made to keep down costs was to limit the number of switch-selectable operating frequencies to 10 evenly spaced frequencies per decade from 20 Hz to 200 kHz. Another cost saving resulted from the extensive use of ICs, even in the most critical circuits. In particular, the superb distortion performance of the 5534 operational amplifier made this possible.

A major expense in many analyzers is due or related to the control elements in the auto-tune circuits. The use of so-called "state-variable filters" in both the oscillator and the notch filter in this analyzer permitted the use of inexpensive FETs as the control elements in these circuits. The greater immunity to control-element nonlinearities of these filters has been pointed out in [2]. The topology of these filters also permits the use of ± 10 percent capacitors where precision components would normally be required.

While several sets of four identical range-selection resistors must be matched to within ± 1 percent, the absolute value of these resistors is not critical. Thus, a patient constructor with a digital VOM or simple resistor bridge can select matched sets from standard 5 percent carbon-film resistors. It's highly unlikely that you won't find four or more resistors matched to within ± 1 percent among a group of ten ± 5 percent carbon-film resistors purchased at the same time.

The exterior and interior views of the completed analyzer are shown in Figs. 3 and 4. The circuitry of the analyzer resides on one small and two medium-sized single-sided printed circuit boards; the regulated power supply is housed in a small metal box at the rear. As can be seen from the photo in Fig. 4, the major part of the construction effort is in the range and frequency switch wiring. As a guide to cost, the three circuit boards and their associated components will typically cost about \$160. The cabinet, power supply, meter, switches, switch-mounted components, etc. will represent additional expenses.

Before proceeding, one word of caution is in order. *This ambitious and moderately expensive project should not be attempted by anyone who has not previously built and troubleshot electronic construction projects. Anyone who does not own or have access to an oscilloscope should also think twice before embarking on it.* This is a challenging construction project requiring considerable effort and patience, but the payoff is great for anyone who wants a THD analyzer with state-of-the-art performance.

Fig. 1 — Typical measurement setup of a THD analyzer.

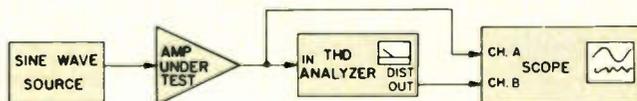
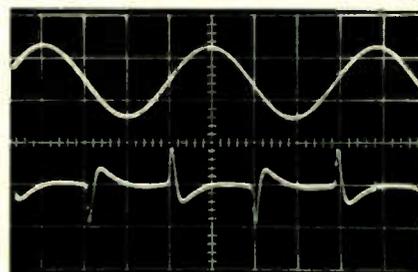


Fig. 2 — 'Scope photo showing the fundamental sine wave (top trace) and a typical crossover distortion waveform (bottom trace).



THD

PART ONE



Fig. 3 — Exterior view of the completed THD analyzer.

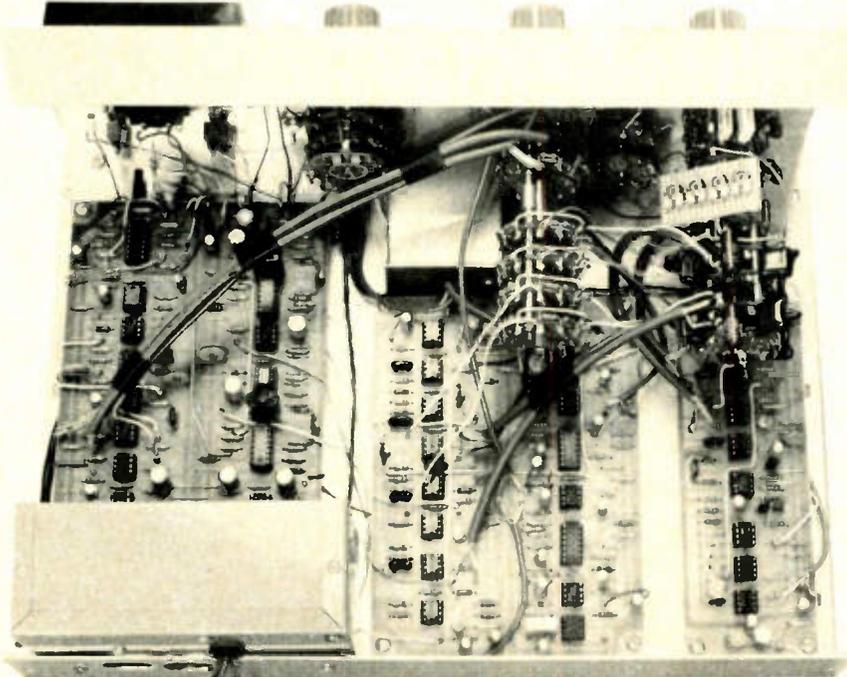


Fig. 4 — Interior view of the THD analyzer.

Overall Design

A block diagram of the complete analyzer is shown in Fig. 5. We'll now proceed with a brief overview of the analyzer's operation at the block diagram level before moving on to more detailed descriptions of the individual circuits.

The signal source resides on a single p.c. card, CP1, and consists of a state-variable oscillator, the necessary amplitude stabilizing circuits, an output amplifier, a level control, and an output atten-

uator. The amplitude control circuit is essentially a level detector which generates a d.c. error signal to feed the amplitude control multiplier. The latter controls the amount of positive feedback in the oscillator and consists of an FET and an operational amplifier.

The input circuits, controllable notch filter, auto-set level circuit, and distortion product amplifiers are located on a second p.c. card, CP2. The notch filter consists of a differential amplifier which is

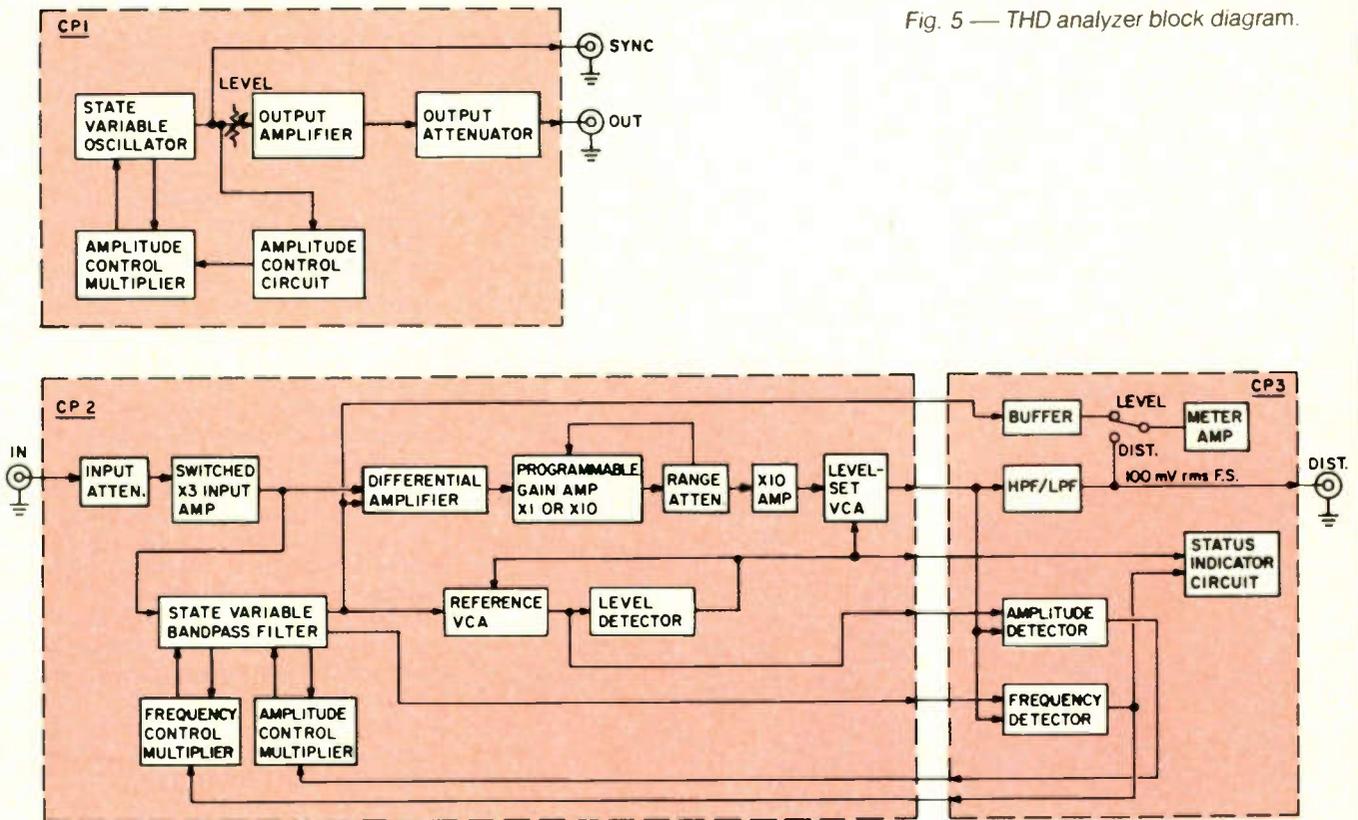
fed the input signal and a version of this signal which has passed through a state-variable bandpass filter whose frequency and gain are controlled electronically. At the center (fundamental) frequency, both inputs to the differential amplifier are identical in phase and amplitude, leaving only the distortion products at its output. The bandpass filter is sufficiently narrow that its output is very small at the second harmonic and higher frequencies, resulting in less than 0.5 dB of attenuation at the second harmonic. Operation of the notch filter is illustrated by the frequency response curves in Fig. 6.

The auto-set level circuit consists of two voltage-controlled amplifiers (VCAs) to which are fed identical control signals so that their gains vary in the same fashion. One VCA is in the path of the distortion product signal, while the other ("reference" VCA) is fed the output (the filtered fundamental) from the state-variable bandpass filter. The latter VCA feeds a level detector whose d.c. output controls both VCAs. The a.g.c. loop formed by the level detector forces the output of the reference VCA to be at a fixed reference level. Thus, if the input signal level doubles, the gain of both VCAs will be halved, resulting in the proper gain correction being applied to the distortion product path. Both VCAs are realized from inexpensive 1496-type balanced modulator ICs and achieve a control range of ± 20 dB with better than ± 0.5 -dB tracking. Notice that the distortion performance of the VCAs need not be exceptionally good because the one in the measurement path is passing only distortion products. Placement of an a.g.c. circuit ahead of the notch filter would necessitate the use of an extremely low-distortion VCA and might also compromise the noise floor of the instrument.

The auto-tune control circuits, product filters, status indicator circuit, and meter amplifier are located on a third p.c. card, CP3. The auto-tune control circuits consist of amplitude and frequency detectors which produce d.c. error signals to control the gain and center frequency of the state variable bandpass filter. These detectors function by looking for small amounts of fundamental in the output of the notch filter.

The principle of operation is as follows: An amplitude error between the two signals at the inputs of the differen-

Fig. 5 — THD analyzer block diagram.



tial amplifier will result in a small amount of in-phase (or 180-degree out-of-phase) fundamental at the output of the notch filter. The polarity of this error signal indicates which direction of amplitude adjustment is necessary. Similarly, but less obviously, a frequency error in the bandpass filter will result in a phase error between the two signals at the differential amplifier. This will result in a small amount of fundamental component at the output of the notch filter whose phase is lagging or leading 90 degrees (quadrature) relative to the fundamental. Whether the component is lagging or leading indicates which direction of frequency adjustment is necessary.

Each detector functions by comparing the output of the notch filter (after the auto-set level VCA) to a version of the fundamental supplied by the bandpass filter. The amplitude detector looks for in-phase fundamental components by making its comparison with an in-phase version of the fundamental supplied by the bandpass filter. Similarly, the frequency detector looks for quadrature

fundamental components by making its comparison with a 90-degree phase-shifted version of the fundamental, also conveniently supplied by a different output of the bandpass filter. The ready availability of this quadrature fundamental signal is an additional advantage of the state-variable filter.

The d.c. control signals from the level and frequency detectors also feed a status indicator circuit. This circuit drives front panel LEDs which indicate whether the input signal is too high or too low and also whether the input frequency is too high or too low (useful when a source other than the internal oscillator is used).

The high-pass and low-pass product filters in this design are both second-order (12 dB/octave) designs whose cut-off frequencies track changes in the selected fundamental frequency. These tracking filters substantially improve the measurement floor and simplify use of the analyzer by automatically providing optimal filtering regardless of the fundamental frequency setting.

The high-pass filter falls off at 12 dB/

octave below the second harmonic frequency. Its roll-off shape is chosen so as to have a minimal effect on distortion product frequency response. The low-pass filter is a second-order Bessel design which is down 3 dB at the tenth harmonic frequency. The excellent phase response characteristic of this design minimizes waveform distortion of the distortion products, preserving the accuracy of the visual display. The analyzer's overall distortion product frequency response is shown in Fig. 7.

While requiring little in the way of electronics, these tracking filters do add substantially to the complexity of the frequency and range switches, and some builders may prefer a simpler and less expensive alternative. Such an approach, providing the fixed filtering at 400 Hz, 30 kHz, and 80 kHz found on many commercial analyzers, is also described later in this article.

As a convenience, notice that with the flip of a switch (S6), the input level can be directly read with the range selected by the analyzer's input attenuator.

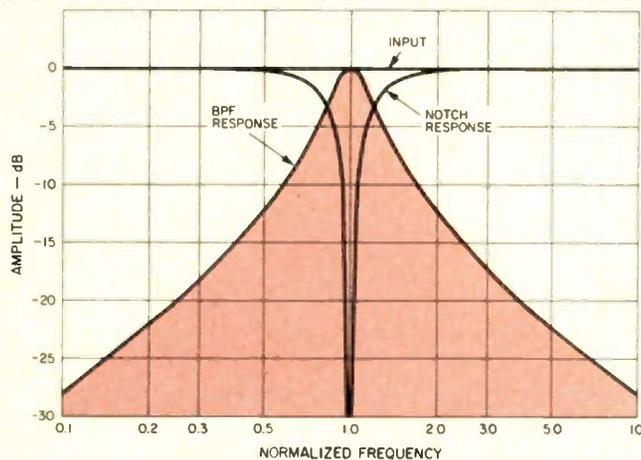


Fig. 6 —
Notch filter operation.

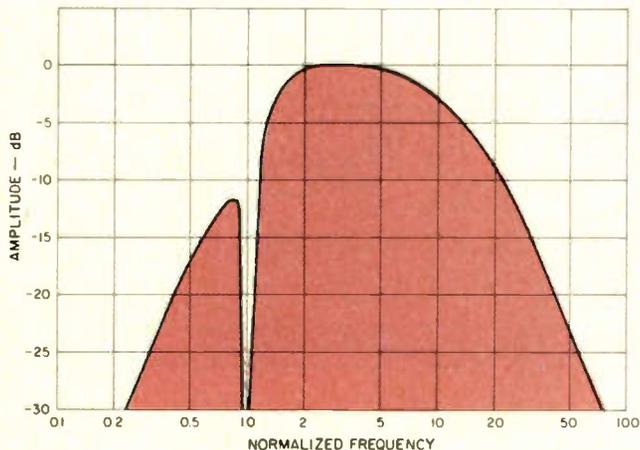


Fig. 7 — THD analyzer
frequency response.

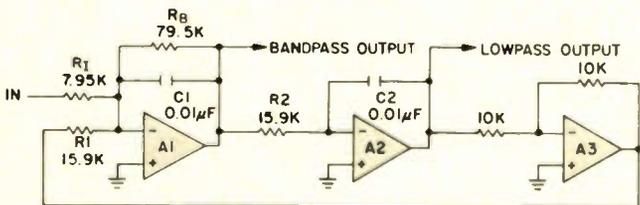


Fig. 8 — A simple state-
variable bandpass filter.

State-Variable Filters

Because it is central to the operation of the analyzer, a few words of explanation regarding the state-variable filter are appropriate at this point.

A simple state-variable bandpass filter is shown in Fig. 8. It consists of two integrators and an inverter connected in a loop. An input resistor (R_1) and a second feedback loop (R_B) around the first integrator (A1) complete the filter.

The term "state variable" comes from linear system theory involving solutions to linear differential equations. The state of such a system at a given point in time is completely determined by the values of the system's state variables. The

state-variable filter models a second-order differential equation in much the same way as one would model such an equation on an analog computer. In this context, the state variables are the output voltages of the two integrators.

A key to understanding the state-variable filter is the recognition that an integrator has a frequency response which decreases with increasing frequency at 6 dB/octave and introduces a 90-degree lagging phase shift at all frequencies. Let's temporarily ignore the input resistor R_1 and the bandwidth-setting resistor R_B and assume that we have a 1-V, 1-kHz signal at the output of A1. Each integrator is formed by a resistor

($R_1 = R_2$), a capacitor ($C_1 = C_2$), and an operational amplifier. The gain of the integrator is equal to $1/(2\pi RCf)$, where f is the frequency of interest and R and C are the values of R_1 , R_2 , C_1 and C_2 . R and C are chosen here for an integrator gain of unity at our 1-kHz operating frequency. The inverter also has a gain of unity. Notice that as the 1-V signal travels around the loop, it picks up 90 degrees from each integrator and 180 degrees from the inverter for a total of 360 degrees, which is the same as zero degrees. Thus, at 1 kHz the signal from A3 feeding the A1 integrator is exactly the signal required to provide and sustain the assumed output. We therefore have an oscillator.

Looking at it from a slightly different view, the feedback from A3 produces a current in R_1 which is just equal to the current required by C_1 given the assumed signal at the output of A1. The currents into and out of an ideal op-amp's virtual ground (the inverting input when the noninverting input is grounded) must always equal each other.

We can think of an oscillator as a bandpass filter with infinite Q . What if we want finite Q ? We add resistor R_B , often called the damping resistor. We now need an input, so R_1 is also added. If we make the same assumptions as before, we see that the current in R_1 still balances that in C_1 at 1 kHz. The current in R_B must therefore come from the input via R_1 , so the voltage gain at 1 kHz (the center frequency, f_0) is R_B/R_1 , and the phase shift is 180 degrees.

At higher frequencies the current demanded by C_1 increases and that provided by R_1 decreases. The input must now supply the extra current for C_1 as well as that demanded by R_B . A larger input is thus required for a given output, corresponding to decreased gain. By a similar argument, the gain can be seen to decrease at frequencies below f_0 as well. We thus have a bandpass characteristic. The Q of this filter is proportional to the value of R_B . The center frequency, f_0 , will always be the frequency at which the gain around the main loop is unity. This means that the center frequency can be conveniently changed by altering R , C , the inverter gain, or any combination of these.

With a bit more reasoning, it is easy to demonstrate that the output of the second integrator (A2) provides a 12 dB/

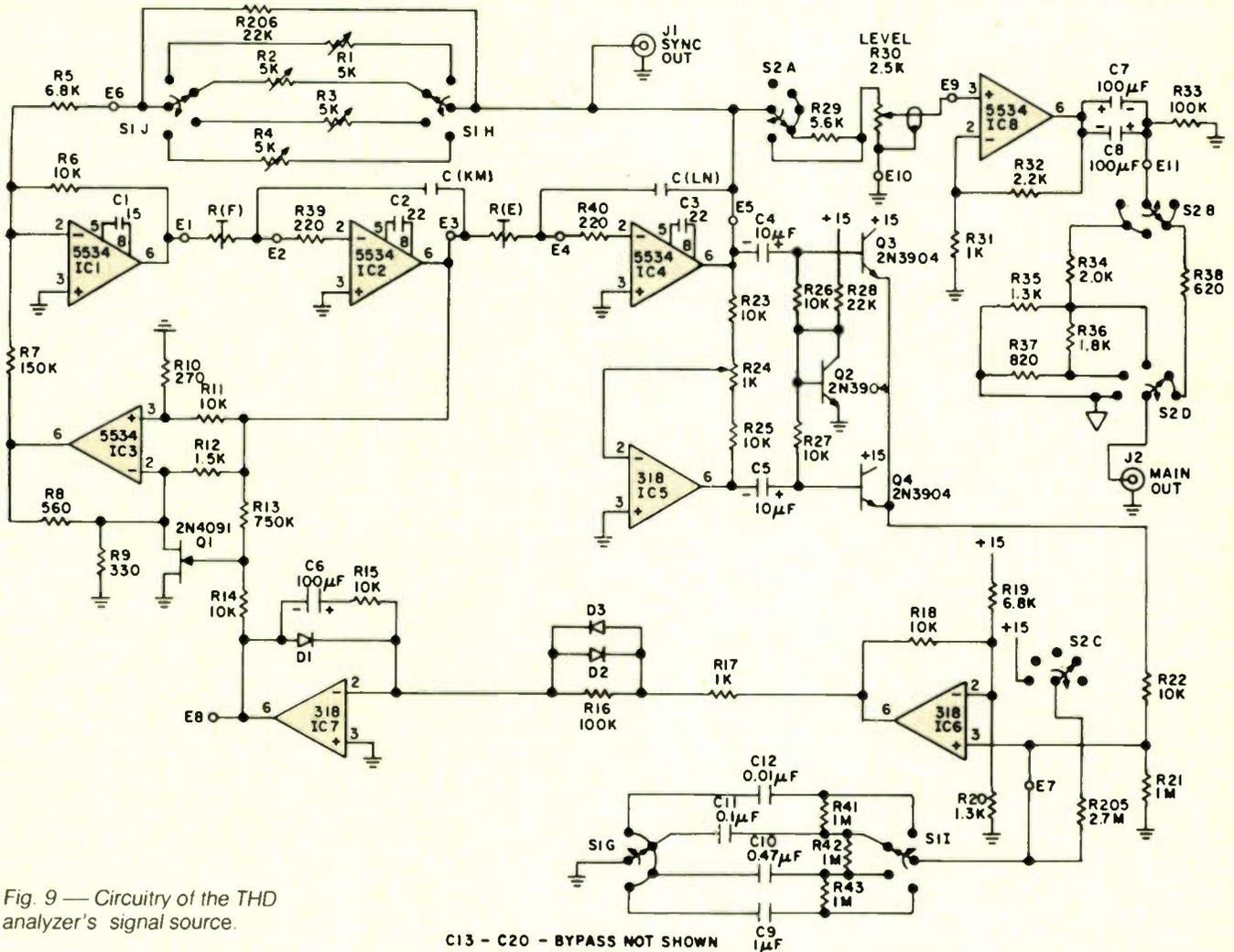


Fig. 9 — Circuitry of the THD analyzer's signal source.

octave low-pass characteristic. Notice that the phase of this output lags that of the bandpass output by 90 degrees at all frequencies. This feature is used to provide the required 90-degree phase-shifted fundamental signal to the frequency detector in the auto-tune circuit.

The Signal Source

With a solid understanding of the state-variable filter, operation of the state-variable oscillator is quite simple. As in the earlier example, we remove R_1 and R_B as a start.

As with any linear oscillator, we must provide a means to control the amplitude of the oscillations, i.e., provide a type of a.g.c. circuit. Recognizing that the presence of R_B produced negative feedback

around the first integrator which tended to damp out oscillations, we can reason that a feedback circuit around A1 which can provide variable amounts of negative or positive feedback will allow us to control the oscillations. Negative feedback will cause the oscillations to decay, while positive feedback will cause them to grow. This can be accomplished with a multiplier and a resistor in place of R_B . To complete the oscillator, we must add a control circuit to measure the amplitude of the oscillations, then compare it to a fixed reference, and finally deliver a d.c. error signal to the control input of the multiplier.

The complete schematic of the signal source is shown in Fig. 9. First, a word about notation and conventions used on

the schematics in this article. For simplicity, power-supply bypass capacitors and power-supply connections to standard pin-out operational amplifiers (+15 V to pin 7, -15 V to pin 4) are not shown. Off-board interconnection terminals are designated with an "E" number. Terminals on different boards which are connected together have the same E designation.

Each pole of a multi-pole rotary switch is designated with a letter, beginning with "A" closest to the front panel. Wafers with two poles have the left-hand pole (as viewed from the front panel) designated with the earlier letter in the alphabet; the letter for the right-hand pole is next in the alphabet. Arrows on switch wipers indicate clockwise rotation

as seen from the front panel. Tuning resistors are designated by the letter of the switch pole on which they are mounted (each resistor is mounted between adjacent switch positions on a given pole). Tuning capacitors are mounted between two adjacent wafers on the range switch, and they are designated by the letters corresponding to the two switch poles to which they connect.

Because of the large amount of wide-band gain packaged in this unit, specific approaches have been taken in terms of grounding and shielding strategy to avoid oscillations and interference pickup. Much of this is shown on the schematics to permit easy duplication. The \downarrow symbol, one of three different grounding symbols on the schematics, denotes a single-point chassis ground located at the input jack. All leads within this symbol are connected directly to this single point. The \llcorner symbol denotes a secondary single-point signal ground on CP2 (Figs. 12 and 13, Part II). This ground is connected to the single-point chassis ground via the shield of the input lead to CP2. The \perp symbol denotes ordinary multi-point circuit grounding. Each circuit board has its ordinary circuit ground connected to the single-point chassis ground, and positive and negative supply voltage is also distributed on a single-point basis from the location of the single-point chassis ground.

Returning to the circuit discussion, the oscillator proper in Fig. 9 consists of IC1 (inverter), IC2 and IC4 (integrators). Frequency-setting resistors R(F) and R(E) are mounted on frequency switch S3, while the corresponding capacitors C(KM) and C(LN) are mounted on range switch S1. Notice that the circuit has been slightly rearranged from that of Fig. 8, with the inverter "up front" and with the amplitude control feedback (IC3) encompassing both the inverter and the integrator. This arrangement permits frequency changes to be made by changing the switch-selected resistors without altering other operating characteristics of the oscillator. The analog multiplier for amplitude control is realized by op-amp IC3 and FET Q1. Notice also that each range has its own frequency trimmer (R1 to R4) to allow close matching of the oscillator frequency to that of the analyzer notch filter without requiring precision frequency-setting capacitors.

The output of the oscillator is taken

from IC4, which would correspond to the low-pass output of the filter in Fig. 8. This provides lower distortion and points to a significant advantage of the state-variable approach [2.] Given low-distortion amplifiers, the dominant distortion in an audio oscillator results from nonlinearity in the amplitude control element (here the multiplier) and ripple in the "d.c." control signal as a result of the detection process in the amplitude control circuit. In either case, this distortion is injected at the inverter (IC1) in this design. The two integrators between this point and the output provide a 12 dB/octave roll-off to these injected harmonics, thus affording a 4-to-1 reduction ratio in second harmonic and a 9-to-1 reduction in the more significant third harmonic. The integrators also tend to filter out noise, permitting the amplitude control multiplier to operate at a lower signal level, thus reducing its distortion from the start. These same advantages are also used in the analyzer notch filter.

As mentioned above, the amplitude control circuitry can be a major source of distortion in an audio oscillator. It is therefore important that ripple in the control signal be minimized by providing adequate filtering. However, it must also be realized that what we are dealing with here is a feedback control system, and stability must be considered. Because heavy filtering of the control signal introduces delay in the feedback loop which will decrease stability, we have conflicting requirements. A further strain on stability is generated by the need to have very high d.c. gain in the control circuit to minimize output amplitude errors and thus provide a very flat frequency response. The control circuit used in this design deals with these problems.

The detector portion of the amplitude control circuit includes IC5 and Q2 to Q4. Balanced oscillator output signals are provided by IC4 and inverter IC5 to the full-wave rectifier composed of transistors Q3 and Q4. Transistor Q2 provides a forward bias equal to one base-emitter drop to Q3 and Q4 so as to minimize detection errors resulting from their turn-on voltage requirement. The use of a full-wave rectifier greatly reduces the magnitude of the ripple in the control signal. The trimmer potentiometer in the feedback path of IC5 permits adjustment for perfect balance of the two signals feeding Q3 and Q4. This mini-

mizes distortion by minimizing ripple.

The rectified signal is filtered by the capacitor connected to E7 whose value is selected by the range switch (S1) to optimize the control dynamics for each frequency range. The filtered d.c. is then applied to differential amplifier IC6 where it is compared to a supply-derived d.c. reference voltage to produce an error voltage. The control circuit establishes the desired operating level of about 1.6 V rms at IC4's output.

From IC6 the error signal proceeds to FET driver amplifier IC7 through a nonlinear network. Under quiescent conditions the error voltage is small, and the gain in this path is relatively low so that ripple transmitted to the FET gate will be minimized. Under large-error conditions, such as just after a range change, the gain in this path becomes large to speed up amplitude stabilization. This is accomplished by diodes D2 and D3, which bypass R16 under these conditions.

For a.c. error signal components, IC7 operates as a simple inverting stage whose gain is set by R15. This assures stability of the feedback loop formed by the a.g.c. circuit. However, for d.c. error signals capacitor C6 provides for an extremely large gain in IC7. In essence, IC7 looks like an integrator at low frequencies. The output from this integrator will continue to change and adjust the gate voltage of Q1 until the error voltage from IC6 goes to zero. Following a range change, it takes the integrator about five seconds to drive the oscillator amplitude to within 0.1 dB of its final value. Diode D1 prevents a large forward bias from ever being applied to Q1.

The amplitude control multiplier is implemented by IC3 and FET Q1. The FET acts as a variable resistance, with the resistance controlled by the d.c. voltage applied to its gate by IC7. As the gate voltage varies from zero to a negative value equal to its "pinch-off" voltage (typically 5 to 10 V), its resistance from drain to source varies from about 25 ohms to infinity. IC3 is connected as a differential amplifier whose positive and negative inputs each receive a portion of the signal applied by IC2. Such a circuit can provide inverting or noninverting gain depending upon the relative balance between the circuits associated with the inverting and noninverting inputs of the op-amp. FET Q1 controls this balance. When the FET resistance is

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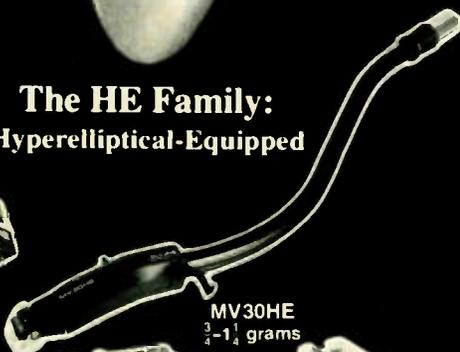
Look over the list at left to see which Shure HE cartridge best matches your tracking force requirements.

Shure has been the top-selling cartridge manufacturer for the past 23 years. For full details on this remarkable line of cartridges write for AL667.

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MV30HE
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V15 LT
 $1\frac{1}{2}$ grams



V15 Type III-HE
 $\frac{3}{4}$ - $1\frac{1}{4}$ grams



M97HE
 $\frac{3}{4}$ - $1\frac{1}{2}$ grams



M97HE-AH
(with attached headshell)
 $\frac{3}{4}$ - $1\frac{1}{4}$ grams



M97 LT
 $1\frac{1}{2}$ grams



M95HE
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M75HE Type 2
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THD

PART ONE

low, the noninverting gain exceeds the inverting gain so that a noninverting overall characteristic results. When the FET resistance is high, the opposite action results. At some intermediate FET resistance, the circuit is balanced and the gain is zero.

FETs are not perfectly linear resistors;

their drain-to-source resistance tends to be a function of the drain-to-source voltage. Such a nonlinearity can create distortion, making this a major concern. One way of minimizing this distortion is to operate the FET at the lowest possible signal level across it that is consistent with acceptable noise performance. The

excellent low-noise performance of the associated 5534 op-amp makes it possible here to operate at a level of only about 40 mV rms across Q1. This is established by the voltage divider which applies a fixed level of about 40 mV rms to the noninverting input of IC3. Because of the virtual short existing between the input terminals of an op-amp operating with negative feedback, this voltage also must appear at the inverting terminal of IC3, and thus across Q1.

A second way of reducing FET distortion involves a well-known technique wherein half of the drain-to-source signal is fed back to the gate of the FET. This provides a first-order correction for the nonlinearity, practically eliminating second harmonic distortion and leaving only a small amount of third and higher order harmonic distortion. This feedback is provided by the 750-kilohm resistor (R13) connected to the gate.

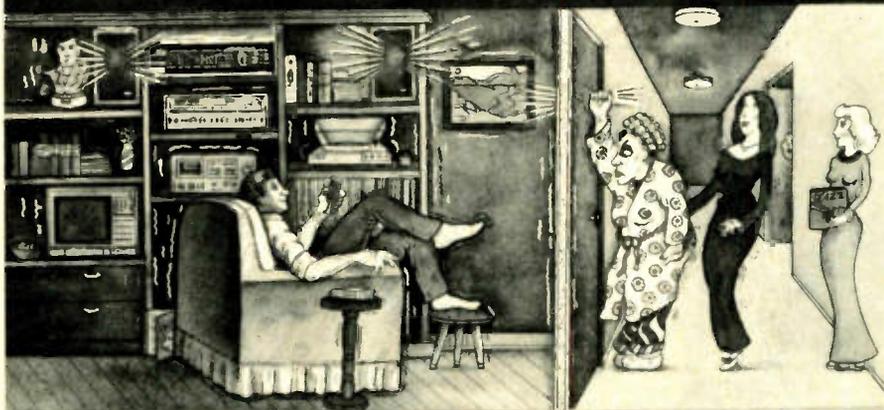
The remainder of the signal source consists of the level control (R30), the output amplifier (IC8), and the output attenuator. The level control provides continuous adjustment of the output amplitude, while the output attenuator provides maximum output ranges of 5 V, 1.5 V, 500 mV, and 150 mV. An off position is also provided which effectively kills oscillations, and it should be used when a different signal source is being employed so that crosstalk from the oscillator into the analyzer cannot affect results. The attenuator establishes a constant output impedance of 600 ohms. A fixed 1.6-V rms "sync" output is also provided by the signal source, which is useful as the trigger source for an oscilloscope used to visually monitor the distortion signal output of the analyzer.

Having discussed the overall analyzer in general and the signal source portion in detail, we now conclude Part I. Next month, in Part II, I will describe the remaining circuits in detail. Construction details and adjustment procedures will be covered in Part III. **A**

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1. Hewlett-Packard, HP 339A Distortion Analyzer User's Manual.
2. Hofer, B. E., "A Comparison of Low Frequency RC Oscillator Topologies," Preprint #1526, 64th Convention of the Audio Engineering Society, New York City, November 1979.
3. Gelfe, P. R., "How to Build High-Quality Filters Out of Low-Quality Parts," *Electronics*, November 11, 1976.

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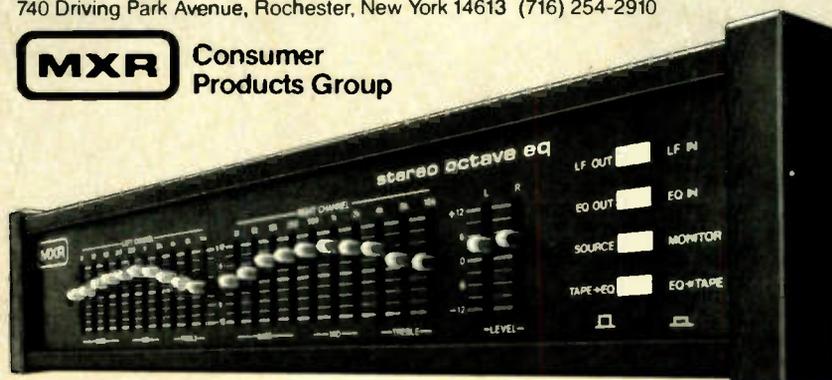
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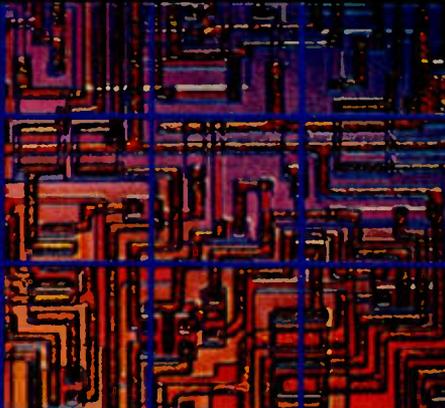


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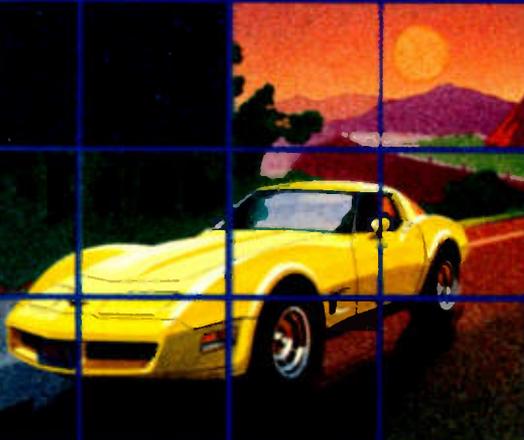


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1

YAMAHA R-2000 RECEIVER

Spurious Rejection: 50 dB.
THD: 0.3 percent, 1 kHz.

Amplifier and Preamp Sections

Power Output: 150 watts per channel, 8-ohm loads, 20 Hz to 20 kHz.

Rated THD: 0.015 percent.

IM: 0.01 percent for 75 watts into 8 ohms.

Damping Factor: Greater than 60.

Frequency Response: MM phono, 20 Hz to 20 kHz, ± 0.2 dB; MC phono, 30 Hz to 20 kHz, ± 0.3 dB; AUX, 5 Hz to 50 kHz, -1.0 dB.

Input Sensitivity: Per new IHF standards, MM phono, 0.2 mV; MC phono, 8.2 μ V; high level, 9.8 mV.

S/N Ratio: Per new IHF standards, MM phono, 80 dB; MC phono, 77 dB; high level, 87 dB; main amp in, 100 dB.

Bass Control Range: ± 11 dB at 80 Hz.

Treble Control Range: ± 12 dB at 10 kHz.

Subsonic Filter Cutoff: 15 Hz, -12 dB per octave.

High-Cut Filter Cutoff: 8 kHz, -6 dB per octave.

Maximum Loudness Control Attenuation: 20 dB at 1 kHz.

General Specifications

Power Requirements: 120 V, 60 Hz, 550 watts.

Dimensions: 21 $\frac{1}{4}$ in. (54 cm) W x 4 $\frac{3}{4}$ in. (12.1 cm) H x 15 $\frac{1}{4}$ in. (38.7 cm) D.

Weight: 29 lbs., 5 oz. (11.5 kg).

Price: \$900.00.

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: Mono, 11.3 dBf, 2.0 μ V @ 300 ohms.

50-dB Quieting: Mono, 14.2 dBf, 2.8 μ V; stereo, 33.2 dBf, 25 μ V.

S/N Ratio: Mono, 85 dB; stereo, 81 dB.

I. f. and Spurious Rejection: 100 dB.

Image Rejection: 70 dB.

AM Rejection: 65 dB.

Capture Ratio: Local, 1.2 dB; DX, 2.5 dB.

Alternate Channel Selectivity: Local, 30 dB; DX, 82 dB.

Mono THD: Local, 0.06 percent at 100 Hz or 1 kHz, 0.08 percent at 6 kHz; DX, 0.1 percent at 100 Hz, 0.3 percent at 1 kHz, 0.7 percent at 6 kHz.

Stereo THD: Local, 0.07 percent at 100 Hz or 1 kHz, 0.09 percent at 6 kHz; DX, 0.1 percent at 100 Hz, 0.5 percent at 1 kHz, 0.8 percent at 6 kHz.

Stereo Separation: Local, 50 dB at 50 Hz and 1 kHz, 45 dB at 10 kHz.

Frequency Response: 30 Hz to 15 kHz, $+0.3$, -0.5 dB.

Subcarrier Rejection: 65 dB.

Muting Threshold: DX, 14.2 dBf, 2.8 μ V.

Auto-DX Threshold: 35.3 dBf.

AM Tuner Section

Usable Sensitivity: 200 μ V, loop antenna.

Selectivity: 30 dB.

S/N Ratio: 50 dB.

Image Rejection: 40 dB.



There is so much that is new and different about this top-of-the-line Yamaha receiver that it would take this entire issue of *Audio* to describe all its features, circuitry, and technology. Many of the features which I admired in some earlier Yamaha receivers, such as a separate (and therefore meaningful) continuously variable loudness control, the totally separate recording and program selector switches, and the useful auto-blend FM stereo circuitry (which sacrifices some high-frequency stereo FM separation in return for reduced noise during weak-signal reception) have been retained on this model. And despite the reduced height of the front panel, a good many new features and controls have been added.

A push-button power switch is at the upper left of the panel. Next comes a major panel area devoted to tuner functions including a digital display of tuned-to AM or FM frequencies, a multi-segment LED signal-strength/quality indicator (which also serves to display multipath effects by flickering), and additional LEDs to indicate the tuner's mode (local or DX), stereo FM reception, and low or high tuning mode. The low and high tuning modes are selected by buttons located just below these last

named indicators. If the low button is selected, tuner scanning will stop at every received signal. If the high button is chosen, the scanning will stop only where strong signals are received. Other touch-buttons in this area include one for memory, which is used to preset station frequencies into one of seven programmable memories; a tuning up/down bar, and the FM and AM selector buttons.

One of the new convenience features of the Yamaha R-2000 is represented on the front panel by a button labelled "auto phono." When this button is depressed, the receiver will automatically switch over to phono input the moment your phono cartridge stylus sets down upon a record being played, no matter what other program source you had manually selected previously. Readers who shun gimmickry may find this feature to be a bit much, but think about it for a while; you just might grow to like the idea of being able to override, say, tuner or tape by simply starting a record going on your turntable!

The upper right section of the panel is devoted to five program selector touch buttons, the master volume control (accurately calibrated in dB below full volume), and the aforementioned seven preset buttons which can be used to memorize seven FM as well as seven different AM station frequencies. All remaining controls and functions are located along the lower section of the front panel. There we find a pair of stereo phone jacks at the left; a speaker selector switch; bass, midrange (or presence) and treble tone controls; a new control identified as a spatial expander with an associated on/off switch; a pre/main amp coupler switch; the record-out selector (with tape copy as well as signal source positions); a phono switch which selects either MM or MC inputs and offers three values of loading capacitance and loading resistance combinations for MM cartridges; a rotary balance control; the separate loudness control referred to earlier; a stereo/mono mode switch; a muting on/off-mono switch, and an auto/local switch.

The presence or midrange tone control is augmented by a three-position, concentrically mounted switch just behind it which selects the center frequency to be boosted or cut by the presence control. The center frequencies are an octave apart, at 800 Hz, 1.6 kHz, and 3.2 kHz. The spatial expander control introduces circuitry which, by manipulating phase and amplitude and by cross-feeding of channels, seems to extend the stereo sound field beyond the space between the two loudspeaker systems used with the receiver. The idea is not new, but this is the first time I have seen such a feature incorporated in a receiver. The pre-main coupler switch simply allows the user to "break" the signal path between the output of the preamp/control section and the main amp section of the receiver so that accessory devices may be interposed between these sections or so that the preamp control section can be used to drive a separate power amplifier, if desired. Normally, such facilities have been provided on receivers through rear-panel wire jumpers or slide switches. Yamaha makes it more convenient by bringing the switch up front. Upon reviewing the list of controls, I note that I overlooked the subsonic and high-cut filters located between the speaker selector switch and the bass control. Small wonder, considering how many controls and features Yamaha has managed to cram on this relatively slim panel. For all of that, the new design does not leave the impression of being cluttered or overdone. The panel is executed with the same good taste that characterized earlier Yamaha receiver and amplifier designs.



The R-2000 includes many of the features of earlier Yamaha receivers, yet adds several new features and worthwhile controls.

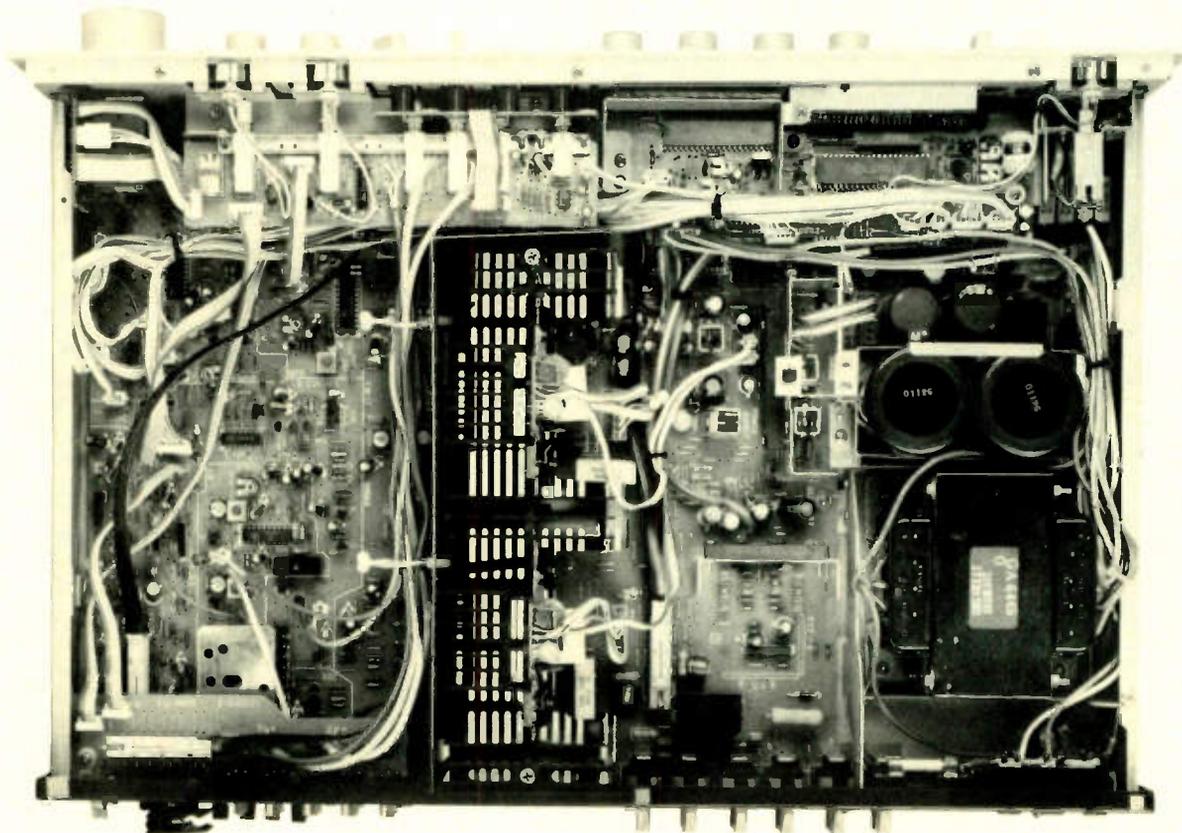
Up to three sets of speakers can be connected to this receiver via a new kind of speaker terminal which is a real pleasure to use. Simply insert the stripped end of the speaker wire into a large hole, twist the entire terminal a quarter-turn, and the wire is locked in place, making good contact with the output circuitry of the amplifier section. One switched and two unswitched a.c. receptacles are located to the right of the speaker terminals, while to their left is the usual array of input and tape-out jacks (there are two full tape-monitor loops on this receiver), 75-ohm unbalanced and 300-ohm balanced FM antenna terminals, external AM and ground terminals, the previously discussed preamp-out/main amp-in jacks, and a chassis ground terminal. The AM loop antenna is provided in a separate accessories envelope (a good idea in view of the number of damaged or broken ones I have unpacked over the years) and can be connected to a bracket on the rear panel or maintained at a distance from the receiver itself if reception conditions so dictate. Despite the fact that the front panel provides for selection of either MM or MC phono cartridge preamp circuitry, there is only one pair of phono inputs on the rear panel. It is, in other words, an either/or proposition.

Circuit Highlights

What Yamaha calls an X-Power Amplifier is apparently a two-level supply voltage system in which a high-speed comparator

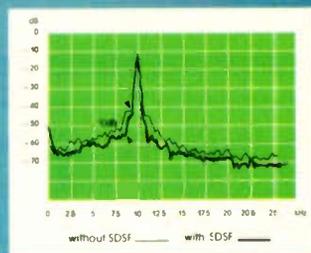
circuit monitors the level of the envelope of the audio signal, switching in the high-voltage supply when it is required to handle high-level music peaks. Additional fast-rise detectors are used to detect fast musical transients and to turn on the higher voltage supply a little before it is required so that switching distortion does not occur. A delay is also incorporated in the switch-down from high to low voltage as well, to eliminate the possibility of any switching distortion during that sequence. The system is said to be fast enough and precise enough so that even a single cycle at 100 kHz at full rated output (150 watts per channel) will not cause distortion. The whole idea is, to me, somewhat reminiscent of the Soundcraftsmen "Class H" idea, introduced a couple of years ago, and of the Carver magnetic field amplifier. As a result of this X-Power scheme, Yamaha has managed to build a lot of amplifier power into a fairly small space, thanks to the improved efficiency resulting from these circuit techniques.

As for the tuner section, I hasten to point out that all appearances notwithstanding, this is *not* a frequency synthesized tuner circuit nor does Yamaha claim it to be one. The manufacturer points out that one of the disadvantages of true frequency synthesized tuners is that the extra local oscillators and divide-down circuits in such tuners actually add noise to the signal and limit the ultimate signal-to-noise performance attainable by the tuner section. Instead of frequency synthesis, the R-2000 uses a microcomputer and memory to provide the desired station frequen-



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In "auto phono" mode, the receiver will switch over automatically from any source to phono at the moment the cartridge stylus touches a record.

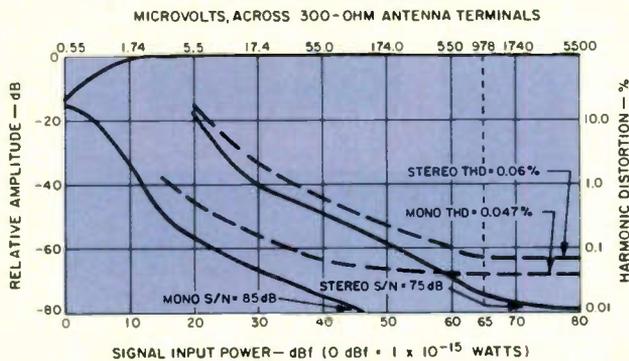


Fig. 1—Mono and stereo quieting and distortion characteristics.

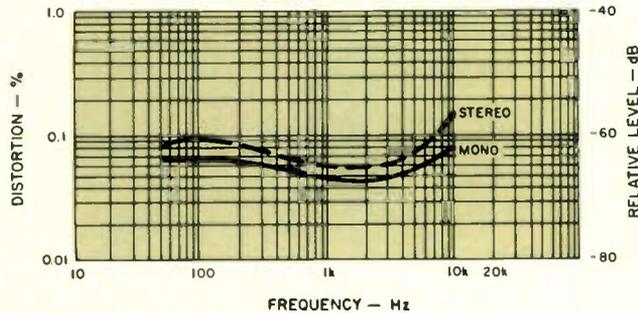


Fig. 2—Stereo FM distortion vs. frequency.

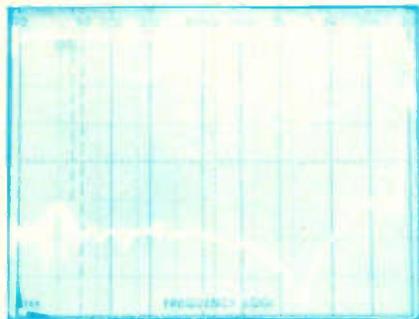


Fig. 3—Stereo FM frequency response and separation.



Fig. 4—Effect of auto-blend control on stereo FM separation.

cy in digital form. This digital code is applied to a D/A converter that puts out a d.c. voltage which corresponds to the digital frequency information. The control voltage governs both the front-end oscillator and tuned-to frequencies, while a special "Station Locked Loop" system makes corrections to the control voltage if the received station is not perfectly tuned in. In short, what we really have here is a rather sophisticated form of a.f.c. circuitry.

Yamaha's argument concerning performance limits of frequency synthesized tuners was, in fact, true up until a few months ago, when such manufacturers as Sony came up with methods which overcome the previous limitations of such tuners. Today, there are true frequency synthesized tuners which do fully as well in the S/N department as does the tuner section of the R-2000. This does not, however, detract from the fact that the tuner section of the R-2000 provides all of the benefits of true frequency synthesis (presets on AM and FM, automatic up and down scanning, and precise center-tuning) without having to resort to actual frequency synthesis.

Tuner Section Measurements

Figure 1 plots the quieting and distortion (1 kHz) characteristics of the tuner section of the R-2000 in mono and stereo. I measured a very outstanding 85 dB of quieting in mono and an impressive 75 dB in stereo (the latter most probably limited by my own test equipment, which has that much residual noise of its own in the stereo mode). THD for a 1-kHz, 100-percent modulating signal in mono was a very low 0.047 percent, rising only very slightly to 0.06 percent in stereo. Perhaps even more importantly, THD remains extremely low at all test frequencies, as can be seen from the plots in Fig. 2.

Usable mono sensitivity measured 13.2 dBf (2.5 μ V), a bit



Fig. 5—Stereo FM crosstalk components, 5-kHz modulating signal.



Fig. 6—Frequency response, AM section.



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THD measurements of the tuner were excellent, as was separation, while the amp's THD tests were probably limited by the laboratory equipment.

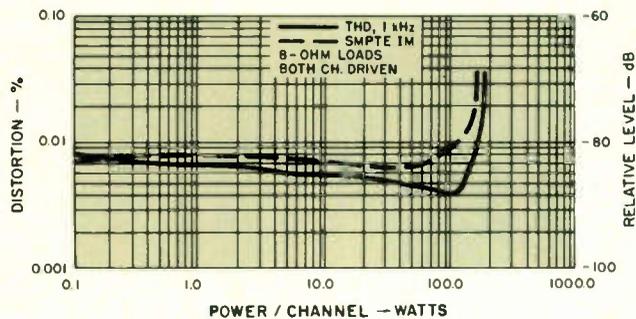


Fig. 7—Power output vs. THD.

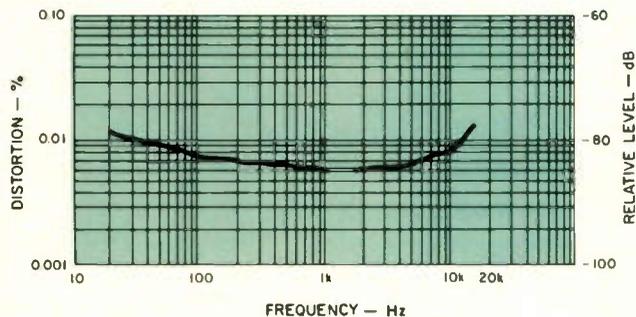


Fig. 8—Distortion vs. frequency.

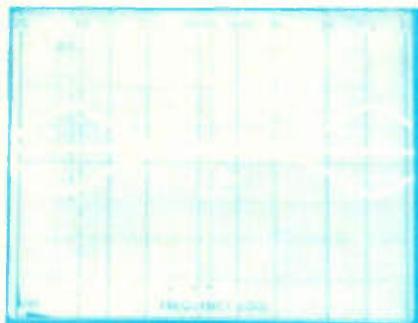


Fig. 9—Range of bass and treble control circuits.



Fig. 10—Range of presence control with each of the three center frequencies.

poorer than claimed, while in stereo it required a signal level of 31 dBf to reach usable sensitivity. The 50-dB quieting point occurred with only 2.8 μ V (14.2 dBf) of signal, exactly as claimed by Yamaha. But if the tuner section was not put in the DX position by a weak signal, it required a full 40 dBf to reach the 50-dB quieting point. Here I have a criticism of the design philosophy of this tuner section. In my opinion, the user should have the option to choose DX or Local (in reality, "broad" or "narrow" i.f.) in addition to having the automatic circuits making that decision.

Capture ratio in the Local position measured exactly 1.2 dB as claimed, and alternate channel selectivity in the DX position measured a full 85 dB as against 82 dB claimed. Distortion at the other two test points (100 Hz and 6 kHz) measured 0.065 percent and 0.06 percent in mono and 0.09 percent and 0.075 percent in stereo, all excellent results for a tuner or receiver and show the very highest quality.

Stereo separation and frequency response of the FM tuner section are plotted on the spectrum analyzer 'scope photo of Fig. 3. In this photo and in Figs. 4, 6, 9, 10 and 11, the frequency sweep is logarithmic from 20 Hz to 20 kHz, while in Fig. 5 the sweeps are linear over the same frequency range. In all of these 'scope photos, vertical sensitivity is 10 dB per division. Spot measurements at specific test frequencies of 100 Hz, 1 kHz, and 10 kHz revealed separation figures of 57 dB, 59 dB and 46 dB respectively — all significantly better than claimed by Yamaha. Figure 4 shows what happens to stereo FM separation when the auto-blend circuit operates. In return for reduced high-frequency noise, the blending reduces separation at high frequencies substantially (it is less than 10 dB at 5 kHz). Figure 5 shows how near-perfect the Yamaha multiplex decoder section is, insofar as the generation of crosstalk distortion products in nonmodulated channels is concerned. Here we see a reference signal at 5 kHz (tall spike at left) from the modulated output and, in a sweep of right-channel output, we see the shorter 5-kHz signal contained within the tall spike (more than 60 dB of separation); the only other significant products seen to the right are some second-order distortion of the 5-kHz signal, the expected 19-kHz pilot residual signal, and a minute amount of 38-kHz subcarrier at the right, surrounded by small amounts of sidebands at 33 kHz and 43 kHz. No other spurious products are produced by this very "clean" MPX decoder circuit. All of the secondary specifications (the various rejection figures) met or exceeded published specifications for the FM section of this receiver.



Fig. 11—Action of the continuously variable loudness control.



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Yet these tears of joy could easily turn to sorrow.

The Metropolitan Opera's task of maintaining its standard of excellence is becoming more costly. And that's where you can play an important role.

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We all owe a lot to music.

While not a true frequency-synthesized tuner, the R-2000 does provide presets, auto scanning, and precise center-channel tuning.

The frequency response of the AM section is plotted in the 'scope photo of Fig. 6 and turns out to be not much better than is typical of most stereo receivers, with -6 dB roll-off points occurring at around 50 Hz and 3 kHz.

Amp/Preamp Measurements

The power amplifier section of the R-2000 receiver delivered 170 watts per channel before reaching the rated distortion figure (THD) of 0.015 percent. Even at low output levels (below 1 watt), THD was well below 0.01 percent, indicating virtually complete absence of any notch or switching distortion. In fact, my results, depicted in graphic form in Fig. 7, are probably limited by the residual distortion in my signal-generating equipment. Yamaha's engineering department supplied me with their own plots (not shown) which showed even lower distortion levels and which I have no reason to disbelieve in view of my laboratory findings.

CCIF IM distortion measured less than 0.01 percent, while IHF IM distortion, which correlates well with the way the amplifier actually sounds, measured an extremely low 0.031 percent at rated output. Damping factor measured 71 at 50 Hz (8-ohm load reference), while dynamic headroom was a fairly high 2.1 dB. THD versus audio frequencies is plotted in Fig. 8 and is again as low as my test equipment would permit measuring.

Figures 9 and 10 show the remarkable flexibility and wide range of adjustment afforded by Yamaha's unique three-control tone control system. Notice that the bass and treble controls, when in the extreme boost or cut position (Fig. 9), do not continue to boost or cut extreme low or high frequencies outside the audio spectrum, but reach a peak and then head back towards the zero axis, unlike most conventional bass and treble control circuits. I think this is a much more intelligent approach to tone control design. Note, too, that the three center-frequency mid-range control's actions, added to those of the bass and treble control, give this tone control system about the same flexibility that one might expect from a three-band full parametric EQ!

Figure 11 shows the range of control and response of the separate loudness control offered by Yamaha on this and many other receivers. The user adjusts the volume control for maximum or "lifelike" loudness levels and then, using this secondary loudness control, can reduce that level by up to 20 dB or so, achieving proper Fletcher-Munson loudness compensation instead of the arbitrary (and generally incorrect) bass and treble boost usually provided by on-off type loudness controls that are tied into the volume control. The way Yamaha handles this con-

trol is the way it *should* be handled, in my opinion.

Input sensitivities measured 0.2 mV for the MM phono inputs, 8.2 μ V for the MC inputs, and 10 mV for the high-level AUX inputs (all referred to 1-watt output). The MM phono input was able to handle signal levels of 350 mV (at 1 kHz) before significant overload was observed, while in the case of the high-gain MC input, overload occurred with input levels of 21 mV. Signal-to-noise for phono measured 85.5 dB for the MM inputs (referred to 5 mV in and 1 watt out), 75 dB for the MC input (referred to 0.5 mV in and 1 watt out), and 89 dB for the AUX inputs (referred to 0.5 V in and 1 watt out). These are, to say the least, excellent figures, typically from 6 to 10 dB better than I usually measure on receivers. At minimum volume setting, hum and noise was 110 dB below 1-watt output. All S/N readings were taken with an A-weighting network, as usual. Overall frequency response, via the AUX inputs, was within 1 dB of flat from 5 Hz to 50 kHz.

Use and Listening Tests

The Yamaha R-2000 is, without a doubt, one of the finest receivers I have ever had the pleasure of testing and auditioning. Its power output capabilities are awesome and rather hard to believe when one looks at the relatively small volume of the product. While I may take issue with some of the claims or even circuit approaches taken by its designers (as in the case of their argument in favor of their FM/AM tuning approach versus true frequency synthesizers), I *cannot* fault the product's performance itself. It is in every sense excellent, both in terms of the way the controls handle and the way in which it reproduces sound. To be sure, my pet peeve (the mono/stereo related muting switch) is an annoyance, as is the non-defeatable auto-blend/auto-DX switching, but for the typical receiver purchaser these may represent sensible approaches to problems that newcomers to audio might not otherwise be able to cope with easily.

Aside from its excellent sonic capabilities, one gets the feeling that the folks at Yamaha must have sat down one day a year or so ago, either in Hamamatsu, Japan or in Buena Park, California, and said to themselves, "What are all the nice features we can put into our next top-of-the-line receiver without pricing ourselves out of the market, and what new circuit approaches can we come up with so that the resulting receiver isn't too heavy to lift?" From my experience with the R-2000 thus far, Yamaha has come up with some valid answers as well as the question.

Leonard Feldman

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You've driven to the end of the world. Alone.
The engine is still warm.

Amid the roar of the waves and the cries of the gulls, you fire up your mobile high-fidelity system for a morning concert.

What will it be? Bach? Mozart? Perhaps some Keith Jarrett.

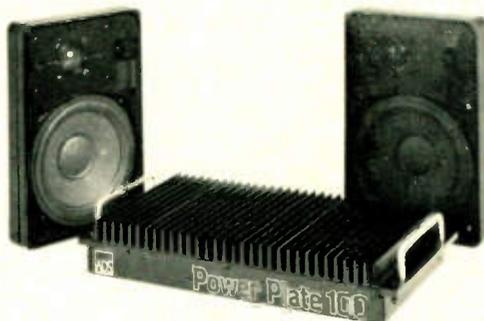
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The ADS Power Plate 100 Automotive Amplifier and the ADS 300i Automotive Loudspeaker System deliver the kind of power it takes to be heard above road noise, engine noise, and ocean waves. And it's not just brute power, but power with performance, subtlety and nuance — qualities collectively known as musical accuracy.

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Audio for the critically demanding

2

**SOUNDCRAFTSMEN
MODEL RA7502
POWER AMPLIFIER**
Manufacturer's Specifications

Continuous Power Output: 250 watts per channel, 8 ohms, stereo; 375 watts per channel, 4 ohms, stereo; 750 watts, 8 ohms, bridged mono; 20 Hz to 20 kHz.

THD Plus Noise: 0.02 percent at rated power, 8 ohms.

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

SMPTÉ IM Distortion: 0.05 percent.

TIM Distortion: Less than 0.02 percent.

S/N Ratio: 105 dB below rated output, A weighted.

Slew Rate: Amplifier, stereo mode, 50 V/ μ S; supply, stereo mode, greater than 90 V/ μ S.

Damping Factor: Stereo, greater than 250; bridged mono, greater than 125; both at 50 Hz.

Input Impedance: Stereo, 32 kilohms; bridged mono, 16 kilohms.

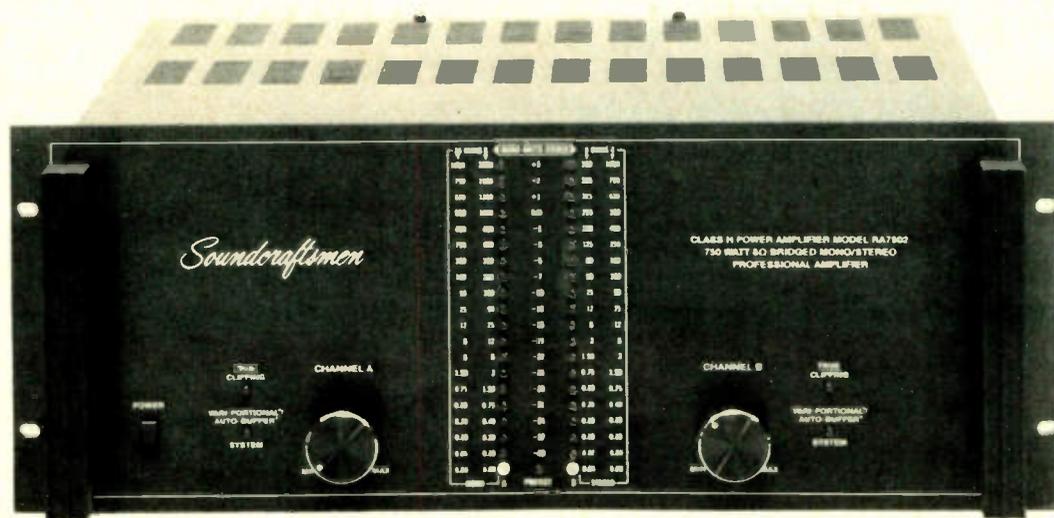
Input Sensitivity: Stereo, 1.2 V; bridged mono, 1.0 V; both for rated output.

Stability: Stable with any load two ohms or above.

Dimensions: 19 in. (48.3 cm) W x 7 in. (17.8 cm) H x 15 in. (38.1 cm) D.

Shipping Weight: 55 lbs. (25 kg).

Price: \$949.00.

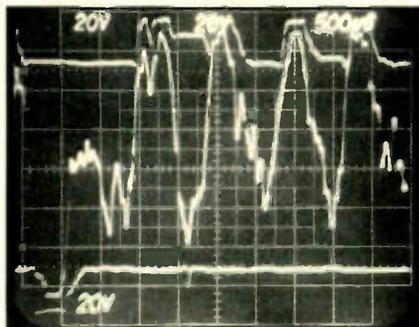


I was introduced to the concept of "Class-H" circuitry by Soundcraftsmen's chief engineer, Paul Rolfe, nearly four years ago, shortly after he had invented and incorporated it in one of the Soundcraftsmen amplifiers. The concept is still very attractive and innovative, as evidenced by the fact that at least two companies that I know of have used "variations on the Class-H theme" ever since Soundcraftsmen showed everyone how it was done. For reasons which have more to do with marketing, public relations and other non-engineering related pursuits, Soundcraftsmen ended up with patents but very little glory. If you are not already familiar with the very clever and energy-efficient Class-H amplifier theory, I'll get to that in a moment, but first let's have a look at the latest powerhouse of an amplifier to use the Class-H circuit, the Model RA7502.

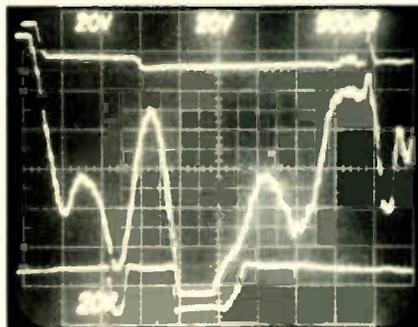
This amplifier is the professional version of Soundcraftsmen's lower priced (\$749.00) Model PA5001A, a basic power amp

that lacks the front panel displays of the RA7502 as well as the mono bridging and balanced input capabilities of the more expensive "pro" version. The lower priced unit does, however, have the same performance specs and circuitry and might therefore be worth considering if the price of the RA7502 seems a bit too high for your budget. The rack-mountable front panel of the RA7502 features a power on/off switch at the left, individual rotary input level controls for each channel, and two vertical banks of LED power indicators (20 LEDs per channel) which show power output levels calibrated from -40 to +3 dB. Calibrated wattage scales are also inscribed along the rows of LEDs for mono or stereo operation into 16-, 8-, or 4-ohm loads. Additional individual LEDs (per channel) illuminate when the Class-H "Vari-Portional" circuitry begins to operate and when actual clipping occurs.

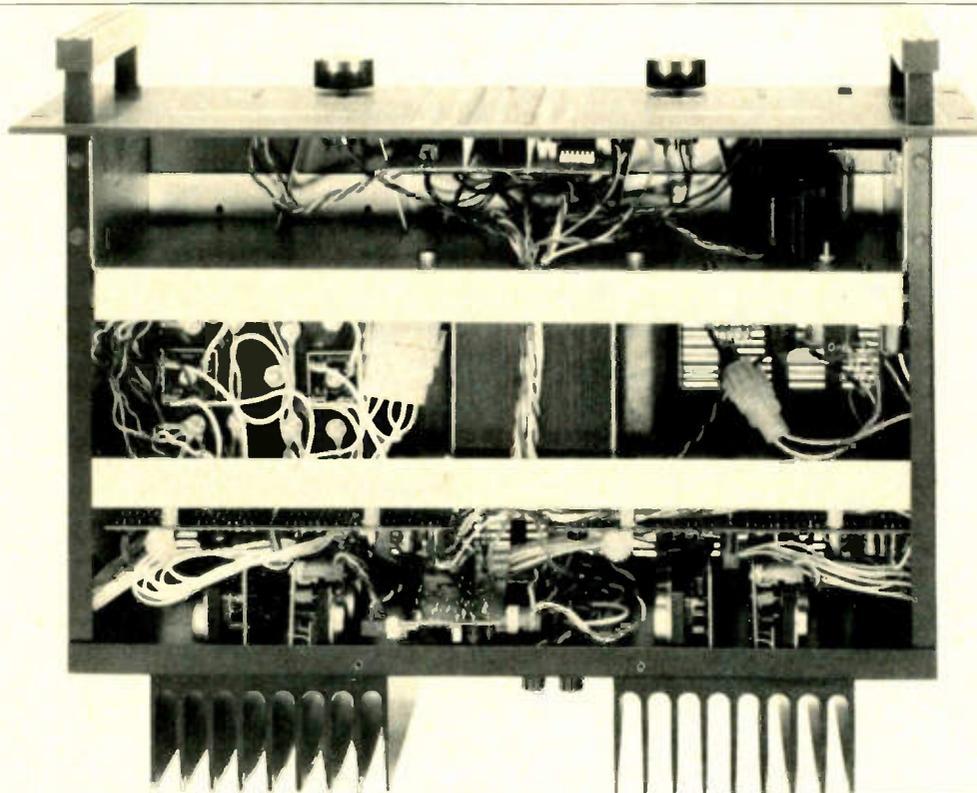
Stereo or bridged mono operation is selectable at the rear



Figs. 1A and 1B—
Multiple traces
showing how B+
(Fig. 1A) and B-
(Fig. 1B) voltages
adjust themselves
in anticipation of



**large signal voltage
swings, Class-H
circuitry of Sound-
craftsmen RA7502
power amplifier.**



panel, which is equipped with 1/4-inch phone-jack inputs wired in such a way that either balanced or unbalanced inputs may be selected depending upon how mating phone plugs are wired. Output terminals are five-way binding post types on standard 3/4-inch centers. The rugged chassis of this hefty amplifier is a 16-gauge steel main-frame structure with modularized construction throughout, which provides easy access to all component parts and p.c. board surfaces. The amplifier is supplied with a parchment-like individualized certificate of performance, on which is noted the serial number of the amplifier and major measured specs for that actual unit, signed off by the final inspector who tested it.

Circuit Highlights

For those unfamiliar with Class-H operation, the following description, largely supplied by the inventor, may be helpful:

The Class-H amplifier has two positive and negative power supplies. The ratio of the voltages in these power supplies is arranged such that the low-voltage supply is 2/3 of the high-voltage supply. The amplifier behaves like a conventional Class-AB amp at low-volume output. As the signal level approaches the limit of the low-voltage supplies, what Soundcraftsmen refers to as their "Vari-Portional" circuit anticipates the sine wave's approach to the lower voltage supply level and begins to increase the B+ voltage to allow for additional headroom. This process continues until the system reaches its maximum, which is the limit of the higher voltage supply.

The advantage of such a system is that the amplifier is operating at the lower voltage most of the time. This not only saves energy but also reduces dissipation within the amplifier substantially. Even when the supply voltage is "turned on" to its maximum value, it is only at that level for the short period during

I have no reservations in recommending the Soundcraftsmen RA7502 amplifier for use in any high-quality home music system.



Fig. 2—Peak-to-peak voltage in bridged mono mode measured 240 V under actual music signal conditions.

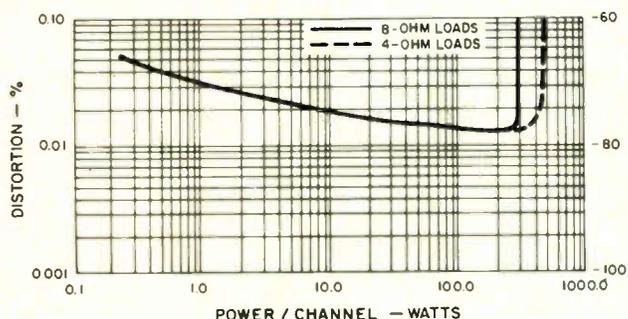


Fig. 3—Power output at 1 kHz vs. THD.

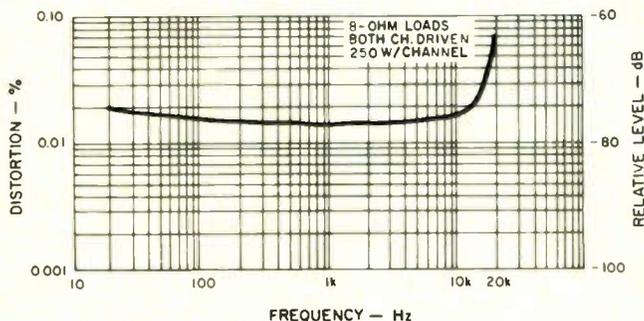


Fig. 4—Distortion vs. frequency.

which the signal peaks call for it.

Figures 1A and 1B show very dramatically how the system works. The basically horizontal upper and lower traces in each of the displays represent the low-voltage supply levels (positive and negative), while the continuously varying waveform in the center is an actual music waveform being amplified by the RA7502. Notice that as the signal waveform approaches the value of the B+ lower supply level, that supply voltage rises before clipping can take place (Fig. 1A). A sharp peak in the signal waveform, this time in the negative polarity (near the cen-

ter of the display in Fig. 1B), causes the B- voltage to increase (become more negative) in value to prevent downward clipping of the waveform.

To be sure, this extra headroom does not go on forever. As can be seen in the 'scope photo of Fig. 2, a point is eventually reached at which final and irreversible clipping does take place. When the RA7502 was operated in the bridged mono mode, that point occurred when output voltage reached a peak-to-peak value of approximately 240 volts across an 8-ohm load—which corresponded to an average power of around 900 watts!

Protection circuitry in the amplifier is of four kinds. Short circuit protection is provided by a dual-purpose auto-crowbar circuit with automatic reset and front panel LED indication. There is also a thermal sensing protection circuit with automatic reset and front panel indicator, as well as external fusing protection. The RA7502 also features an unusual patent-pending "Auto-Buffer" circuit which is designed to provide automatic internal electronic compensation for continuous 2-ohm operation without actuating any of the protective circuitry and without current limiting. Details of this circuit refinement were not provided in schematic form, so I can only comment to the effect that it worked effectively when I lowered the load impedance to 2 ohms for a brief period and pushed the amplifier into overload.

Measurements

Figure 3 is a plot of power output, at 4- and 8-ohm loads, versus harmonic distortion for a 1-kHz test signal. For its rated distortion of 0.09 percent at this frequency, the amplifier delivered in excess of 300 watts per channel into 8-ohm loads, and nearly 450 watts per channel into 4-ohm loads. Backing off to rated values of power output (250 watts per channel at 8 ohms), I measured a THD of 0.015 percent and an SMPTE-IM figure of only 0.035 percent. Figure 4 is a plot of distortion versus frequency for rated output (8-ohm loads). CCIF twin-tone IM distortion measured a very low 0.0097 percent, while IHF-IM was only 0.06 percent (measured using the twin-tone method, with worst-case observed using 9- and 10-kHz equal amplitude test tones, as shown in the 'scope photo of Fig. 5).

Damping factor measured in excess of 200 (that's about as high as I can measure, even with short leads connecting my test fixture and with the amplifier output contributing a tiny fraction of an ohm of resistance to the actual measurement), while dynamic headroom, measured with reference to rated outputs, was 1.94 dB. With 8-ohm loads, that means that the amplifier, operated in the stereo mode, could deliver short term peaks of as high as 390 watts per channel!

Signal-to-noise ratio, measured with respect to 1-watt output and with 0.5 volt of signal input (level controls suitably adjusted) was 85 dB. If measured with the level controls wide open and with respect to rated output (the way Soundcraftsmen and others continue to quote S/N despite Standards-conscious reviewers' pleadings), the reading increases to 113 dB, well above the manufacturer's claimed value of 105 dB. Frequency response for this amplifier measured flat within -1.0 dB from 5 Hz to 50 kHz.

Use and Listening Tests

Although the RA7502 is billed as a professional amplifier (and, according to its makers, was specifically designed for use by touring musical groups or other professionals requiring high-

Class-H circuitry not only saves energy but also reduces dissipation within the amplifier substantially.

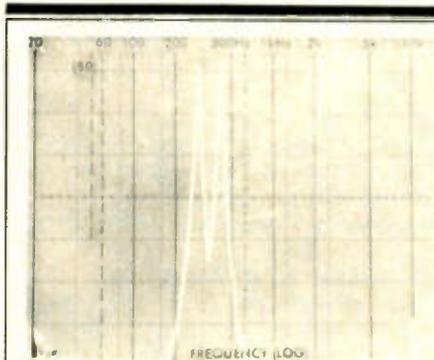


Fig. 5—Spectrum analysis (see text) shows IM components near high end of audio spectrum. Sweep is linear from d.c. to 20 kHz, 2 kHz per linear division. IM percentage equivalent works out to be 0.06 percent.

power sound reinforcement amplification), I would have no reservations in recommending it or its less expensive first cousin, the PA5001A, for use in any high-quality home music system. Soundcraftsmen makes an interesting point in calling this amp (and others in their line) "digital/PCM ready." What they mean, very simply, is that the future PCM/digital program sources are going to have so much dynamic range that you are going to need more powerful amplifiers, or at least amplifiers that offer a great deal of headroom (the RA7502 has ample power *and* ample headroom), if you hope to be able to reproduce such wide dynamic range program sources without compression or clipping. Indeed, I played all manner of demanding source material through this amplifier and it just refused to quit. Furthermore, even at peak levels which caused the 0-dB LEDs to light repeatedly, the RA7502 remained unusually cool, confirming Soundcraftsmen's contention that their Class-H circuitry eliminates the need for any cooling fan, even for amplifiers with such high-power ratings used under the most difficult conditions. If you need a full horsepower of audio power (at 4 ohms it actually puts out a bit more than 1 HP) and don't want to give up accurate sound reproduction and ultra low TIM, THD and IM of all forms to get it, I would urge you to audition this rugged amplifier. Don't let its "industrial" look fool you; it's a true high fidelity product in every good sense of that much abused pair of words.

Leonard Feldman

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It takes more than a ruby cantilever to make a moving coil cartridge capable of excellent sound reproduction. It takes imagination, engineering knowledge and dedication to perfection.

The Dynavector DV/Karat series is the culmination of these efforts.

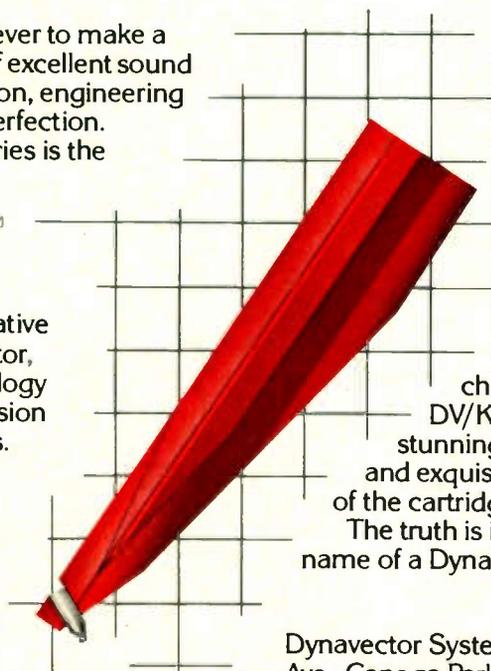
$$C_R = \alpha \sqrt{2\pi f} \left[1 - \frac{1}{4}\beta \frac{2\pi f}{\alpha^2} + \frac{1}{4}\delta (2\pi f)^2 + \dots \right] \dots \dots (2)$$

$$\alpha^4 = \frac{EI}{m}, \quad \beta = \rho \alpha^4 \left(\frac{1}{E} + \frac{\gamma}{G} \right), \quad \delta = \frac{\rho^2 \gamma \alpha^4}{EG}$$

Dr. Noboru Tominari, the creative genius and founder of Dynavector, developed a radical new technology taking into account wave dispersion and cantilever vibration theories.

Dr. Tominari reasons that the "soft" sound of most cartridges was due to the various delays of frequencies along the length of the cantilever.

The role of the cantilever as a sound dispersing medium has been mitigated by making it as



short and as hard as possible. As a result, a solid laser cut synthetic ruby cantilever only 2.5mm in length with a diamond contact tip is utilized.

Another benefit of the short/hard ruby cantilever is the high resonance frequency above 50 kHz. Therefore, the elimination of rubber damping. Without the "creeping time

effects of rubber" (temperature changes and age deterioration), the DV/Karat's ability to produce sound with stunning realism, brilliant tonal balance and exquisite detail is maintained over the life of the cartridge.

The truth is in the listening. Call or write for the name of a Dynavector audio specialist near you.

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WORLD LEADER IN MC CARTRIDGES

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3

**JENSEN T-415 AM/FM
CAR STEREO
TUNER CASSETTE DECK
and
A-60 POWER AMP**

Manufacturer's Specifications

T-415 Tuner/Deck Preamp

FM Usable Sensitivity: Mono, 14.8 dBf; stereo, 23.3 dBf.

50-dB Quieting: Mono, 19.2 dBf.

Selectivity: 60 dB.

S/N Ratio: 65 dB.

Image Response Ratio: 60 dB.

I.f. Rejection: 65 dB.

AM Suppression: 50 dB.

Capture Ratio: 1.5 dB.

Stereo Separation: 30 dB at 1 kHz.

FM Frequency Response: 30 Hz to 15 kHz.

AM Usable Sensitivity: 12 μ V.

AM Image Rejection: 60 dB.

Preamp Section THD: 0.15 percent at 0.5-V out.

Bass and Treble Control Range: \pm 10 dB at 100 Hz and 10 kHz.

Loudness Compensation: +6 dB at 100 Hz.

Tape Section S/N: 55 dB.

Tape Separation: 35 dB.

Tape Crosstalk: 40 dB.

Wow and Flutter: 0.2 percent, unweighted rms.

Tape Playback Frequency Response: 50 Hz to 10 kHz, -3 dB.

Recommended Load Impedance: 25 to 47 ohms.

Dimensions: 7 in. (18.0 cm) W x 2 in.

(5.0 cm) H x 5 $\frac{3}{8}$ in. (13.5 cm) D.

Price: \$299.95.

A-60 Power Amplifier

Power Output: 25 watts per channel into 4 ohms from 20 Hz to 20 kHz.

Rated THD: 0.6 percent.

Frequency Response: 20 Hz to 50 kHz, \pm 1.5 dB.

S/N Ratio: 80 dB, A weighted.

Input Sensitivity: Front, 0.5 V for 1-watt out; rear, 0.125 V for 1-watt out.

Minimum Input Impedance: Selectable, 10 or 47 ohms.

Blamp Crossover Frequency: 1 kHz, -12 dB/octave.

Power Per Amplifier: Front, 5 watts into 4 ohms; rear, 20 watts into 4 ohms.

Maximum Power Per Channel: Front, 6.25 watts; rear, 25 watts; both at 10 percent THD.

Dimensions: 2 $\frac{3}{8}$ in. (6.0 cm) H x 8 $\frac{3}{8}$ in. (22.55 cm) D x 7 $\frac{1}{8}$ in. (18.1 cm) W.

Price: \$199.95.



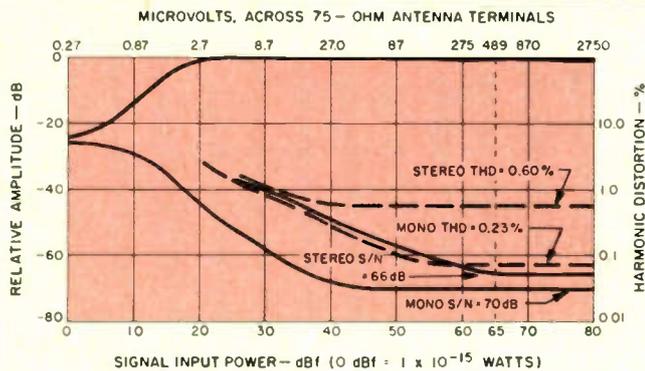


Fig. 1—Mono and stereo quieting and distortion characteristics, FM section of the Jensen T-415.

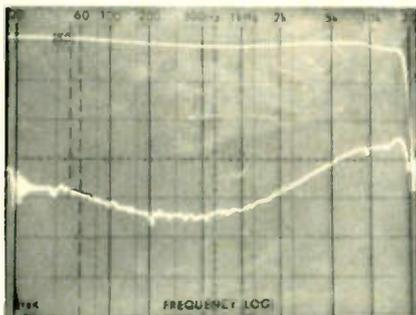


Fig. 2—Stereo FM frequency response and separation characteristics, T-415 tuner/preamp/deck.

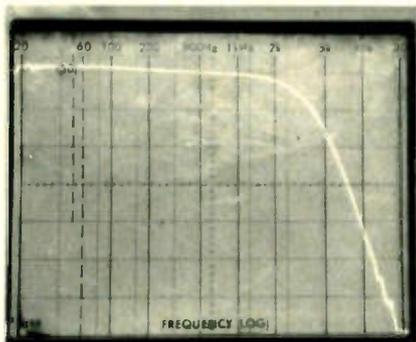


Fig. 3—Frequency response, AM section of the T-415.

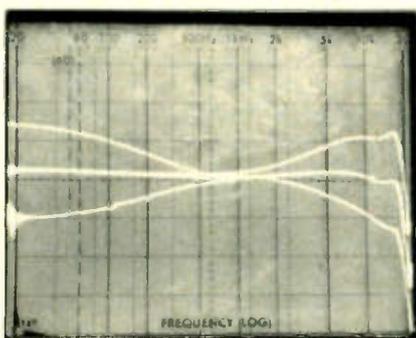


Fig. 4—Bass and treble control range, Jensen T-415.

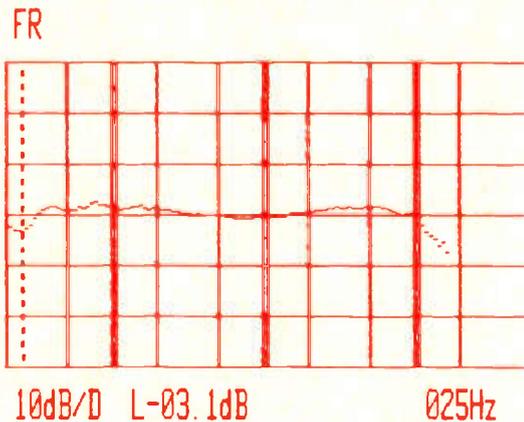
Although these two products were treated as a single, complete car stereo system, I should note at the outset that either the T-415 tuner/preamp/tape player or the A-60 power amp/bi-amp may be bought as separate units and will interface quite readily with other component models. Before getting into the details of these two components from Jensen, I should also point out that the specifications supplied by the maker not only conform in every way to the new Car Stereo Standard first promulgated by the Ad Hoc Committee of Car Stereo Manufacturers (and since published as an interim standard by the Electronic Industries Association) but in many ways go beyond the minimum requirements of that standard. Small wonder, since one of the guiding forces behind the creation of the standards was Jim Twerdahl, the Chief Operating Officer at Jensen Sound Labs. What a welcome sight it is to see car stereo amplifier power depicted in meaningful terms not unlike the ones used for home audio components! Not to mention the other properly stated specs of this component pair.

Examining the front panel of the easily installed T-415 tuner/deck/preamp unit, we find the usual left and right multiple controls whose shafts are also used to mount the in-dash unit. The triple-concentric controls at the left are volume/on-off, treble and bass, while the three at the right are tuning, balance and mode selection (AM, stereo FM, or mono FM). A conventionally calibrated dial scale for AM and FM frequencies is centrally located on the front panel, and below it are five mechanically operated push buttons which can be set for a total of five AM or FM station frequencies. A muting push button is located to the right of the dial scales, as is the stereo indicator light; Dolby noise-reduction and loudness switches are at the left of the frequency scales. The cassette compartment is located above the dial area, and its auto load mechanism is about the smoothest and gentlest I have run across. You simply insert the tape in the slot and an automatic motorized mechanism gently grasps the cassette and lowers it into playing position, smoothly and silently. Eject and program-reverse buttons as well as tape direction indicator lights are located to the right of the cassette slot, while fast forward and rewind buttons are at the left. A variety of long and short cables equipped with multiple-pin connectors and with bare-wire ends are supplied to facilitate connection of the T-415 to other components.

FM Section Performance

Mono usable sensitivity for the T-415 measured 1.51 microvolts, or exactly 14.8 dBf as claimed. (Remember, we are dealing with a 75-ohm antenna input impedance, so the more familiar "translations" from dBf to μ V and vice versa will not apply here.) Stereo usable sensitivity was 20.44 dBf, a bit better than claimed. Mono 50-dB quieting measured 20 dBf, marginally higher than claimed, while in stereo, the 50-dB quieting sensitivity was 40.7 dBf. Quieting and distortion characteristics as a function of increasing input signal strength are shown for mono and stereo FM reception in Fig. 1. Distortion, with 1-kHz 100-percent modulation, levels off to a value of 0.23 percent in mono and 0.6 percent in stereo, while ultimate signal-to-noise ratio measured 70 dB in mono and 66 dB in stereo. Jensen does not state whether their claimed S/N of 65 dB applies to mono or stereo, but in any case, my results, even in the worst case, were better than claimed.

The Jensen T-415 is devoid of some of the fancier frills, but if it's strictly performance you are after, this unit will provide it.



Figs. 5A and 5B— Playback response, cassette tape section, Jensen T-415.

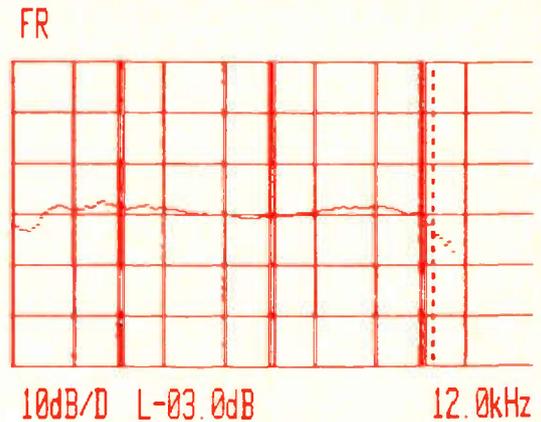


Figure 2 is a multiple sweep from 20 Hz to 20 kHz using the log-sweep mode of a spectrum analyzer, and it shows stereo FM frequency response (upper trace) as well as stereo FM separation (lower trace). Separation measured 39 dB at mid-band, 38 dB at 100 Hz, and 27 dB at the 10-kHz test point. Harmonic distortion at the two other required test points (100 Hz and 6 kHz) measured 0.27 percent and 0.29 percent for mono and 0.9 percent and 1.0 percent for stereo, respectively. These results are quite good compared with those obtained for other car stereo tuner sections measured recently. Even with relatively weak signal inputs (the 50-dB quieting levels), distortion is below 1.0 percent in both mono and stereo. Capture ratio measured 1.5 dB as claimed, while AM suppression was better than claimed, measuring 52 dB. Image and i.f. rejection both measured 65 dB, while alternate channel selectivity measured a bit better than the 60 dB claimed by the manufacturer.

Although AM tuner section frequency response did not extend much beyond the usual 2.5 kHz commonly found in home and auto AM tuner circuitry, the response below that cutoff point was extremely smooth and flat, as can be seen in the frequency sweep 'scope photo of Fig. 3. The AM signal-to-noise ratio for strong signals measured in excess of 45 dB.

Tone control range was measured via the FM tuner section of the T-415, since there is no easy way to inject a high-level audio signal directly into the preamp section of this unit. Results are depicted in the 'scope photo of Fig. 4 and are typical of the bass and treble control action found on home high-fidelity components (but rarely on car stereo units). The slight discontinuity visible at the high end of the spectrum in each of the response sweeps is a function of the FM high frequency (MPX filter) cutoff above 15 kHz and not a fault of the tone control circuitry itself.

Tape Player Section Performance

Using a test tape produced by Standard Tape Laboratory, Inc. for use with a Sound Technology 1500A tape tester, I measured playback frequency response of the cassette player section of the T-415. Results are shown in the video printouts of Figs. 5A and 5B. The two printouts are identical, except that in Fig. 5A the cursor on the display has been moved to 25 Hz to show a -3.1 dB roll-off relative to 1 kHz, while in Fig. 5B the cursor has been moved to show a -3 dB response at the high-frequency extreme of 12 kHz. In both instances, response was

better than claimed by Jensen. The weighted wow-and-flutter reading was 0.09 percent, while unweighted (as specified by Jensen), the figure obtained was 0.15 percent—still much better than claimed. Tape speed was off on the plus side by nearly 2.0 percent—a characteristic which I have noted for many of the car tape units I have checked recently, and one for which I have no explanation.

A-60 Amplifier Performance

The powerful A-60 amplifier which I measured along with the T-415 tuner/preamp/deck arrived without its owner's manual. I was, nevertheless, able to hook the unit up to the T-415 with no great difficulty, thanks to the clear markings supplied on all of the connecting cables and with the aid of references made to this model in the owner's manual for the T-415. The amplifier's front panel has only two switches: One selects front/rear or bi-amplified operating modes, and the other selects a 10- or 47-ohm input impedance to the amp. The 10-ohm choice would be made if you were to use this amplifier as a booster by connecting it to the speaker outputs of an existing car receiver (using the output of that receiver as a signal voltage rather than as a feed to speakers). In the tests, I used the 47-ohm setting which proved to be a better match for operating this amplifier with the T-415. A hefty 5.5-meter cable is supplied with the A-60 so that it can be stowed in the car trunk or at any other remote location (relative to the in-dash mounted T-415). The B+ lead of the amplifier is connected directly to the car battery, but this doesn't mean the amp is constantly drawing power; it is activated by means of the power on/off switch located on the T-415.

With a standard B+ supply voltage of +14.4 volts applied and maintained for the amplifier, it delivered 22.5 watts of power per channel at the rear outputs, using an input frequency of 1 kHz and a load impedance of 4 ohms for its rated THD of 0.6 percent. At the frequency extremes, the amplifier was able to produce its rated 20 watts per channel at 20 kHz and a bit more at 20 Hz. Output power via the front outputs was 6.0 watts under the same test conditions at mid-frequencies, and almost exactly 5 watts at the frequency extremes, again measured for rated THD of 0.6 percent. No attempt was made to measure so-called "maximum" power output (the power out for 10 percent THD), as I feel that Jensen included this spec in response to those manufacturers who are not supporting the new standard.

I was amazed to note how much headroom the 20-watt rear amplifiers of the A-60 had when hooked up to home speakers.

In time, I hope enough car stereo makers will use *only* the new standard's method of reporting power in car audio equipment so that Jensen and others who make better equipment will not be forced to provide this alternate type of power output disclosure.

Frequency response for the A-60 amplifier alone extended from 15 Hz to 40 kHz, -1.0 dB, while input sensitivity was exactly 0.5 volt for 1-watt output via the rear amplifier outputs and 0.12 volt for 1-watt output via the front amplifiers. When used in the biamp mode, the higher powered amps become the bass-frequency channels while the lower, 5-watt per channel amps become the high-frequency tweeter amplifiers. The -3 dB crossover point for both sets of amplifiers measured very close to the nominal 1 kHz claimed, and slope for each pair of amps was 12 dB per octave as stated by Jensen. A-weighted signal-to-noise ratio for the power amps alone was 83 dB for the high powered amplifier sections and 78 dB for the lower powered circuits.

Subjective Evaluation

While it is impossible to evaluate a car stereo system subjectively without installing that system inside an automobile, I can comment on some of the elements which go into making the Jensen units very acceptable car audio products. The tuner section of the T-415 was sufficiently sensitive to provide quiet reception even under weak-signal mono and stereo conditions, and the muting circuitry was particularly effective when activat-

ed. The Dolby noise-reduction system incorporated in the tape player section was properly calibrated so that no response aberrations were observed when playing prerecorded, Dolby-encoded software during the listening tests. The tuner is devoid of some of the fancier automatic tuning frills now found on more expensive, frequency synthesized car units, but if it's strictly performance you are after, the Jensen T-415 will give it to you.

As an experiment, I hooked up the A-60 amplifier to home-type speakers, and, with the aid of a well-regulated source of d.c. voltage set to 14.4 volts, was amazed to note how much headroom the 20-watt rear amplifiers had when dealing with actual music signals. I did not do any listening to the amplifier in its biamped mode (simply because suitable speakers were not available at the time the tests were conducted), but the bench measurements give me no reason to expect anything but equally excellent results when the equipment is operated in that mode.

What features the tuner/preamp/deck unit does offer (such as separate bass and treble tone controls, Dolby NR, FM interstation muting, bidirectional tape travel, and that marvelous tape loading system) are all executed with care and professional skill. Jensen should have no trouble selling a great number of the T-415 units this year, but if sales of the high-powered A-60 don't do quite as well, there is still likely to be a pretty good demand for them.

Leonard Feldman

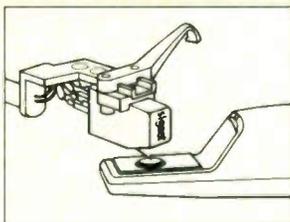
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The Cannon Shot Heard Round the World

Tchaikovsky: "1812 Overture" and "Capriccio Italien"
Cincinnati Symphony Orchestra, Erich Kunzel, Cond.
Telarc DG-10041, stereo, \$17.95.

By now, practically everyone with even a passing interest in audio has heard the Telarc recording of Tchaikovsky's "1812 Overture." When this record was issued about two years ago, it not only put many loudspeaker-amplifier combinations to shame, it also embarrassed a number of fine cartridge manufacturers. The low-frequency information on the disc is quite visible to the naked eye; this fact, plus the inability of many otherwise excellent cartridges to track the disc, has led many people in the industry to judge it as a gross example of overmodulation in the disc transfer process. It is overmodulated in some respects, yet when played back with the appropriate cartridge in a well-balanced tonearm — and with an amplifier-speaker combination with adequate headroom — the record comes across as clean and spectacular. Just how low does the information go and what are the overall levels on the disc?

Since most of the very low-frequency information is lateral, I decided to make a mono analysis only. The next thing was to find a tonearm-cartridge combination I felt was tracking the modulation reliably (with cannon shots, this may be hard to determine). I settled on a Technics Model SP-10 MK II turntable with a Shure V15 Type IV cartridge. Signal output was fed to a JBL SG-620 preamplifier with the rumble filter disengaged (leaving only the preamp's roll-off in the 2.5-Hz region). The mono output of the summed channels was then fed to a Bruel & Kjaer Model 2131 1/3-octave analyzer. This instrument was set on its low frequency range, in which mode it extends down to 1.6 Hz. Figure 1 shows the peak-hold 1/3-octave spectra for the last 3:30 minutes of the side. Both cannon shots and the bass drum account for the rise in response in the 31.5 to 63 Hz bands. The cannon shots alone are responsible for the considerable extension of information down to the 8-Hz band. A reference point of 7 cm/S peak lateral stylus velocity is shown on the graph, and it will enable us to determine

the exact levels of the low-frequency signals. Figure 2 shows the relation between lateral (side-to-side) stylus velocity and displacement as a function of frequency in disc recording. If a record were to be cut with a constant velocity of 7 cm/S (normal reference level at 1 kHz), then the groove displacement at 8 Hz would be in excess of 0.1 cm peak (0.2 cm peak-to-peak). Obviously, records cannot be cut this way, and the signal must be rolled off at low frequencies during the record function and boosted by a complementary amount

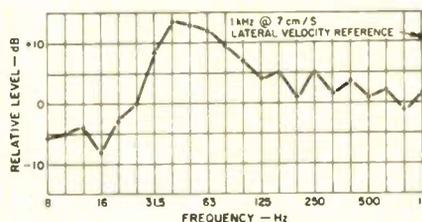


Fig. 1 — Peak-hold 1/3-octave spectra, last 3:30 minutes, RIAA playback, lateral only.

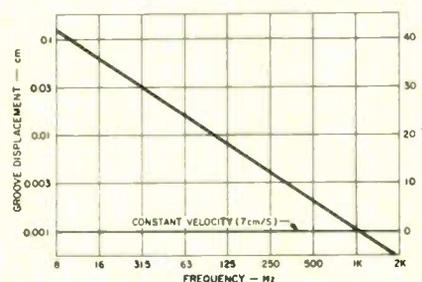


Fig. 2 — Relation between velocity and displacement in disc recording.

during playback. The standards for this relationship were established in the 1950s by the RIAA (Recording Industry Association of America), and they are universally observed in the cutting of 33 1/3 rpm discs around the world. Figure 3 shows this record-playback relationship extended down to 8 Hz. Note that the recording de-emphasis at 8 Hz is 20 dB lower than at 1 kHz.

Now we are ready to calculate the exact displacement, or excursion, of the signals down to the lowest range. By combining the data, 1/3 octave at a time, from Figs. 1 through 3, we arrive at the plot of points shown in Fig. 4. Here, we

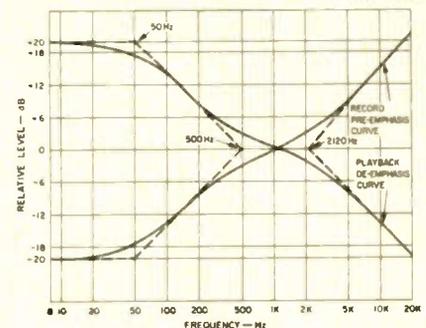


Fig. 3 — RIAA record and playback curves extended to 8 Hz. Break points in these curves are at 50, 500, and 2120 Hz.

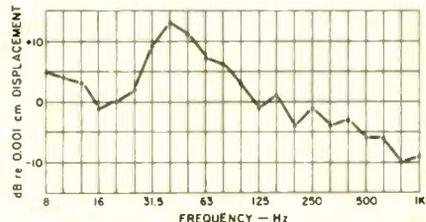


Fig. 4 — Peak-hold spectra, last 3:30 minutes, equalized to show displacement.

see the peak displacement in each band in dB relative to 0.001 cm. The summation of these data points is 18.7 dB above 0.001 cm or 0.0086 cm. For peak-to-peak displacement, we double this figure. In thousandths of an inch (mils), this figure is 14, which corresponds very closely to the measured 17-mil displacement observed, with some dismay we may add, by a number of manufacturers whose cartridges couldn't handle the side-to-side swing.

Normal definitions of overload in disc transfer have to do with slope overload, when the trajectory of the groove exceeds the nominal back-relief angle of the cutting stylus (normally 45 degrees), and with curvature overload, when the stylus cuts a groove with greater curvature than the playback stylus. These are both upper-mid- and high-frequency problems and have nothing to do with the signal in the range we have examined thus far. Purely in terms of groove displacement, the only playback requirements are: (1) that the cutter head be able to negotiate the required side-to-side swing, (2) that the grooves not ex-

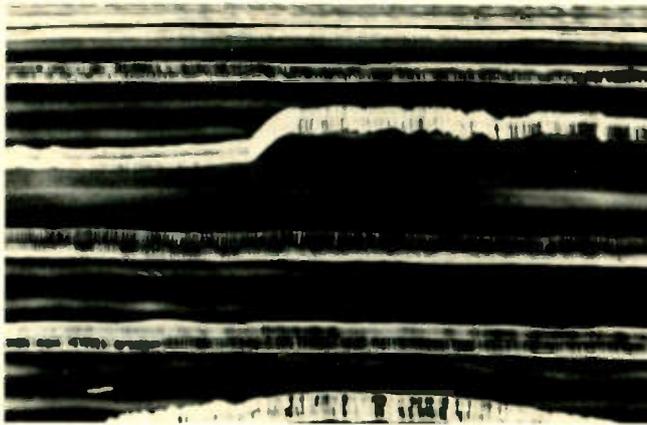


Fig. 5 — Photomicrograph at about 35X enlargement of a portion of the record surface showing the groove geometry of a cannon shot section of the recording.

hibit over-cut (i.e., run in to each other), and (3) that the playback cartridge be capable of negotiating the side-to-side swing.

Since the grooves do not overlap each other, and since there are many cartridges which handle them in stride, the record is *not* overcut by the criteria we have presented here. However, the onset of each cannon shot produces severe slope overload. In fact, the promotional band wrapped around each album jacket (Fig. 5 here) shows a photomicrograph illustrating a sharp jog in the groove trajectory typical of the cannon shots. The first cannon shot occurs at a diameter of 20 cm, and the angle of tra-

jectory is just about 45 degrees. Under this condition, the tangential groove velocity and side-to-side velocity are equal. At 33 1/3 rpm and at a diameter of 20 cm, the tangential velocity (and thus the side-to-side stylus velocity) is 33 cm/S.

Many cartridge manufacturers and recording engineers would consider this velocity to be excessive and conducive to processing problems. On music, these objections would certainly be well taken — but on cannon shots, the added distortion produced by the slope overload is not noticeable as such. I would add that the stylus velocities observed in the music itself are well within the bounds of normal good practice.

Any reasonably well-balanced tone-arm fitted with a cartridge capable of the 17-mil side-to-side groove swing will track the disc. Most of the problems which are encountered have to do with speaker-amplifier limitations. The record starts off softly, and there is a tendency to crank the level up to a point of satisfaction. All may be well until the cannon shots come along. At that point, most systems have to be turned down a good 10 to 12 dB, and it is this gross program level variation between the first portion of the disc and that of the last 3:30 minutes which causes most of the playback problems.

If a standard playback system, RIAA equalized, is calibrated so that the 7 cm/S 1-kHz tone is set to read "zero" on the VU meter, the canon shot passages will reach levels some 8 dB above the reference level. Most typical audiophile discs will, in their louder passages, reach 3 dB above this reference point.

A survey of two different pressings indicates slight variations in overall level and a substantial difference in subsonic information. The sides in question are from master number 11 (which has more subsonic information) and number 12 (which we reviewed here). It seems likely that the overall levels — and tracking problems — have been reduced in the new master, possibly in response to field complaints.

John Eargle

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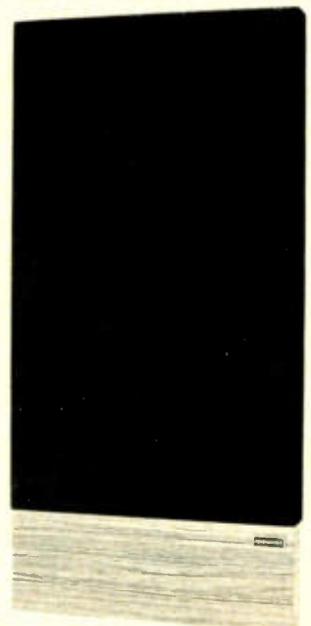
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Rachmaninoff: Prelude in C# minor; Debussy: Feux d'artifice, Boyeres, La Fille aux chevaux de Lin, Reflets dans l'eau; Scriabin: Etude Op. 2, No. 1; Poem; Sonata No. 9 "Black Mass"; Prokofiev: Sonata No. 3 in A minor, Op. 28. Ruth Laredo, piano. Producer, E. Alan Silver; engineering, Ray A. Rayburn.

In Sync Labs C-4060 (2211 Broadway, New York, N.Y. 10024), cassette, \$14.98.

Recording: A+ Processing: A+
Performance: A+

Here is a recording that will begin, at least, to vindicate the quality potential of analog recording. The sound of the piano here is easily among the best, if not *the* best, and most realistic I've heard on a recording. All the power of the piano is effortlessly conveyed in this cassette without sacrificing any of the colors elicited from the instrument by the performer. Indeed, even the noise of the action is realistically conveyed and in perspective, and there is no audible hiss or other spurious noise to mar the marvelous recreation of the piano afforded by this magnificent recording. The original tape was made on a Studer A-80 at 15 ips with Dolby A noise reduction and four AKG 451 omni mikes for main pickup and ambience. In Sync cassettes are only third-generation tapes which in part accounts for the extremely low distortion and noise level. As a matter of fact, there's no clearly perceivable difference in the hiss level between low-level passages and the tape segments separating the selections. The room in which the recording was made (actually a small church on West 73rd Street in New York) is not altogether perfect in its acoustics, but all in all, little can be faulted.

What is just glorious is the power projected by the piano and, in particular, the left hand. The piano, a Baldwin SD-10, is Baldwin's answer to the famous Steinway — and it requires no apologies whatever. Ruth Laredo should be well known to record listeners everywhere. She has recorded almost the entire piano repertoire of Scriabin for Connoisseur Society and that of Rachmaninoff for Columbia. She is a relatively young performer of extraordinary musical insight who plays the selections here with great understanding and love.

In sum, this is one of those very rare issues in which the recording technology perfectly serves the music and performer with a completely satisfactory and felicitous result. The performances presented here are from new recording sessions undertaken in April 1980.

C. Victor Campos

MICHAEL TEARSON
JON TIVEN**Twangin . . . : Dave Edmunds**
Swan Song SS 16034, stereo, \$8.98.

Sound: A Performance: A

If the demise of Rockpile is what it takes for Dave Edmunds to start making terrific albums again, then *long live* his solo career! Although the first (and last) Rockpile album had its moments of good fun, it was more or less a Nick Lowe elpee disguised as Rockpile, and the contributions of Mr. Edmunds were assuredly minimal. While *Twangin . . .* is not "I Hear You Knockin,'" it is undeniably Edmunds' finest album since his first, and shows him to be back on track both in terms of his playing and choice of material.

However, "It's Been So Long" (an Ian Gomm composition) sounds an awful lot like Elvis Costello's "Girls Talk" (Dave's last single), and the "original" compositions (all of them) are rather weak. But this still leaves undoubtedly the best version of "Almost Saturday Night" since John Fogerty's original — there have been four cover versions in the past six months — as well as Dave's best soul tune ever, a killer called "Three Time Loser" written by Don Covay. Two fairly obscure modern writers, Mickey Jupp and John Hiatt, contribute some excellent songs delivered exquisitely, and Dave's single, "Singin' the Blues," is also included. Perhaps the standout performance is a 1968 recording of Elvis Presley's "Baby Let's Play House" which contains absolutely the screechingest, most distorted guitar we've heard in a long while and a fine Edmunds vocal.

Whereas the last few Dave Edmunds records have appeared to be outlets for Billy Bremner's songs and Nick Lowe's throwaways, *Twangin . . .* contains material which seems to have been selected on merit alone. The guitar soloing on this record is far and away the best we've heard from Edmunds in about five years, with the exception of his live performances (how about a live Rockpile LP?). One can only hope that the kind of nasty rock 'n' roll provided by Dave Edmunds on *Twangin . . .* is just a taste of licks ahead and that the master craftsman will continue plying his trade for many years to come. *Jon & Sally Tiven*

Three Into One: Ultravox
Antilles AN 7079, stereo, \$8.98

Sound: A- Performance: A

When New Wave burst upon us in '76 and '77, with The Sex Pistols and The Ramones raving about anarchy and pinheads, it sent shockwaves throughout music that are still being felt. Standards of acceptance were shaken and new precepts of appreciation had to be devised, with many established and new groups falling by the wayside. One of the bands to be caught in the maelstrom was Ultravox.

Ultravox!, their first album, was almost too perfect amid the angst of The Dead Boys, The Damned, and The Vibrators. Produced by avant-rocker Brian Eno, Ultravox fused the manic energy of The Yardbirds with the stark imagery of lyricist and singer John Foxx. Tempered by Eno's cerebral production work, Ultravox fell into the cracks between trends. They were too intellectual and sophisticated to be termed punk (as were The Sex Pistols; it just took us three years to figure it out) and they had too much New Wave intensity and too many slashing edges to be associated with progressive rock.

On *Ha!Ha!Ha!*, Ultravox moved even further from the mainstream with thickly textured production provided by Steve Lillywhite (Peter Gabriel, The Brains). John Foxx took the band through psychedelic rave-ups on "Fear in the Western World" and bleak desolation on "Hiroshima Mon Amour." With this latter song Ultravox began introducing the electronic rhythms and textures that now

dominate their music.

Ha!Ha!Ha! apparently didn't fare too well since Island Records never released it in the U.S. and subsequently dropped Ultravox down to its budget subsidiary, Antilles, on which *Systems of Romance* came out. With their increasing use of electronics, the switch to Conny Plank as producer was a logical step. Plank has long been involved in the German avant-garde electronics scene, producing groups like Cluster and Kraftwerk. *Systems* was Ultravox's most direct effort to date, with Foxx doing obliquely honed visions of alienation.

To make short of a long story, Island

dropped the group and Ultravox became the most fully developed, unsigned band on two continents. Foxx eventually left, and after a brief hiatus, he, followed by his abandoned cohorts, emerged with strong albums in the midst of the synth-pop trend (most successfully popularized by Gary Numan's "Cars" and Devo). Now Island (which abandoned the group in the first place) has released a compilation of their three albums. This album, cleverly titled *Three Into One*, sports a suitably fashionable Devo-style cover.

Three Into One features three tracks from each LP plus an unavailable single B-side, "Young Savage." As compilations go, this one gives a good indication

of Ultravox's scope and holds together well as an album. The double-exposure images of "Rockwrok" (sic) capture the frenzy of New Wave, while "Just for a Moment" shows Foxx's growing introspection and need to be removed from the rush of that same genre. "My Sex" is a paean to sexual dislocation that brings poignancy to lyrics like "Sometimes I'm a novacaine shot, sometimes I'm an automat."

Three Into One illuminates the benefits of a good producer. All the albums coproduced by Eno, Lillywhite, and Plank show a strong regard for the record as a separate medium from straight live performance and use the studio to its fullest in placing the sound in space and creating some enveloping depth relationships.

I find *Three Into One* conceptually offensive because the group didn't get the record company support they deserved until it was too late. But as the only Ultravox album available domestically (excluding the Foxx-less *Vienna*), it is a superior introduction. *John Diliberto*

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Mistaken Identity: Kim Carnes
EMI America SO-17052, stereo, \$8.98.

Sound: A-

Performance: A-

It might have taken late bloomer Kim Carnes some time, but *Mistaken Identity* finds her considerable talents fully flowering. The big extra difference could boil down to two technical credits. First: "Produced and Recorded by Val Garay." Garay engineers Linda Ronstadt and James Taylor records and produces prolifically these days. In addition he mixed Kim's previous album, *Romance Dance*, including her breakthrough hit "More Love." Clean, lively sound is the Val Garay trademark. Second: "Recorded Live at Record One." The operative word is *Live*. Recording with minimal dubbing gives *Mistaken Identity* a very real spontaneity that automatically elevates it to the best thing Carnes has done out of half a dozen fine albums. Most noticeable is the liberating effect it has on her singing, which is throatier and more openly emotional than ever before. She seems to have tapped something fresh inside. Even the sequencing of the songs is another subliminal that makes the album work so well as a whole.

Ironically this album has the fewest Kim Carnes compositions or co-compositions ever, just five out of ten. The five outsiders are mostly by friends and are carefully chosen. The two Donna Weiss/Jackie De Shannon songs are terrific, the haunting hit "Bette Davis Eyes" and the jaunty "Hit and Run," a song which pairs off nicely with Kim's own "Break



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the Rules Tonight — the most unabashed rocker she's ever done. Frankie Miller's wonderful "When I'm Away from You" is given the best treatment it's ever received.

Richard Stekol's "My Old Pals" closes the album on a sentimental, wistful note. It's a song that The Band might have thought of years ago but didn't. The Carnes song before it, "Miss You Tonight," is a beautiful sad one that really draws a great reading out of Kim's husky, rasping, even occasionally crackling voice. Mystery pervades the title cut with its memorable chorus featuring Dave Ellingson's falsetto vocal. The only really false note is "Draw of the Cards," an ambitious song that aims for art and mystique and down, dirty atmosphere but by accident hits on pretense.

Mistaken Identity is a notable leap forward for Kim Carnes. She has learned how to use the unusual qualities of her voice to make a song work, how to make it its most effective. She seems to have stopped trying to be prettier than she needs to or can comfortably be. She has learned something about communication through a song on *Mistaken Identity*.

M.T.

Journey to Glory: Spandau Ballet
Chrysalis CHR 1331, stereo, \$8.98.

Sound: A- Performance: B

Spandau Ballet exploded onto the English charts with a pair of wonderful hit songs to become one of 1981's earliest press darlings. Their high-tech danceable rock is clever and catchy, irresistible on the hits "To Cut a Long Story Short" and "The Freeze."

The catch is that the beat can get tiring over the course of a complete album side. So it's excellent for partying or dancing, less so for pure listening.

Still, this is an auspicious debut from a band with fresh ideas and bright sound and vision.

M.T.

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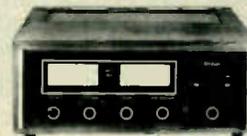
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By popular demand, The Audio Critic is going back to its original format.

The biweekly Bulletin format of The Audio Critic, started in January of this year, has been discontinued after just a few issues. The main reason for this decision was the widely expressed preference of our subscribers for the long-awaited feasts of audio information served up in our original magazine-size format, as against the more frequent snacks provided by the Bulletins, but certain misrepresentations made to us by the post office were a serious contributing factor. In any event, with the new issue about to be published, which will be called #10 (it would have been Vol. 2, No. 4 under the old nomenclature), everything will be back to the old format.

Issue #10 contains, among other things, in-depth reviews of new state-of-the-art components in several categories, including power amplifiers, phono cartridges, step-up transformers and tone-arms. All previous recommendations of The Audio Critic are also reconsidered and updated in this issue, after new listening tests through our \$37,000 reference system and measurements in our superbly equipped in-house laboratory.

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TOM BINGHAM



Strings Attached: Mick Moloney
Green Linnet SIF 1027, stereo,
\$7.98.

Sound: B+ Performance: A

Two of the most widely heralded of Mick Moloney's many talents are his mandolin and tenor banjo work. Finally, after a few tantalizing glimpses on earlier records, he has recorded an entire album of instrumentals, seven on mandolin, seven on tenor banjo.

Not only is Mick Moloney a highly accomplished musician from a technical viewpoint, he has superb taste in selecting tunes. Most of them are rather obscure, at least to American listeners — how many Irish music fanciers are familiar with "Arthur Darley's Jig," or the hornpipe "Peacock's Feather," or "Richard Brennan's Jig," or . . . ? Well, you get the idea. There are also a number of recent compositions in traditional style, most notably Ed Reavey's "Munster Grass" and Liz Carroll's reels "Ricky's White Face/The Top of the Stairs."

Beyond tunes and technique, Moloney plays mandolin with an exuberance matched by no one else. He energetically ripples his pick over the strings, extracting intricate embellishments while making it all sound easy, natural and totally musical. His tenor banjo work is no less incisive. He sportively enriches his rhythmic playing with triplets and even more complex ornamentation as in the jig set "Sheehy's/Taylor's." He brings a fluidity to the instrument far in advance of the stiff pacing common to many Irish banjists.

Moloney accompanies himself on guitar and, on two cuts, bouzouki (which is somewhat undermixed) with the flexibility, logic, and control we've come to expect from him. The melody and rhythm parts interlock so naturally, I can't tell the basic track from the overdub. On the last cut, pianist Marty Fahey backs up Moloney in a home recording. Although the piano is somewhat distant and the mandolin sound rather "hot," Fahey is an intelligent accompanist and the combination of the two instruments is quite delightful.

Without taking anything away from Mick Moloney's past accomplishments, I must say that this is my personal favorite among all the records he's had a hand in so far, either as performer or producer. It's an essential item for anyone with an interest in Irish instrumental music or, for that matter, traditional string music of any sort. (Mail orders, send \$6.50 to Green Linnet Records, 70 Turner Hill Road, New Canaan, Conn. 06840.)

Tom Bingham

Shuffle Rag: Andy Cohen
June Appal JA 027, stereo, \$7.98.

Sound: B- Performance: A

Although Andy Cohen has been a fixture on the coffeehouse scene as performer, entrepreneur, and inspiration for several years now, this is his first album. It's well worth the wait.

Cohen is best known for his jauntily enthusiastic performances of rags and raggy blues, both on guitar and piano. Unfortunately, there aren't any examples of his stomping piano romps on this al-

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bum. (He denies any special keyboard prowess, but those who've heard him in person will agree that he puts so much of himself into his piano playing, he more than makes up for any deficiencies in technique.) But there is enough of his buoyantly infectious guitar picking and refreshingly unslick singing (which reminds me somewhat of Michael Cooney, though Cohen isn't quite so droll) to satisfy anyone with a taste for Rev. Gary Davis, Blind Blake, and other East Coast rag-bluesmen.

The somewhat low-key first side spotlights Andy Cohen solo and features two highlights from his live act. "Talking Hard Luck" is a whimsical assemblage of self-deprecation and ugly jokes learned from Pegleg Sam, delivered with a facetiously dry matter-of-factness. Gary Davis' "Soldier's Drill" is a military march transferred to guitar complete with a pseudo drumline.

Side two presents Cohen in the company of his regular collaborators, multi-instrumentalist Joe La Rose and harp blower Gary Hawk. As enjoyable as side one is, Andy really comes to life in the company of his friends. LaRose is a quiet sort who lets his fingers do the talking for him. On Rev. Davis' "Buck Rag," his banjo merrily supplement some of Andy's most exciting guitar work on the album. The excitement carries through to a propulsive workout on "I Don't Love Nobody," sung by Joe.

Hawk plays gruffly rhythmic harmonica on three tracks. His roots are in Sonny Terry, but with more of a Memphis-jugband feel. He blends in almost instinctively with Andy and Joe, as on the energetic two-guitar jumper, "Mr. Crump Don't Like It." Mandolinist Rick Ruble joins Andy for a sprightly string arrangement of Scott Joplin's "Stoptime Rag," which I've also heard Andy do on piano; either way it's a thorough delight.

Side one will entertain you, but side two will get you out of your chair to shout for an encore. Hopefully, a second album will satisfy those cravings for more before too long. In the meantime, don't be surprised if this spends a lot of time on your turntable.

The recording is rather dry on side one, the voice in particular lacking presence. The mandolin is a bit over-prominent on "Stoptime," but otherwise side two is more judiciously balanced and, as befits the performance, livelier than side one. (Mail orders, contact June Appal Records, Box 743, Whitesburg, Ky. 41858.)

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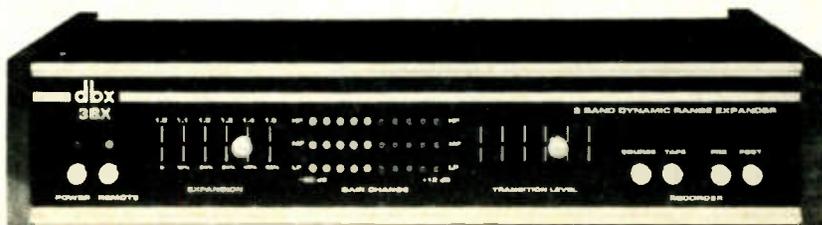
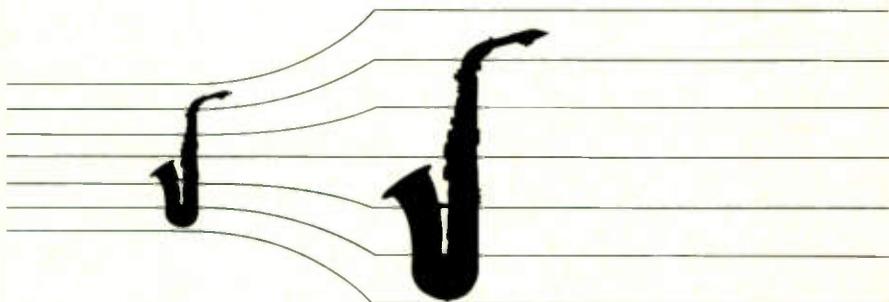
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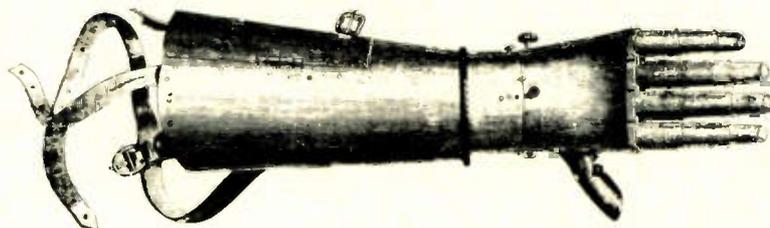
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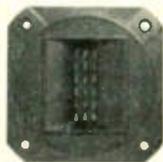
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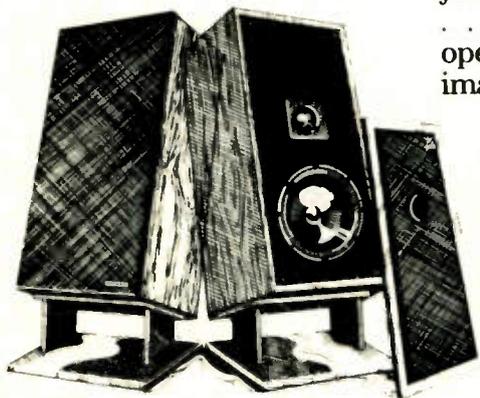
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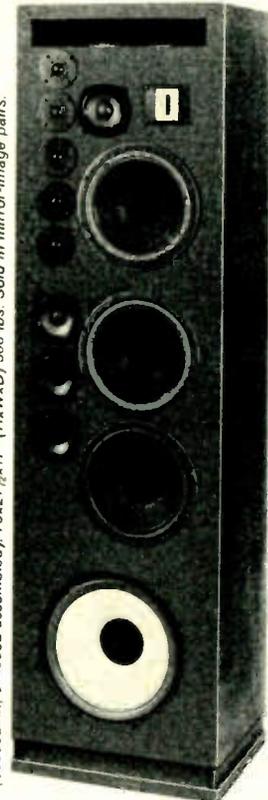
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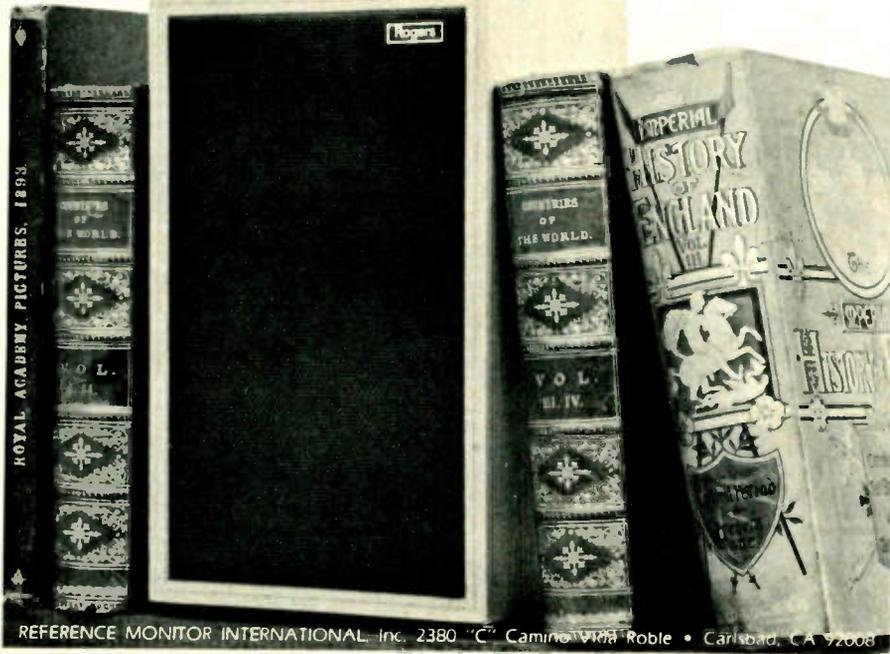
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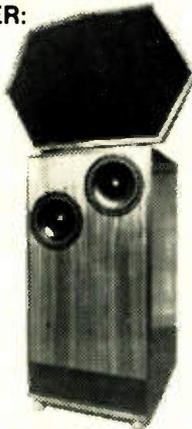
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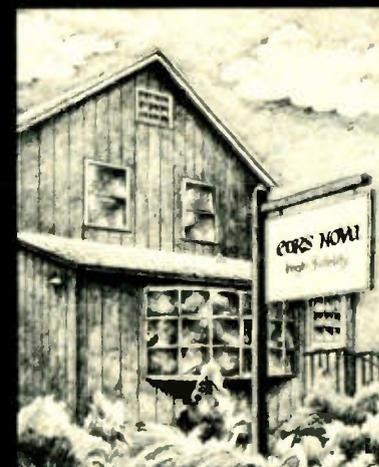
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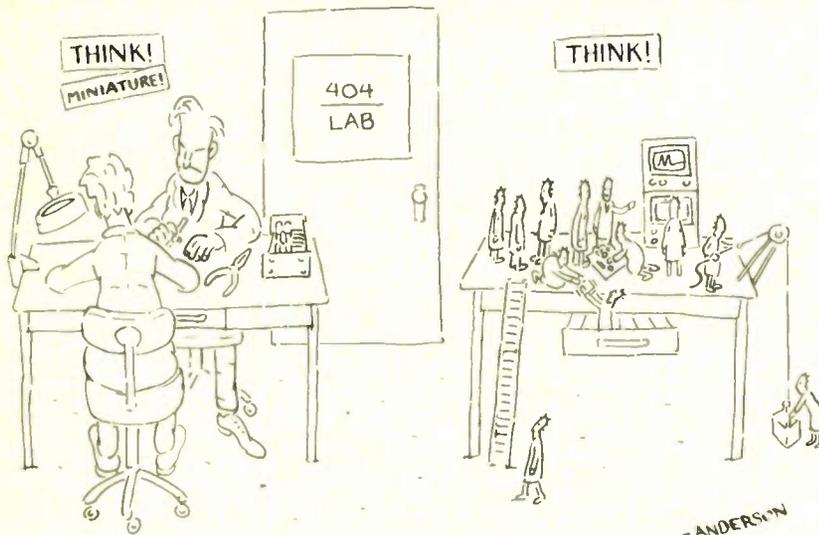
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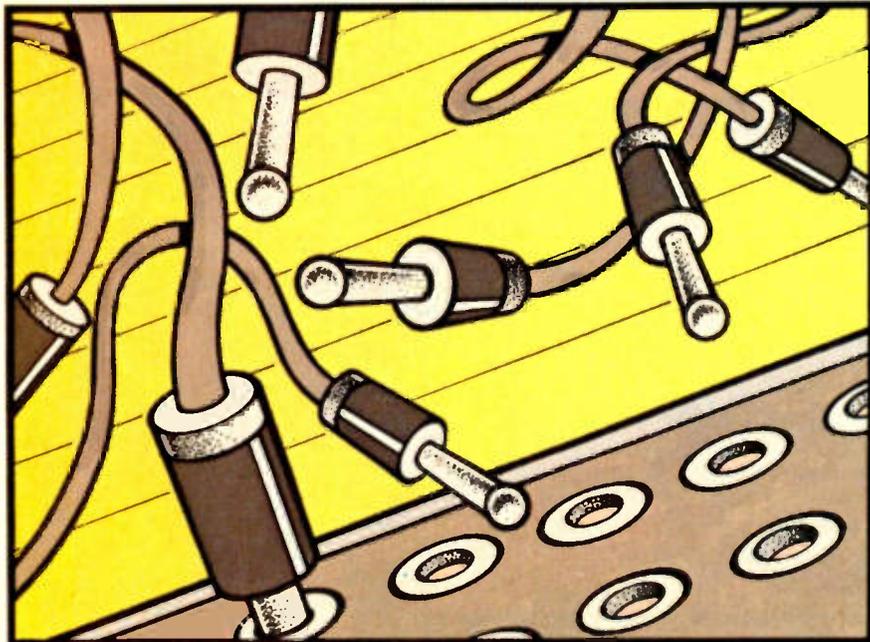
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BEHIND THE SCENES

BERT WHYTE



This column is devoted to "aid and comfort for the audiophile." Every now and then, it is worthwhile to address our attention to equipment other than the major items of amplifiers, loudspeakers, tuners, turntables, and cartridges. Much of this "minor" equipment might be dismissed as gadgets and gizmos, but more often than not these items are amenities and conveniences which not only add to the enjoyment of an audio system, but make a very significant contribution to its overall quality.

Many audiophiles are afflicted with what might best be called "tape-loop trauma." They have acquired so much auxiliary equipment and so many signal-processing devices, all of which require high-level inputs and tape-monitor loops, that even the most elaborate preamp/control centers lack sufficient input capabilities.

Consider that a well-equipped audiophile may own a cassette deck (or two), perhaps a pair of open-reel tape decks, external Dolby and dbx noise-reduction systems (including dbx disc playback), an expander, an equalizer, a time-delay system, an autocorrelator, a click suppressor, a Tate SQ decoder, a hologram or audio image enhancer, and Lord knows what else. Up to now, integrating all these devices into a work-

able, flexible, hum-free system has been a classic exercise in frustration. The smaller interconnect devices, such as those made by Russound, have been helpful, and if you are still into four-channel sound, they make a box to help cope with those problems. However, folks with a knowledge of professional studio practice are well aware that a patch bay and jack system is really the answer to multiple-device and interconnect problems. However, they've equally been aware of the intimidating job of soldering and construction such a project entailed, to say nothing of the very considerable initial expense.

A bright young fellow named Orrin Charm had the good sense to recognize this interconnect problem and devised an elegant, truly flexible patch bay system based on professional recording and broadcast studio practices. Charm's Audiovisual Systems Model PB-289G patch bay system is the embodiment of all his ideas on this subject. The PB-289G is 19-inch rack-mountable, to EIA standards, or it may be placed on a shelf on four supplied rubber feet. The unit is but 1.7 inches high and 5.5 inches deep, and its chassis is welded steel with a double-anodized black aluminum front panel. The rear panel has 16 color-coded two-channel inputs (32 gold-plated RCA phono jacks) and 16 two-

channel outputs (32 more gold-plated RCA phono jacks). The front panel has 16 stereo inputs and 16 outputs using three-conductor Bantam jacks with gold cross-bar contacts; patch cords are three-conductor Bantam. Plugs and jacks are said to be capable of a minimum life expectancy of 10,000 cycles. The front panel also has an extra pair of stereo phono jacks for temporary use of external components and a special blue-colored corresponding Bantam jack for utilizing these jacks. On the right of the front panel are patch cord jacks labelled "Mult 1" and "Mult 2" which in essence function as built-in "Y" connectors to feed a signal to several components simultaneously.

Internally, this patch bay uses a fully shielded printed circuit design with no discrete wiring or active circuitry. There is an ultra-low resistance ground plane on the input board, providing a true single-point ground for prevention of ground loops, crosstalk, and r.f. pickup. All switches, jacks, circuit board interfaces, and other contact surfaces are gold plated.

What is unique about this Audiovisual Systems patch bay is its concept of "programmable normalizing." Removing the top cover plate of the patch bay reveals 16 slider-type switches. When the switches are in the "Normal" or in position, the correspondingly numbered outputs are internally connected to the same numbered inputs when no patch cord is inserted. When the switches are in the out position, the rear panel jacks are connected only to their corresponding front panel jacks, and not to each other. With this kind of setup, all of your various components can be plugged into the rear panel jacks, and with the switches in the "Normal" position, no patch cords are necessary for regular system operation. The patch bay can be "programmed" in the sense that when the "Normal" switch on a designated channel is in the out position, you have the option of using equipment which you ordinarily would not use, such as test gear, but which you would like to have available. Although all your components are now hooked up to the rear panel and no access to it is necessary in normal operation, what do you do if you want to rearrange signal flow among some of the components? The patch cords carry both channels of the stereo signal, so



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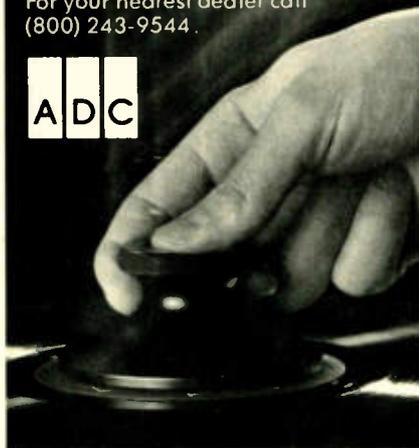
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If you have ever had to contend with a maze of wires, Audiovisual Systems' PB-289G patch bay can be a godsend.

simply by plugging in a patch cord to any output, you have an additional source of that signal, without disturbing the normal connection. Plugging the other end of the cord into any input will disconnect the normal source and substitute the selected output signal. There are many combinations of equipment signal flow possible, and two patch cords can reportedly handle about 95 percent of the patching requirements in a recording system. The front panel's external jacks permit patching in of test equipment for component checking; for example, easy alignment of tape recorders. The PB-289G is designed for unbalanced stereo signals but with an accessory balanced bridging box may be used for high-level balanced signals. The PB-289G is of precision construction with high-quality material used throughout; its price is \$795. If you have ever had to contend with a maze of wires and connections in a complex audio system, this patch bay is a godsend. It is versatile, flexible, quiet, and hum-free. For owners of some of the more stark purist-oriented preamplifiers with few input facilities, the PB-289G can be invaluable.

Bob Fulton of Fulton Musical Industries is always coming up with new ideas to maintain or improve the quality of high-fidelity music reproduction. Whether or not you feel that the various special types of speaker wires have a salutary effect on the sound quality in an audio system, many audiophiles do use such cables. Invariably, these wires are heavier than the usual 16-gauge wire found in most audio systems. Those who favor Fulton Gold speaker wire are faced with something approaching the diameter of garden hose! Now as is well known, many amplifiers and loudspeakers are equipped with banana plugs for interconnection, and these plugs are fervently cursed and condemned by the audiophiles who use the heavier speaker wires for the very simple reason that such plugs can rarely accommodate the larger wires. Even when the fitting is accomplished by some jury-rigged expedient, the sheer weight of the wire often causes the plugs to disconnect — sometimes with catastrophic results. Bob Fulton has been investigating the problems of banana plugs and believes that even with normal speaker wire they are bad news. He states that because of

the thinness of the "leaves" on a banana plug, under typical signal output conditions these leaves cause the plug to vibrate and chatter violently. Fulton reports there is discrete arcing and wildly fluctuating voltage and noise spikes across the entire frequency bandwidth. He says that with older banana plugs whose considerable use has resulted in a loss of springiness in the leaves, signal loss can be as much as half a volt.

To counteract these anomalies of banana plugs, Bob Fulton has introduced his latest product, the Fulton High Performance Audio Connector. Available in small, medium and large sizes accordingly matched to amplifiers of ascending output power, these are two-piece, high-mass, gold-plated, solid copper connectors with special tapered interface plugs that are said to insure maximum contact area and secure fit without arcing. Each plug has what is known as a "Murphy Taper," which fits into its jack receptacle quite easily, and, although there are no threads or machined interlock slots, the plug cannot be dislodged unless rapped sharply on the side of its housing. A threaded screw bolt with an hexagonal head screws into the end of the tapered plug. In use, the speaker wire is fitted with a rugged closed-eye lug and then is connected to the plug by the screw bolt.

Bob Fulton showed me a photograph of the CRT screen of his Crown Badap signal analyzer, which has the ability to show multiple signal traces in various colors. A blue trace at the top of the screen recorded the amplifier output through a banana plug as a very spiky, jagged display. Some 70 dB down at the bottom of the screen was a pink trace, which was virtually a straight line and represented the amplifier output through the new Fulton connector. Bob said this showed its ability for maximum power transfer without being frequency selective. Needless to say, to secure maximum benefit of these Fulton connectors, they should be fitted to both amplifier and loudspeakers. The small, medium, and large connectors require mounting holes of 7/16-inch, 11/16-inch, and 1-inch diameter respectively. They are fitted with heavy nylon washers and massive nuts, and the back ends of the connectors have the same threaded bolt setup for wire connection as does the tapered input plug. The small, medium, and large Fulton connectors respectively

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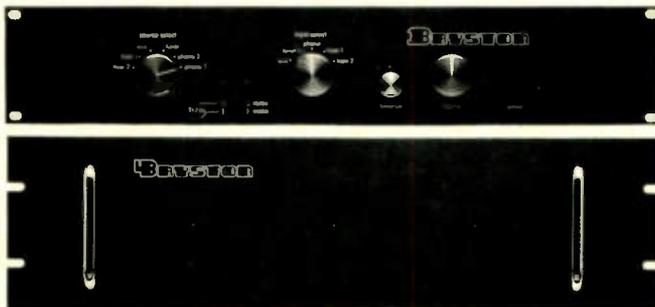
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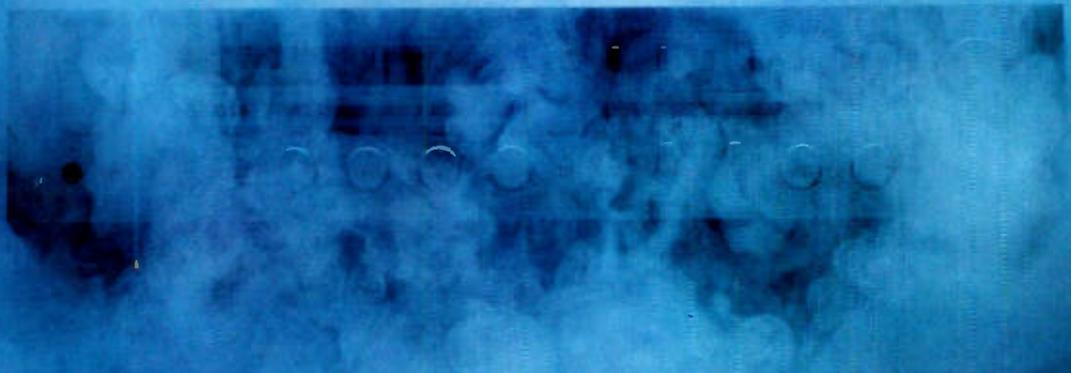
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The Fulton connectors can handle heavy speaker wires, and their power transfer characteristics may justify the use of such wire.

cost \$19.95, \$29.95, and \$49.95. Not only do these connectors make possible the use of the heavy speaker wires, their higher quality power transfer may justify the use and expense of such wire.

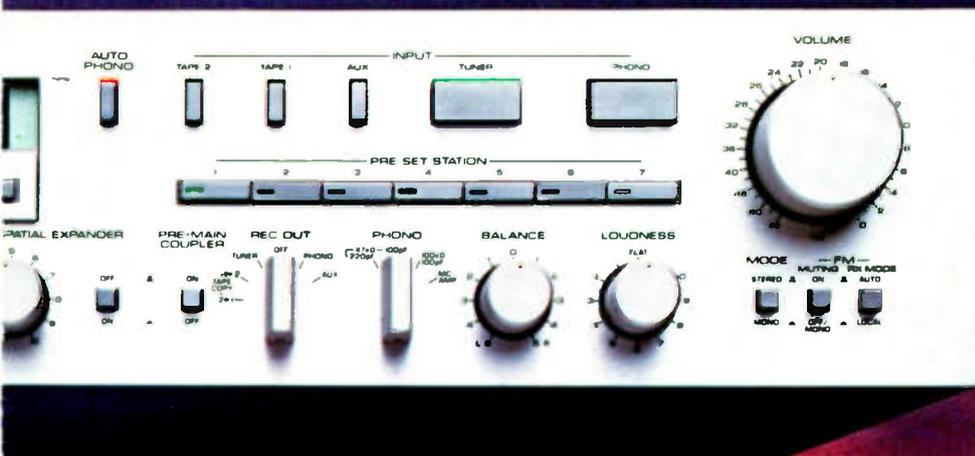
The Electro-Clamp Four is a useful voltage clamping device, a solid-state shunting system designed around a semiconductor NASA chose for such purposes. Although electrical service is pretty much taken for granted in this country as steady and reliable, it is subject to voltage transients and harmonic distortion. It is claimed that the average commercial a.c. power circuit receives many transient voltage spikes in excess of 1,000 volts every day. The IEEE reports that standard 120-volt a.c. lines receive transient pulses up to 5,600 volts from a variety of sources including lightning, static electricity, brush-type motors, air conditioning, electrical circuits on furnaces, etc. With more and more audio equipment using microprocessors (especially cassette recorders) and all manner of IC chips, these transient pulses or surges can be a problem. The transients can cause misreading of logic, falsely trigger semiconductors into conduction, and if you are into home computers of the Radio Shack and Apple variety, they can actually cause loss of data. The cycling of refrigerators and furnaces can cause transients which can create annoying "pops" through your speakers. The Electro-Clamp Four effectively eliminates all these line transients. Installation is as easy as removing the wall plate from a standard duplex a.c. circuit, plugging the device into place, and fastening it with the center screw. The Electro-Clamp Four also converts the duplex outlet to four outlets. The device is rated for 15 amps at 125 volts, clamping voltage is 160 V rms, 226 V peak, peak pulse dissipation 6,000 W for 1 mS, and surge rating 500 amps for 1/120 S. Response time is better than 5 nanoseconds. The price of the unit is \$39.95, and it is manufactured by CNS Electronics Corp., 41 Sun St., Waltham, Mass. 02154.

So there you have a few interesting and worthwhile pieces of ancillary equipment, one of which may well solve a serious problem for you. Certainly, there are others of this type, and I will mention them from time to time, for they are worthy of our attention, though perhaps not of being reviewed. **A**



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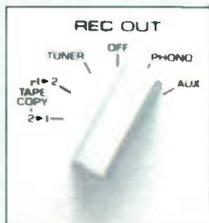


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favorite station. You're never without sound.

The Record Out function.

With Yamaha's independent Record Out, you can record from any source (tuner, tape, phono) while listening to any other. You can also feed a separate, different signal to a second amplifier and speakers in another part of your home. So you can have two complete home music systems for just the price of an extra amplifier and speakers.



Station-locking tuning.

Quartz-locked tuning is accurate. But quartz tuning circuits have an internal frequency oscillator which generates RF signals. These signals can be picked up by the



tuner and be mixed with the regular audio signal to cause distortion. To solve this problem, Yamaha engineers

developed a unique microprocessor chip with a memory. It stores the exact tuning location of every AM and FM station. When you tune a Yamaha receiver, the microprocessor produces exactly the frequency you're looking for instantly... from its memory. Tuning is 100% accurate. All you get is clean music.

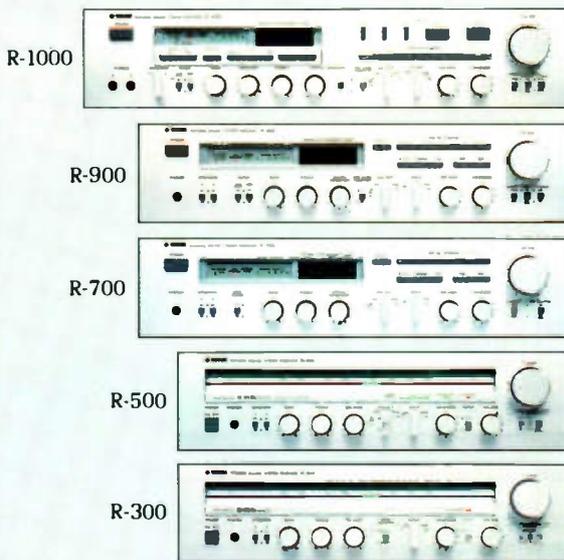
Pushbutton tuning.

The Yamaha R-2000 virtually tunes itself. At the push of a button, the tuning circuitry quickly sweeps the band in the direction you desire. The receiver locks automatically onto the next station—perfectly. You can also pre-select seven FM and seven AM frequencies for instant access to your 14 favorite stations.

We could go on. But hearing is believing. There are six completely new R-Series receivers. Each step up brings

more power, convenience and versatility. All feature the accurate, musical sound quality for which Yamaha has become world-renowned. And naturally, every Yamaha product is backed by a nationwide network of Preferred Customer Service Centers. The new R-Series receivers will make a dramatic improvement in the enjoyment and realism you get from your home music system. Truly the next step in sound from Yamaha.

For more information, write to: Yamaha Audio, P.O. Box 6600, Buena Park, CA 90622.

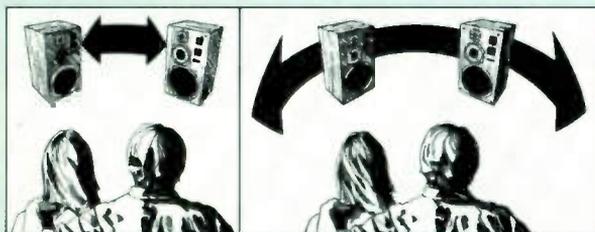




The R-2000 receiver featuring Ya

Now Yamaha takes you a giant step closer to the excitement of live music. The new R-2000 receiver goes beyond ordinary stereo to re-create the full depth, presence and excitement of actually being at a live performance. It's the top of the line of our new R-Series receivers; each designed to bring you pure, accurate musical reproduction. Sound to please the most discriminating audiophile—and features to please the most sophisticated music lover.

The Spatial Expander recreates the feel of a live performance.



Normal stereo sound field. Stereo sound field with Spatial Expander.

Normal stereo is limited to the space between two speakers. Yamaha's Spatial Expander extends the sound field out beyond the speakers. This wider sound stage recreates the ambience and spaciousness of a live performance. There is more space between musicians, more depth and richness to the overall sound. You get the feeling of live sound without the expense of adding extra speakers or amplifiers. The Spatial Expander works with any good stereo source material. Phono, FM or tape. For the first time you can enjoy the feeling of sitting front row center at your favorite concert.

X-Amplifier for more power and cleaner sound.

The R-2000 with our new X-Amplifier is more efficient and

more faithful to music than any receiver we've ever built. The circuit design evolved from the nature of music itself. We discovered that true musical crescendos, which require full amplifier power, occur only about 2% of the time. Conventional amplifier designs operate at full power *all* of the time in anticipation of those loud musical passages. The remaining 98% of the time, full power isn't required. That means conventional designs waste electricity and produce huge amounts of heat—which shortens component life.

The new Yamaha X-Amplifier works at low power most of the time. A unique (patent pending) comparator circuit switches the amplifier to high power when a loud passage is detected, and back to low power when the peak has passed.

As a result, the amp runs significantly cooler than conventional designs, which measurably increases component life.

And the X-Amplifier of the new R-2000 is the most powerful we've ever built into a receiver. It delivers 150 watts RMS per channel with 0.015% THD, at 8 ohms from 20 to 20,000 Hz. So the new X-Amplifier will easily handle the wide dynamic range of the newest digital and direct-to-disc recordings.

Yamaha's R-Receivers bring you sophisticated features and unparalleled convenience.

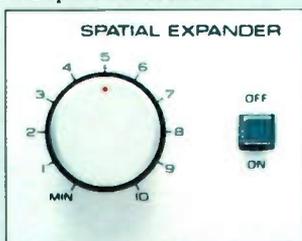
Continuously variable loudness control.

At low levels, music sounds like it's missing something. That's because at low volume your ear loses its ability to hear high and low frequencies.

Most "loudness" controls compensate for this by boosting the high and low frequencies. This can lead to increased distortion. Yamaha found a smoother way. By suppressing the mid-range. And unlike everybody else, we let you adjust the *amount* of loudness compensation to suit *your* taste. So at low listening levels you get full, balanced sound without distortion.

Auto phono.

Now you can have continuous music without getting up to switch sound sources. For example, you can set the R-2000 to a favorite FM station. Then, you can put on a record and the receiver will automatically switch to the phono mode. Once the record is over, the receiver automatically switches back to your



The First Discwasher Tape Accessory

discwasher® **PERFECT PATH™** Head Cleaner

● No alcohols
to damage tape
mechanism.

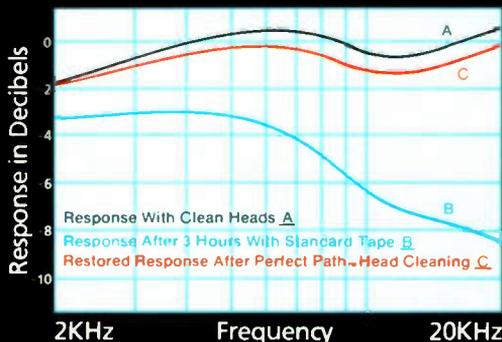
● High technology system;
simultaneously cleans heads and
removes oxide from tape path.

● Non-abrasive.

Special non-abrasive cleaning fibers are backed with an exclusive "capture surface" designed to trap tiny particles of tape residue, preventing them from contaminating tape mechanisms.

The Perfect Path Difference:

- "Cleaning contact" is made along the total tape path including guides and heads, normally untouched by wiper cleaners.
- Perfect Path cleans without alcohol or freon. It will not extract and age pinch rollers.
- Perfect Path simultaneously cleans tape heads while removing debris from along the tape path.
- Perfect Path's cleaning fiber grid is non-abrasive. Even after hundreds of passes, it will not scratch heads.
- Perfect Path restores high frequency "air" and transient response of cassette recordings.



Playback accuracy of a calibrated test tape. Note that after only three hours' play, high frequency response is reduced by as much as 10 dB. One cleaning with the Perfect Path Head Cleaner restores the highs to within 1 dB of the original response.

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PERFECT PATH™

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