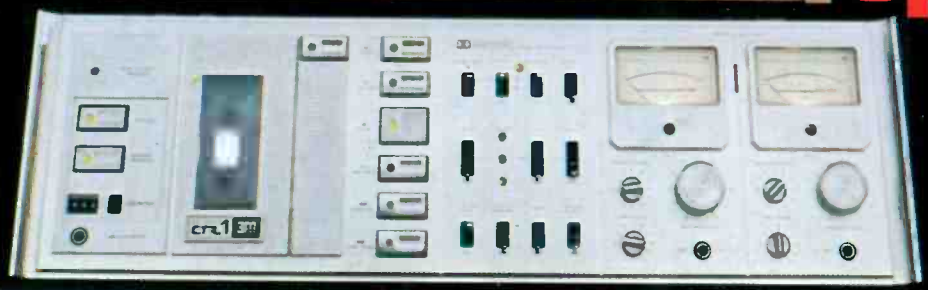
King Wrestles Ampzilla

Audio

THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • SEPTEMBER 1975 75¢

How Valid Is The FTC Rule?

Cassette Decks— How Do They Stack Up?



receivers the world

Pioneer believes that any objective comparison of quality/performance/price between our new SX-1010, SX-939 and SX-838 AM-FM stereo receivers and any other fine receivers will overwhelmingly indicate Pioneer's outstanding superiority and value.

Our most powerful ever.

Pioneer uses the most conservative power rating standard: minimum continuous power output per channel, into 8 ohm loads, across the full audio spectrum from 20 Hz to 20,000 Hz.

Despite this conservatism, the SX-1010 far surpasses any unit that has come before it with an unprecedented 100 watts of power per channel, minimum RMS, at no more than 0.1% total harmonic distortion. Closely following are the SX-939 (70 watts RMS per channel, minimum) and the SX-838 (50 watts RMS per channel, minimum), both with no more than 0.3% total harmonic distortion. Dual power supplies driving direct-coupled circuitry maintain consistent high power output with positive stability. A fail-safe circuit protects speakers and circuitry against damage from overloading.

Outstanding specifications for flawless reception

FM reception poses no challenge to the exceptionally advanced circuitry of these fine instruments. Their FM tuner sections are designed with MOS FETs, ceramic filters and phase lock loop circuitry. The result is remarkable sensitivity, selectivity and capture ratio that brings in stations effortlessly, clearly and with maximum channel separation.

	SX-1010	SX-939	SX-838
FM Sensitivity (IHF) (the lower the better)	1.7uV	1.8uV	1.8uV
Selectivity (the higher the better)	90dB	80dB	80dB
Capture Ratio (the lower the better)	1dB	1dB	1dB
Signal/Noise Ratio (the higher the better)	72dB	70dB	70dB

Total versatility plus innovations

Only your listening interests limit the capabilities of these extraordinary receivers. They have terminals for every conceivable accommodation: records, tape, microphones, headsets — plus Dolby and 4-channel multiplex connectors. Completely unique on the SX-1010 and SX-939 is tape-to-tape duplication while listening simultaneously to another program source. The SX-838 innovates with its Recording

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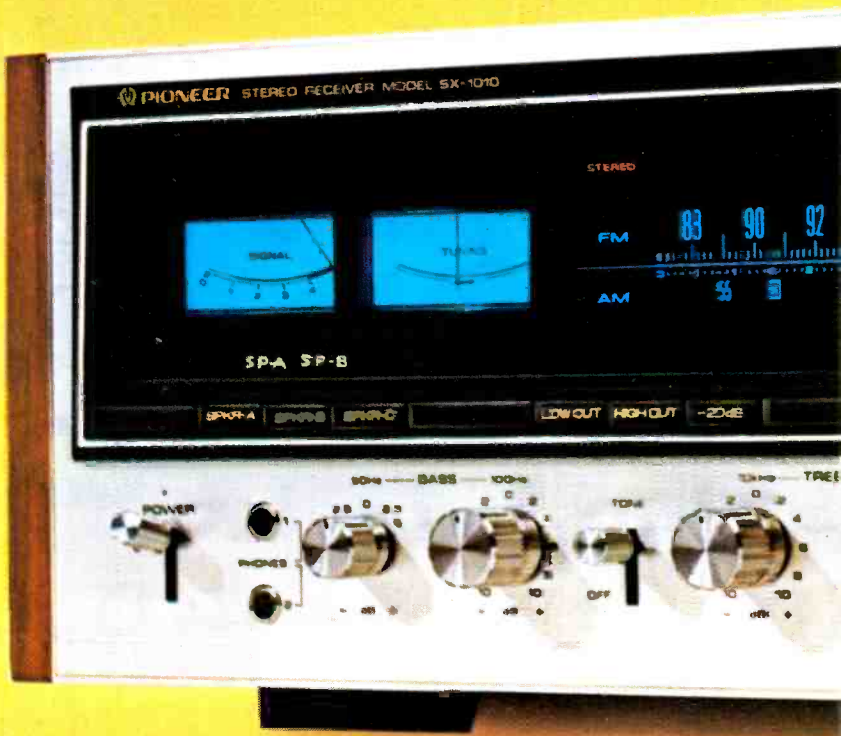
There can be only one best.



3,025 possible tonal compensations with unique twin stepped tone controls (SX-1010, SX-939)

Selector that permits FM recording while listening to records and vice versa. Up to three pairs of speakers may be connected to each model.

INPUTS	SX-1010	SX-939	SX-838
Tape monitor/4-ch. adaptor	3	2	2
Phono	2	2	2
Microphone	2	2	1
Auxiliary	1	1	1
Noise reduction	1	1	1
OUTPUTS			
Speakers	3	3	3
Tape Rec./4-ch. adaptor	3	2	2
Headsets	2	2	1
Noise reduction	1	1	1
4-channel MPX	1	1	1

Master control system capability

Pioneer's engineers have surpassed themselves with a combination of control features never before found in a single receiver. All three units include: pushbutton function selection with illuminated readouts on the ultra wide tuning dial, FM and audio muting, loudness contour, hi/low filters, dual tuning meters and a dial dimmer.

Never before used on a receiver are the twin stepped bass and treble tone controls found on the SX-1010 and SX-939. They offer over 3,000 tonal variations. A tone defeat switch provides flat response instantly throughout the audio spectrum. The SX-838 features switched turnover bass and treble controls for more precise tonal compensation for room acoustics and other program source characteristics.

In their respective price ranges, these are unquestionably the finest values in stereo receivers the world has ever known. Audition their uniqueness at your Pioneer dealer. SX-1010 — $699.95; SX-939 — $599.95, SX-838 — $499.95. Prices include walnut cabinets.

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SX-636

SX-737

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Audio

September, 1975 *"Succesor to RADIO Est. 1917"* **Vol. 59, No. 9**

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Record Reviews

Audio in General

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AUDIO (title registerd U.S. Pat. Off.) is published monthly by North American Publishing Co., Irvin J. Borowsky, President; Frank Nemeyer, and Jay L. Butler, Vice Presidents; R. Kenneth Baxter, Vice President/Production: Nate Rosenblatt, Promotion Director; Mary Claffey, Circulation Director.
RATES—United States only: 1 year for $7.00, 2 years for $12.00, 3 years for $17.00; outside the U.S.: 1 year for $9.00, 2 years for $16.00, and 3 years for $23.00. Printed in U.S.A. at Columbus, Ohio. All rights reserved. Entire contents copyrighted 1975 by North American Publishing Co. Second class postage paid at Philadelphia, Pa. and additional mailing office. Back issues, $2.00 each. **World Library Congress** number: ISSN 0004-752X. **Dewey Decimal number: 621.381 or 778.5.**
REGIONAL SALES OFFICES: Jay L. Butler, Publisher and Sanford L. Cahn, Marketing Director, 41 East 42nd St., New York, N.Y. 10017, telephone (212) 687-8924.
Jay Martin, 2525 West 8th St., Los Angeles, California, 90057, telephone (213) 385-2917.
REPRESENTATIVES: Continental Europe: John Ashcraft, 12 Bear St., Leicester-Square, London W.C.2, telephone 930-0525.
For Benelux and Germany. W.J.M. Saunders, Mgr., Herengracht 365. Amsterdam, Holland, telephone 24.09.08.
Japan: Japan Printing News Co., Ltd., No. 13.2 Chome Ginza Higasi, Chuo-ku, Tokyo, telephone 541-5795.

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Audioclinic

Joseph Giovanelli

Matching Headphone To Amplifiers

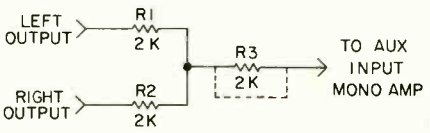
Q. I have headphones rated at 250 ohms which I would like to use with my amplifier's front panel headphone jack. Do I just install resistors in series with the jack, and what value should I use? The jack is rated at 8 ohms. —Steve Anderson, Santa Ana, CA.

A. A source rated for a low impedance (8 ohms) load can drive one of higher impedance (250 ohms) easily. The reverse is not true, however. Matching them in this case will make no improvement in sound, but would lower the signal input into the phones because your amplifier already has resistors in series with its output. These are required to keep from feeding the amplifier's entire output to the phones and blowing them out (and hurting your ears).

Mono Sound From Stereo Tapes

Q. I have a Sony CF550 cassette recorder with line output. I would like to listen to stereo tapes from this unit over my Bogen P.A. (mono) amplifier. It has an AUX input.—Rudolph Repac, Hillside, N.J.

A. You can play two stereo channels into a single-channel amplifier by using a "Y" connector. Connect two of the connectors of the Y to the line outputs of the tape machine and the other to the *AUX* input of the mono amplifier. Occasionally this setup will lower the output of the recorder and produce some distortion. In such a case, you should insert an isolating network as shown in the diagram.



R3 MAY OFTEN BE OMITTED.
(REPLACED BY DIRECT CONNECTION)

Record Noise vs. Pickup Output

Q. I have a Dual turntable, Micro-Acoustics QDC-1E pickup, and a Pioneer SA-9100 amplifier. Because of the low output of the cartridge, I must turn the volume up to between one and three o'clock. The surface noise of my discs is sometimes annoying, and I often hear a low-frequency rumbling. These noises change with different records, from nearly inaudible to terrible. Can this be turntable rumble, or it is groove noise (stylus friction) because my volume control is set too high?—Michael Bartholomew, Hellertown, PA.

A. The relatively small signal output of your cartridge has no bearing on how much record noise the cartridge transmits to the rest of the sound system. The cartridge produces record noise and desired signal to the degree that each is present on any given recording.

The fact that some discs produce more of this noise than others indicates that the problem you have is actually with the discs, as the problem varies from one to another. Some low-frequency noise is on the discs themselves, either because of problems during mastering or, more likely, problems in the pressing process. In this case, the rumble-like noise will be more like a roar than a rumble. When you have fine equipment, flaws in discs are heard more easily (Of course, the good things are also revealed.).

ABOUT THE COVER: This star-lit stack of front-loading cassette decks represents the new heights to which tape recorder designers have pushed their art. Find out how well cassette decks really stack up in our lead article this month.

If you have a problem or question on audio, write to Mr. Joseph Giovanelli, at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107. All letters are answered. Please enclose a stamped, self-addressed envelope.

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Tape Guide

Herman Burstein

Comparing Specs

Q. Recorder A has the following specifications: frequency response 20-20 kHz, wow and flutter .09%, signal-to-noise ratio 52 dB. Recorder B has specifications of: frequency response 50-15 kHz, wow and flutter less than .15%, signal-to-noise ratio 55 dB. Recorder B sounds better than A. Why? Is a full-track head better than a quarter-track head?—Dean Frazier, Huntsville, Ala.

A. Recorder B should sound better because (1) it has flatter frequency response (although a more limited range) and (2) it has a better signal-to-noise ratio. Many tape machines that boast of response down to 20 Hz and up to 20,000 Hz fail to keep response flat within 1 dB or so throughout this range. To achieve response out to 20,000 Hz, they may sacrifice performance in terms of noise and/or distortion. They may also have a treble peak in an audible part of the audio spectrum. To achieve response down to 20 Hz, they may make similar sacrifices.

A full-track head has the advantage of higher signal-to-noise ratio since it picks up more information from the tape than do half-track and quarter-track heads. Also, the full-track head permits tape flaws, such as dropouts, to average out better (that is, to be less noticeable). On the other hand, a full-track head has the disadvantage that a given amount of azimuth misalignment results in more severe treble loss.

Limiting and "Unlimiting"

Q. Can program material which has been processed through a limiting amplifier (limiter) be restored to its original dynamic range? — Andrew Butler, Victoria, B.C., Canada

A. A limiter or clipper completely removes dynamic changes above a particular signal level, no matter how large a signal is fed into it. A complementary "unlimiter" would have to detect how much dynamic range had been lost. This is obviously impossible if the limiter has done its job perfectly. A *compressor*, on the other hand, only narrows the dynamic range of the program material, but does not cut it off, as a limiter or clipper does. Thus, programs which have been compressed may be processed back to their original dynamic range by an *expander*, if the expander is set to complement the action of the compressor.

Taping Phono Discs

Q. I have questions about taping new phono records. It seems that, depending on the manufacturer, recording levels on channels A and B vary 4 to 5 db from each other. This is more obvious with popular music than with classical records. Is this situation common? Also, when taping records, should both channels be adjusted to the same level as indicated on the VU meters?—Ted E. Hayen, Lawton, Oklahoma

A. To the extent that each channel on a stereo record has different frequency content, one may expect some variation in sound level between channels. In the processing of the master tape and subsequent tapes until the sound gets onto the records, there may be unbalance resulting in different levels on the record even for the same sound. Something like 2 or 3 db may be expected. But 4 to 5 db differences are a bit high. On the other hand, rock records are not always made with as much care as are classical records. Too, it's possible that the difference is not entirely on the record, but partly in the calibration of your VU meters.

In recording a tape from a record, adjust separately the recording gain control for each channel on the basis of the VU meter indication. This may result in different settings for the two gain controls. It is assumed that the two VU meters are identically calibrated, so that a given sound level produces the same indication on each.

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107. All letters are answered. Please enclose a stamped, self-addressed envelope.

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Audio ETC

Edward Tatnall Canby

NEVER CAN TELL where true binaural sound will pop up these days, for listening inside those thousands of headphones we have been buying. By the time this hits print, my latest binaural experiment will be audible to you, hopefully, right in your home. It'll get there by radio, The Bottom Line—which hasn't a thing to do with IRS Form 1040—broadcasts that were scheduled to begin, all over, in mid-August. Try your local FM schedule. We've found a way to broadcast for both binaural *and* loudspeakers and OK for both. No—*not* stereo via phones! True binaural, specifically tailored from binaural mikes at ear distance. I've named the principle *The KC Factor*, for self and Don Ketteler, the sound man who got me involved and who did most of the work.

The Bottom Line is what we elders would call a rock palace. It is a big, successful, good natured place that crowds itself into a vast ground-floor cavern deep in the heart of the Village (NYC)—great, dusky spaces; tall, old-fashioned iron pillars, art nouveau style, and ex-factory, and the whole is painted a dark dun color so that when the lights go down, space becomes infinity. On the floor, a score of long, narrow wooden tables jammed around a thrust stage—the waitresses practically climb onto them to reach the customers. In there, you stay put, unless you are a table hopper. On a small projecting rear balcony, accessible by iron rung ladders, is the guts of the place, sound and light, and one of the finest, smoothest sound systems, for its size, this side of the A. and the P. Slung from the ceiling are great hulking speakers, dun-colored too, their odd-looking downward-aimed slats directing tidal waves of sound to the tidal waves of young people who wave up from the waves of tables. . . . enuf. It's a rock palace! Two shows a nite and jammed to the air conditioners for such acts as Manhattan Transfer (I was there—no fingers in ears and I did NOT walk out) or maybe Mike Bloomfield, David Bromberg, Kenny Rankin, Rachel Faro, the Persuasions (a c*appella* vocals), the Nitty Gritty Dirt Band &c &c &c. That's the unlikely *mise en scène* for our binaural.

Don Ketteler is a sound man who inhabits the BL platform. He had read my two "Ispy" articles (*Audio*, Nov., Dec. 1974), all about the Sennheiser binaural plastic head with the miniature mikes hooked into its ears, and had come up with a hot idea. His balcony, alas, is sonically defective; air ducts and the like hem him in and they make his job quite tough. Why not try a binaural head, located at a favorable listening place, and monitor the shows via binaural surrogate ears? Fascinating, but things aren't as simple as they seem in this world and that project is still hanging. Still, Don got himself an "Ispy II," (exactly like mine except, of course, dun colored) and in no time the boys were taking down binaural on a cassette machine, just to see what was what. Good, too, even unto a Vivaldi concerto playing on the big P.A. system in mono. (It sounded exactly like Vivaldi played in mono.) They did find that the best place for Ispy II was high up on one of those iron pillars, above the audience and well removed from the stage. That was significant. Mike distance of some 30 feet or more to the nearest performer vs. maybe an inch or so for the close-up cardioids used in the regular stage show. Some contrast!

Then came another and better idea. There was already a remixed "live" tape going out to a nearby FM station which the management was planning to expand into a big-time nationwide hookup via "live" tape. Hey, why not feed some of Ispy II into the remix lines, and get binaural from the BL—on the air! No sooner thought than done, experimentally. Don had the facilities and young engineers are quick to enthuse. In short order, their cassette was taking down a mix, partly Ispy II's binaural signal from up on the pillar and partly the regular broadcast feed. Interesting.

The house P.A., you'll understand, is strictly mono, one enormous audio signal out of 16 or so mike channels combined at Don's console. The stage channels are necessarily either direct, just from guitars, etc., or via ultra-close cardioid mike—otherwise FEEDBACK. Totally dead and projected directly as the "live" out-loud sound of the performers. The radio feed is separately mixed, via splitters, into an arbitrary two channels out of all of these same house channels. Note that the actual loudspeaker P.A. sound is almost totally suppressed in this sort of system. It's only for the customers.

Well, the mix didn't work out very well, and it was about this time that Don contacted me, maybe for inspiration à la Ispy. Trouble was, they found that in the phones, in order to overcome the powerful mono signal for the radio feed, the mix had to be

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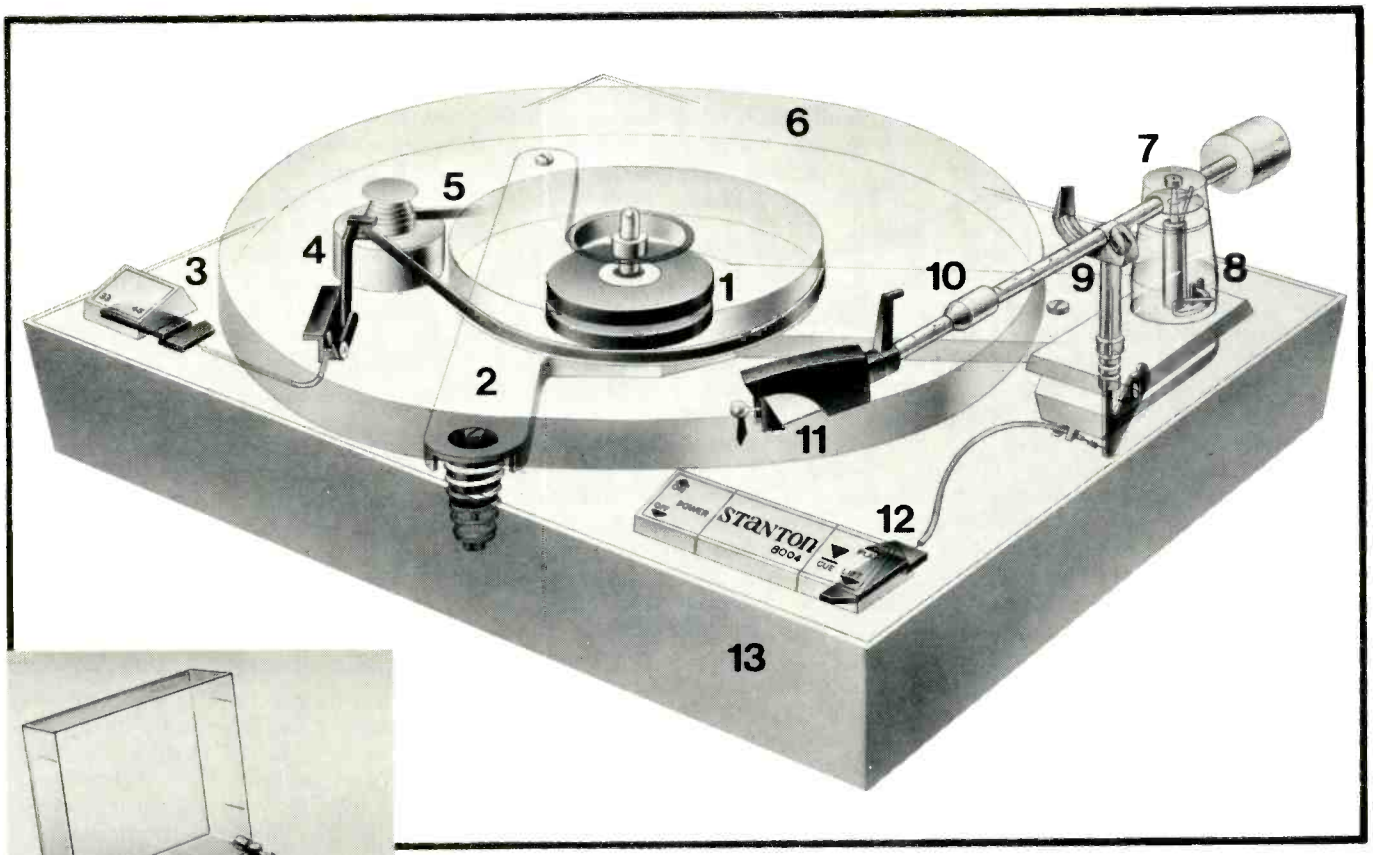

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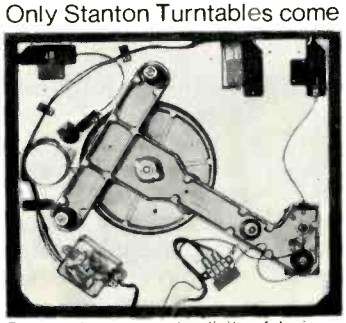

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almost all-binaural—and useless for loudspeakers. Fix things to sound OK on loudspeakers (essential for any broadcast) and there was no binaural. What to do?

Binaural oldtimers will understand. Binaural is *Different*. Each channel is fed exclusively to a single ear; whereas via speakers we hear each channel, each speaker, with *both* ears (and thereby locate them in space). That means utterly different requirements in mike technique. For loudspeakers, notably in pop, plenty of cardioid ultra-close pickup, for crisp definition and localization. For binaural headphone listening—*distance*, 'way off, via omni-mikes (seldom used in pop—the BL hasn't a single omni). And of omnis, only two, spaced a mere eight inches apart. Imagine broadcasting that!

. . . Did I say mono, above? Don didn't get me. Wasn't the broadcast mix two-channel, for FM stereo? Well, yes, but my trusty ears heard the house-mikes' sound, two-channel or no, right down at the back of my inner skull. It was MONO. So we checked—yep. Up at remix control old Ketteler had set the multiple panpots straight ahead, centered, in neat rows. Probably just to look nice between shows, like pens and pencils on a desk. So we had two-channel mono, to mix with our binaural signal. No wonder.

You simply cannot feed a strong mono signal like that into phones. It compresses the brain, kills every vestige of space and overwhelms binaural. (Even worse is to feed any signal into one ear and not the other. Then, all you hear is a one-eared jangle. Yet a lot of pop and even some classical does virtually this very thing, to get sounds into one speaker or the other.) All this gave me my own bright idea.

I suggested for remix we set up the panpots, just for experiment (and NOT on the air!) at opposite extremes, either all-right or all-left. Crazy, but I was getting a hunch. We would now have a feed that was not mono, not stereo, but two-channel discrete, the music split right down the middle. Could I use the binaural signal *to pull these channels together?* That was the KC Factor, incipient.

Via speakers this would sound incredible, as well as discredible. On phones, it would be schizophrenic. Just what I wanted! So Don followed through. Next time I listened to his mix, things were really beginning to schizz. Via speakers, the remix feed was two separate recordings of the music, half-and-half sidewise. Via phones, it was chaos. Now we took on a new and useful tool, my handy TEAC 2340 quadraphonic recorder, so portable the boys almost didn't hail a taxi to bring it to the BL. On two TEAC tracks we recorded Ispy II from his pillar, pure binaural, plastic head and all. On the other two tracks, we took down the bifurcated experimental radio feed, right out of the stage close-up channel. Now we could blend variably to taste, and after the fact, KC was beginning to define itself. Get the idea?

Here's how. In practice, even the deadest, most-discrete pop mixdown has *some* sort of sonic meld to join the final channels into a unity of space and presence. Usually this is via a bit of cross-mix, live or synthetic, here and there, plus additional over-all ambience, the same. A well-recognized art, even into classical technique where ambience is already inherent in the performance. We do it there —close-ish mikes, separated, for definition. Then in mixdown an overall ambience to focus and place the whole. Standard approach.

Clearly, something of this nature would be required for a Bottom Line broadcast. My thought was to *use the binaural signal for this very purpose.* We could try! All we had to do was turn on the TEAC and mix our channels to taste. It worked. At least, to my satisfaction. (Ye Editor heard it, and looked cryptic.) I was delighted, because I had a further and trickier hunch. Phones and speakers would "see" this mixed signal very differently—and to our advantage, if we played things right.

Take it from the speakers' viewpoint. To a pair of loudspeakers, Ispy II's mikes, distant and close together, are virtually a point source out in the audience, an omni-ambience mike (with, to be sure, a hint of stereo spread, all of eight inches!), which picks up not only space ambience but the sounds of satisfied customers, right down to the last bravo, which is balm to sponsors' ears. Ah yes. We needed that, and we had it. We could even bring the audience up, between musical numbers. So what could be better, for loudspeakers via FM broadcast?

Now look at it from the viewpoint of the headphones, hearing the same mixdown signal. Remember the 100 percent separation. In phones, a very little binaural signal goes a long way, if you give it a chance (no mono). Why else does Mama N. give us only a few inches? All we need. Otherwise we'd have ears on stalks. We are so sensitive to real binaural signals, separately to each ear, that a tiny bit of signal in one ear, the other channel being at full level, is enough for complete binaural fusion, roundness and space—try it. Maybe 60 dB difference. (And just try waggling the image from side to side via your volume balance control, as you can do with speakers. Won't budge.) So—from the headphone viewpoint, a small increment of binaural signal should be enough to pull the close-up discrete signals together and add binaural space and realism. In fact—just about the amount we use to liven up the signal for broadcasting. That's the KC Factor. You can have it both ways.

Of course, this isn't going to be a *literal* binaural pickup, as from Ispy's own signal up on his pillar. That's OK for phones, but poison for speakers. What we do get via phones is parallel to the speaker sound, a synthesized, artificial but aesthetically-pleasing binaural *effect*, a lot better than mere loudspeaker stereo via phones, though even that often works out fairly well, as we all know. Can do better.

Get the formula, then. A generalized principle for all sorts of widely different mike situations. You start with your main or close-up signals, whatever, and give them MORE separation and LESS ambience than you want in the final mix. Then use the distant, ambient-binaural signal to pull the sound into desired focus and space, to taste. Fix things right for loudspeakers and—with the binaural signal present—the sound will be automatically OK for phones. Binaural is flexible, inside the headphones. In practice, you may not need nearly as much exaggeration as we used, but it's good to start that way, just to see how the thing works. So long as your binaural signal is (a) relatively distant, as ambience/audience sound, (b) can be used to *pull together that which is overly separated* and (c) *add space and liveness to that which is overly dead and close*, you should be OK for results. Even in classical. Lots of ambience there already, but you still can manage enough exaggeration, as per above, to do the trick. That's the KC Factor.

P.S. in stage whisper: I suspect that two ordinary omni mikes (never cardioid) placed eight inches apart and minus any head, should serve almost as well as anybody's Ispy, though less picturesquely. You can try, anyhow.

So now go out and catch the Bottom Line via your local FM. And have your phones ready.

The tuner that restates the state of the art.

Imagine a stereo FM tuner that performs as cleanly and vividly as your favorite records. That has distortion so low it defies laboratory measurement. That automatically rejects all unwanted noise and interference.

You're looking at it. The YAMAHA CT-7000... the new state of the art tuner. Its cost? $1,200. So listen at your own risk, because you may never be satisfied with any other tuner again.

It's the first tuner with Negative Feedback. Long used in amplifiers to lower distortion, the application of Negative Feedback to the CT-7000 has all but eliminated MPX distortion. (At 400 Hz, for example, it's an unheard of 0.02%—and that includes distortion caused by the measuring instrument itself.) Also, Negative Feedback eliminates the need for distortion-causing Side Carrier Filters.

For superior separation of the left and right channels, Yamaha designed a unique *Phase Lock Loop MPX Decoder.* Instead of being a single IC chip as in other tuners, our Phase Lock Loop consists of discrete components mounted on their own circuit board, thus allowing precise control in production and hand-tuning adjustment to meet exact specifications.

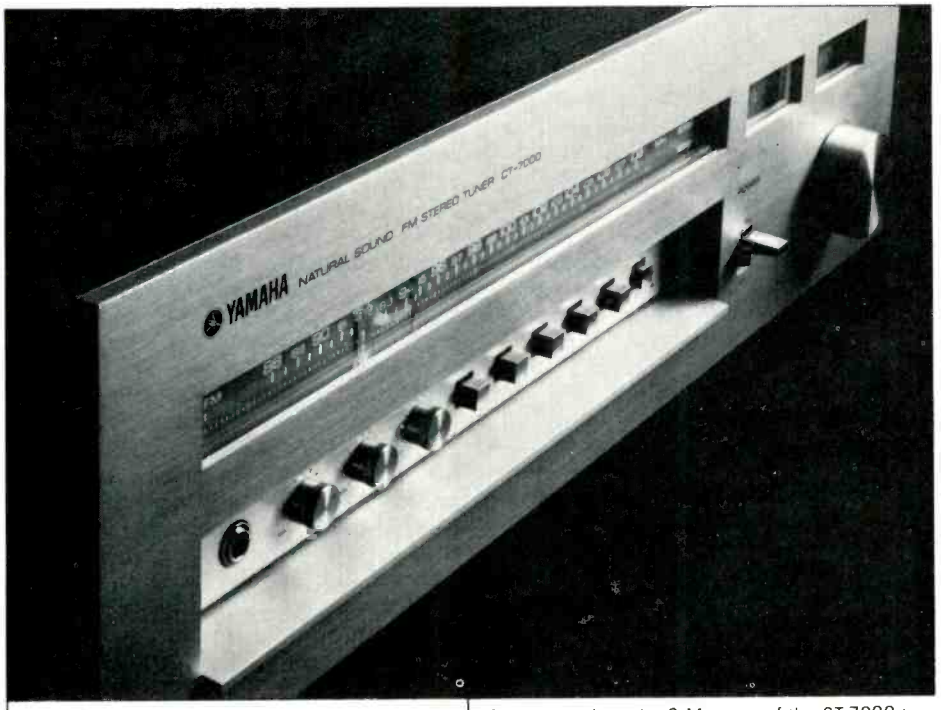
A 7-Gang Tuning Capacitor? Most tuners get by with 4 or 5 stages. We refused to. By designing the Front End with our unique 7-Gang Tuning Capacitor and utilizing Dual Gate MOS FETs, the CT-7000 can receive the weakest stations and, at the same time, accept an extremely high input (up to 1 volt input signal) without overloading.

Advanced IF Amp Stages. Inside the IF amp stage is the world's finest combination of ceramic and L/C filters. This has resulted in an advanced degree of selectivity (the ability to pick out a desired signal while rejecting neighboring frequencies). And maintains proper phase linearity and minimum distortion (less than 0.08%).

A selectable IF Mode lets you choose the width of the tuner's selectivity...narrow setting for crowded band areas; wide setting for uncrowded areas. The tuner's reception can be optimized for virtually every listening situation.

Some other important differences. *An Auto Blend Logic Circuit* automatically operates in three stages to blend high and middle-high frequencies for maximum stereo separation with minimum noise and distortion on even the weakest stations. And you don't need to get up and switch in the MPX filter when a station turns noisy. The CT-7000 does it for you—silently, automatically.

There's Auto-Touch Tuning that automatically disengages AFC while you tune, for maximum station selection. When you release the tuning knob, AFC reengages and locks onto the station, electronically fine-tuning it to the one point of maximum stereo separation and minimum distortion.



A unique Variable Muting Control makes it possible to receive music where there used to be just noise. This control lets you select the muting cut-off level to an unbelievably low 10 dB (3 mμ), yet it can be adjusted to accommodate stations up to 30 dB (30 mμ) in level.

Variable Output Level permits adjustment of the tuner's output to match the other input levels. So, when switching from tape, to records, to the CT-7000, you don't have to readjust your volume control.

The end of Multipath Distortion. Reflection of FM signals off their surroundings causes multipath distortion. And that causes muddled, distorted sound. Until now, you could rely on inaccurate signal strength meters to orient the antenna—or you could invest about 800 dollars in an external oscilloscope.

The CT-7000 neatly solved that problem with a unique signal minus multipath circuit which when activated by the S-M front panel relay, allows the signal strength meter to accurately display the multipath content of the incoming signal. Without guesswork, you now can zero-in the antenna incoming signal to reduce to a minimum multipath interference and distortion. In fact, tests show the S-M meter of the CT-7000 to be three times more accurate for this purpose than an oscilloscope.

Some things we didn't have to do. We could have settled for just having the best performing tuner in the world. But we also wanted it to be the most reliable and durable.

That's why all the push buttons are silky-smooth, precision reed relays instead of switches. Why the flywheel is solid brass. And why, beneath the walnut wood case, each circuit board is protected by a stainless steel cover to guard against stray noises and interference.

Or as Stereo Review summed it up in its January 1975 issue: "Judged by its overall measured performance, the Yamaha CT-7000 is clearly one of the finest FM Tuners ever made. In no respect was it less than superb, and in a few areas—notably distortion, image rejection. AM rejection, and pilot-carrier suppression—it was either far better than anything we had previously measured or simply beyond the measurement abilities of the best laboratory instruments."

Your Yamaha Audio Dealer will be pleased to demonstrate the incomparable CT-7000. Plus other state of the art Yamaha components that make up the system—designed to make you unhappy with what you're listening to now. Because, like life, the best is always yet to come.

YAMAHA

INTERNATIONAL CORPORATION, P.O. BOX 6600, BUENA PARK, CA 90620

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Behind The Scenes

Bert Whyte

TIME WAS when the Consumer Electronic Show was an annual event, an industry extravaganza fiendishly timed to coincide with the onset of Chicago's "sultry season" in early June. Then the powers-that-be decided to hold a Winter CES, in January when Chicago is cold enough to freeze the you-know-what off a brass monkey. Thus, these days we must be sure to get our CES bashes in the proper solstice. This, then, is a report on the *Summer* CES, held as usual in the cavernous reaches of McCormick Place in Chicago.

The Consumer Electronic Show is generally regarded as an industry "barometer," a reflection of equipment trends and marketing emphasis that can be expected during the following year. In this recession year, people approached this show with an admixture of trepidation, confusion, uncertainty, a little sweetening of hope, and a tincture of optimism. If there was a prevailing attitude, it would have to be "proceed with caution."

This was to have been the CES that revitalized the industry's approach to quadraphonic sound. You may recall that a few months ago I reported that the hi-fi industry "rediscovered" quadraphonic sound, and some of the bigger companies were going to mount massive programs promoting four channel sound, in the hope that this would lead them out of the sales doldrums. These promotions did indeed take place and, in fact, are an ongoing thing. However, the lead time, from the inception of the campaigns to the opening of the CES on June 1, was simply too short for most companies to introduce new generations of quadraphonic equipment. Oh, to be sure ... there were some new models, but nothing like the flood that had been anticipated. The CES management put a brave foot forward by presenting a special exhibit named "Quadarama." This was a well-designed and neatly executed display of the quadraphonic equipment of many different companies, with no emphasis given to any of the competing four-channel formats. In fact, the CD-4, QS, SQ, and UD-4 camps have most commendably decided to stop their internecine warfare as to which of them produces the "best" four-channel sound, in favor of promoting the over-all concept of quadraphony. This all helps, of course, but as I talked to various manufacturers around the Show, I heard quite a bit of the "quad is dead" sentiment expressed. Fortunately, after digging a bit, you find that this pessimism has a bit of "sour grapes" flavor. In general, while quadraphonic equipment didn't make the "big splash" at this CES, there is evidently plenty of interest, judging from the amount of new equipment purportedly "in the pipeline," and presumably due for introduction at the Winter CES.

The recession notwithstanding, there was plenty of interesting new audio equipment at the CES, and the proliferation of costly "high end" equipment was amazing. For example, there was a Stax amplifier, all Class A, 300 watts per channel, at a mere $3,000. The Lux company of Japan, which had a flirtation with the American market through British Industries Corp. some years ago, is back as Lux Audio of America and was showing a complete line of receivers, pre-amps, power amps, and a turntable. Highlight of their line was the Luxman M-6000, a solid-state 300-watt-per-channel, 114-lb. brute amplifier tagged at $2,995! Sansui got into the high-power amplifier act with a big 250-watt-per-channel unit. Kenwood is reaching for the audiophile stratosphere. They showed their impressive 700 series units, comprising separate tuner, preamp, and 170-watt-per-channel power amplifier, all three for $2,250. Kenwood also showed one of the most advanced quadraphonic receivers at the show, their KR-9940 with full CD-4, SQ with wave-matching and variable blend, and RM (QS) matrix facilities.

Still on the subject of amplifiers, the new "glamour queens" of the amplifier world were being demonstrated. Infinity Systems is finally producing ("just a trickle yet," say they) their DSP Class-D switching amplifier. I described this unit some time ago on the occasion of my visit to Infinity. Rated at 250 watts per channel, it is not much bigger than some preamps and produces virtually no heat in operation. Yours for $1,200. Yamaha was showing their B-1 power amplifier featuring vertical FETs, with an output of 150 watts per channel ($1,600). The companion unit is the new Yamaha C-1 all FET preamp. This will delight the more technically inclined "dial-twiddlers" with its host of controls, including such unusual items as built-in signal generator with 4 selectable sine-wave frequencies and a pink noise generator. Projected price is $1,800. Sony Corp. of America was displaying their 100-watt-per-channel, vertical-FET power amp, an 80-watt-per-channel vertical-FET integrated amplifier, and a multi-control FET preamplifier. Digressing for a moment from amplifiers, Sony was also demonstrating a doozy of a TV console called the "Betamax," a 19-in. Trinitron TV set combined with a half-inch video recorder. There are two tuners so you can tape one program while viewing another, and there is also a built-in timer that will record programs when you are absent. The picture quality on direct viewing and from the tape is among the most brilliant and sharpest I have ever seen.

At Phase Linear's suite, they were showing the unit I intimated would be forthcoming from them in my evaluation of their Model 4000 preamplifier some months ago, to wit: an add-on box containing the noise-reduction correlator and peak unlimit/downward expand systems. This can be added to any preamplifier (or receiver) with tape monitor facilities. Projected price is $349.95.

I should have mentioned that many of the familiar hi-fi manufacturers were not actively demonstrating their equipment at McCormick Place, but were using suites in various hotels around Chicago. Plenty of firms were at McCormick Place, but except for a few special rooms, isolated away from the main area, the acoustics were impossible, to say nothing of the noise levels. There was an interesting juxtaposition in two of these McCormick Place rooms ... one was occupied by

Is it live or is it Memorex? Who knows?

In our most recent test, we asked Ella Fitzgerald's old friend and longtime jazz arranger, Nelson Riddle, if he was listening to Ella live, or Ella as recorded on a Memorex cassette.

He couldn't tell.

We believe that's a strong endorsement of our exclusive MRX_2 Oxide formulation.

In fact, since we introduced MRX_2 Oxide, a lot of other ferric tapes have been scrambling to find something to beat it.

Nobody has.

MEMOREX Recording Tape.
Is it live, or is it Memorex?

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Cerwin-Vega, with the redoubtable Gene (Earthquake) Czerwinski showing off his latest high-efficiency column-type speakers and caving in a few chests with the 16-Hz roar from the corner "plugs" used in the movie; the other room had Bill Johnson and his Magneplanar speakers reproducing some lovely classical music with exceptional smoothness and detail. Inevitably, in the middle of a quiet passage, the "earthquake" would leak through the walls . . . .

Crown International was really gilding the lily in their hotel suite; they had four of their electrostatic hybrid ES212 speakers in a semi-circle. Each speaker was bi-amped through their new VFX electronic crossover, the electrostatic top being driven by their DC-300A amplifier and the dynamic bass section by the new D-150A amplifier. Their IC-150 pre-amps fed the crossovers. Source was the big Crown four-channel tape machine, with master tape copies going through four channels of dbx noise reduction. Gadzooks!

Genial Bob Fulton of Fulton Musical Industries was demonstrating his beautiful Model J modular speaker system. This is now the production model, the final revisions having gained almost 10 dB in efficiency as compared to the prototype. The speaker is characterized by its smoothness, high definition, and exceptional balance. People kept listening to 3 and 4 in the morning, as Bob wisely played his own superb recordings to show off the virtues of his speaker.

Joe Alinsky of RTR Industries demonstrated something quite new and interesting in the form of a column speaker, in which the tweeter portion consists of a specially fabricated array of electrostatic units which gives a full 360° omnidirectional pattern. The units are driven by their own internal amplifier which has been specially tailored to the load characteristics of electrostatics. Bass frequencies are covered with a conventional dynamic woofer. The smoothness of the omnidirectional electrostatics is outstanding . . . a seamless, ultraclean sound. This is a development that bears watching.

The new Infinity Servostatik 1A is now in production and was being demonstrated with the new DSP switching amplifier. Unfortunately, I didn't get to hear it, but reliable surrogate ears say the combination is a knockout. I'm told by Infinity President Arnie Nudell that one of these days this system will show up on my doorstep. I can hardly wait to play some new tape masters on this rig!

The Ampzilla amplifier of Great American Sound Co. now has a companion pre-amp, the "Phaedra." (Where does GAS President Jim Bongiorno get those names?) The styling is rather clinical in black and white, but looks extremely functional. Projected price: $750.

I don't think it had anything to do with the Bi-centennial, but the British invaded the CES this year. The Federation of British Audio is a group of British hi-fi manufacturers most of whom have never sold their products in this country. Some 11 of them were displaying their wares at a special British section on the main floor of McCormick Place. If, like me, you read the estimable British publications, *The Grammophone* and *Hi-Fi News*, many of the companies exhibiting will be familiar to you. The products of Acoustical Manufacturing (Quad electrostatic speakers and amplifiers) and Decca (phono cartridges and arms) are well known in this country, but such high quality manufacturers as Richard Allen (speakers), Linn Products (turntables), A. R. Sugden (turntables and amplifiers), Cambridge Audio (amplifiers), Keith Monks Audio Ltd. (phono arms, record cleaning machines), Gale Electronics (speakers and turntables), Lamb Laboratories (mixers, amplifiers), and KEF Electronics Ltd. (loudspeakers) will soon have their products in specialty audio shops across the country. Raymond Cooke, the head of KEF, is an old friend of mine and used to attend my Everest recording sessions in London. Raymond was a former associate of the grand, old Gilbert Briggs of Wharfedale, and since forming his own speaker company, the KEF speakers have enjoyed a worldwide reputation for excellence. I have a pair of his new 104 reference models, and their wide range and truly uncolored response are most impressive. All of the components and finish are of the highest quality. KEF does a lot of very sophisticated research in their speaker labs, including such exotic techniques as laser holography. A most hearty welcome to our British cousins, and I will look forward to testing many of their products!

Needless to say, there were many other interesting new audio products at the CES . . . enough to fill several columns, but space is getting almost as scarce as Malossal caviar! As usual, apologies to those whose products I didn't get to see; maybe I can catch them in the audio shops.

The difference between the Dokorder 7100 and Teac's 2300S is about two miles of tape.

The DOKORDER 7100 costs almost $100 less than the TEAC 2300S. That's about ten reels of the finest tape you can buy, which will give you 12 hours of recording time, which is equivalent to some 24 albums.

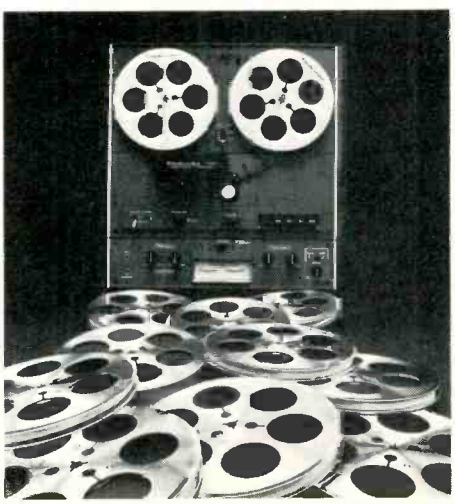
That's an important advantage because, like anything else you drive these days, a tape recorder takes a lot of expensive fuel to get you where you're going and it's no fun to start out empty.

Just as important, you won't have to give up anything important to get that tape. When you compare functions, features, specs and performance you'll see our tape recorder is as good as theirs.

But when you compare price you'll find us miles apart.

After you look at Teac listen to

DOKORDER



	TEAC 2300S	DOKORDER 7100
Motors	3	3
Heads	3	3
Frequency Response at 7½ ips	±3 dB, 40-24,000 Hz	±3 dB, 30-23,000 Hz
S/N	58 dB	58 dB
Wow and Flutter at 7½ ips	0.08%	0.08%
Manufacturer's suggested retail price	**$499.50**	**$399.95**

Features and specifications as published by respective manufacturers in currently available literature.

5430 Rosecrans Avenue, Lawndale, California 90260

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Bi-Amplification - Power vs. Program Material vs. Crossover Frequency

John M. Lovda and Stephen Muchow*

OVER THE PAST several years, the demand for clean, high level sound reproduction has brought the concept of biamplification into prominence among both audiophiles and professional sound men. In situations where the system amplifier is being pushed to its limits and the use of larger amplifiers could result in loudspeaker failure, biamplification provides a means of achieving low distortion sound *and* high acoustic sound pressure levels. If the desired acoustic output level can be achieved without overloading the amplifier, as is the case with most home high fidelity systems, biamplification is unnecessary. However, even these systems can benefit from biamping in terms of higher sound pressure levels with lower distortion.

This article will focus on situations where biamplification is useful by describing some of the theoretical and practical advantages of this approach to achieving high sound pressure levels. Several objective and subjective experiments will be described which were performed in an attempt to determine optimum amplifier power ratios and crossover frequencies. The results of this work provide insight as to why biamplification can improve performance. Finally, a typical sound reinforcement system will be described for use in high sound pressure level applications.

Single Amplifier System

A conventional arrangement consisting of a single amplifier feeding a multi-driver loudspeaker system is shown in Fig. 1. The output of the amplifier is fed into a passive large signal crossover network which contains a low-pass filter, high-pass filter, and (usually) a high frequency attenuator. In many home high fidelity or studio monitoring systems, a mid-range loudspeaker and crossover section is also found.

The corner frequencies and rolloff slopes of these crossover filters are optimized to match the acoustic characteristics of the loudspeakers and to protect the speakers from signal frequencies which may be potentially damaging. The most common area for concern regarding loudspeaker danger is the resonance frequency point of high frequency drivers. Depending on the internal damping of the diaphragm, signals in the resonance region can cause excursions of excessive magnitude, resulting in physical destruction. To minimize this problem at high operating levels, high- and mid-frequency crossover networks should be designed with skirts that are sufficiently steep to keep the acoustic output of the driver in the resonance region at least 20 dB below the normal passband level.

***Sr. Development Engineers,**
Shure Bros, Inc.
Evanston, Ill.

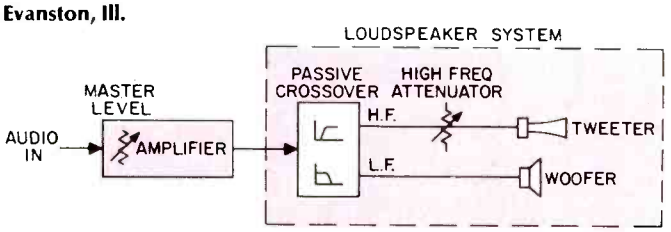

Fig. 1—Single amplifier system.

The output of the high-pass filter normally connects to a resistive attenuator, providing level adjustment for the tweeter to attain a desired acoustical balance. This attenuator is usually a T or L pad constructed either with a stepped or a continuously-variable resistive network. Because high-frequency drivers are typically more efficient than low-frequency speakers, some attenuation is usually necessary.

The basic advantage of the single-amplifier arrangement is simplicity—one amplifier and speaker system are the only components required. There are several major disadvantages, however, if the system is to be operated at high acoustic output levels.

First, the crossover components, including the high-frequency attenuator, must be specially selected for high-power use. Capacitors are usually metalized mylar, non-polarized types. For sound reinforcement applications where high peak-output power is the rule, the capacitors must also have high breakdown-voltage ratings (100 volts or higher) and low dissipation factors (typically less than 1% at 1 kHz). Capacitance values as high as 50 μF may be necessary if the system is designed with four-ohm speakers and a low crossover frequency.

Inductors can be either air or iron core but must not saturate. The wire gauge in the coil must be sufficiently large to keep the Q high and reduce power loss to a minimum.

The power resistors or rheostats used for the high frequency attenuator are usually wire-wound devices of high-wattage rating. This is necessary because the sensitivity of the tweeter must be reduced to match that of the low-frequency speaker by dissipating the power difference in the resistors. Tapped auto-transformers can be used as high-frequency attenuators and in this application provide very low loss. However, they must also be large enough to avoid saturation and are more expensive than resistors.

A second disadvantage is related to the generation of distortion components during amplifier clipping. Consider first a high-amplitude, low-frequency signal. Should the level become large enough to clip the amplifier, high-frequency distortion components will be generated whose frequency distribution is dependent upon the degree of clipping. Conversely, if high-level, high-frequency information is presented in a pulsed fashion causing the amplifier to clip, low-frequency distortion components will be generated at multiples of the pulse rate. (This was discussed by C.R. Anderson and P.W. Jenrick in "A Practical High-Frequency Trackability Test for Phono Pickups," *Audio*, August, 1972, pp. 34-36.)

The Monster

The new BA 5000 Power Amplifier from Sansui

The most dramatic component in Sansui's new "DEFINITION" Series. the BA 5000 solid-state power amplifier is capable of 300 watts min rms per channel into 8 ohms, both channels driven, from 20 to 20,000 Hz, with no more than 0.1% harmonic distortion in the stereo mode. What's more, the BA 5000 can be strapped for mono operation to deliver 600 watts rms under the same conditions.

A true monster amplifier.

But that's not all. Unlike other solid-state amplifiers, the BA 5000 has a huge, laboratory-quality output transformer, enabling it to deliver rated power into 2, 4 or 8 ohms plus 25 volt line output in stereo and 4, 8 or 16 ohms plus 70 volt line output in mono. A rating of 600 watts into a 16 ohm mono load with no more than 0.1% harmonic distortion, 20 to 20,000 Hz. is simply unprecedented in transistor equipment.

The "DEFINITION" series also includes the BA 3000, our Junior Monster, and the CA 3000 a very high quality, low distortion preamplifier.

For professionals, sophisticated audiophiles and monster lovers everywhere. See it and touch it if you wish at your nearest Sansui franchised dealer or write for complete literature.

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Biamplified System

A biamplified system consists of a low-level passive or active crossover network and two power amplifiers (see Fig. 2). The incoming low-level signal is first split into low- and high-frequency bands and then routed to separate power amplifiers. These amplifiers are directly connected to their appropriate low- and high-frequency speakers. Although it is not a necessity, a properly designed speaker system for biamplified use should have some means of high-frequency-driver protection. This circuitry will help prevent failure due to reverse hookup of low- and high-frequency speakers, amplifier turn-on transients, and amplifier failures. Although the cost of the biamplified system is greater due to the addition of a second power amplifier, several advantages result.

First, a large degree of circuit design flexibility is allowed because the crossover network operates at low signal levels and is terminated by the high input impedances of the power amplifiers. With a passive biamp crossover design, components with reduced size and power-handling capabilities can be employed. High-value, low-loss, expensive capacitors are unnecessary because of the increased termination impedance. If an electronic crossover is used employing active filters, inductors can be eliminated completely. Active-filter design also permits the use of filters with extremely steep roll-off rates when necessary, at reasonable cost and circuit complexity. One commercial design employs a novel circuit in which the high-pass signal is directly obtained by filtering, and the low-pass signal is derived by taking the difference of the input and the high-pass signals. Regardless of component tolerances, the high- and low-frequency outputs of this circuit complement each other exactly in the crossover region. Crossover frequency selection can also be accomplished with a minimum amount of component switching.

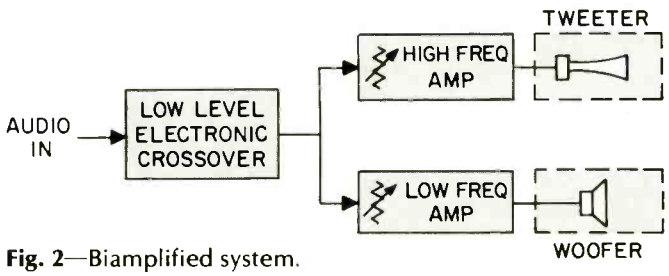
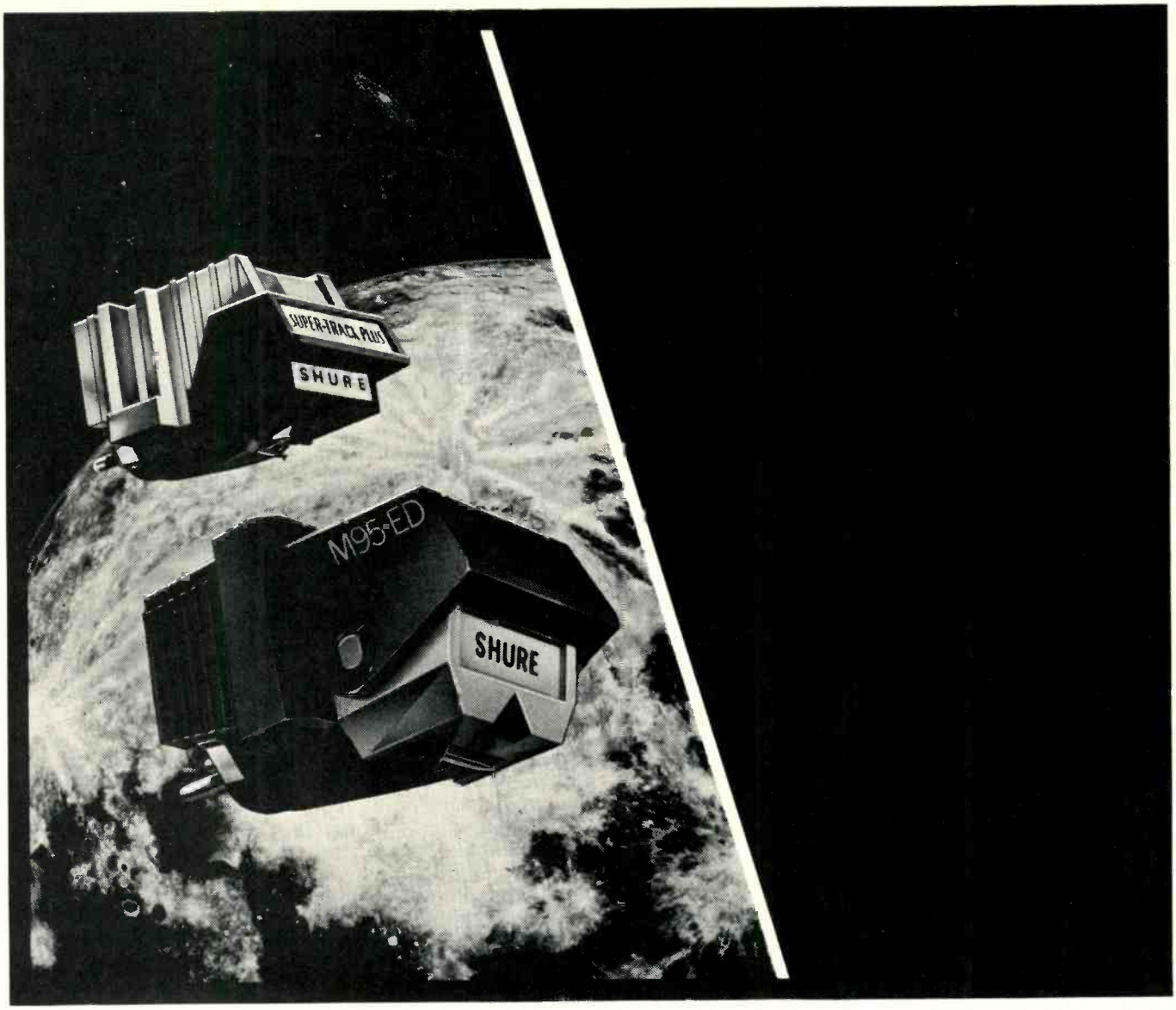


Fig. 2—Biamplified system.

The second advantage is the ability to assign different power output capabilities to the two frequency bands. By matching the peak-voltage capability of the amplifier with the recommended maximum voltage rating of the driver, transient program peaks and noise spikes will be clipped and limited to a safe value. This protection is provided regardless of gain settings of the previous stages or the voltage levels present at the low frequency speaker. The use of "super" amplifiers or bridged pairs of amplifiers connected to a single amplifier system cannot provide this safety factor without external speaker protection circuits. In many applications, small high-frequency amplifiers can be used without compromising system performance. As will be shown later, this requirement relates directly to loudspeaker efficiency and crossover frequency selection.

The ability to drive an unlimited number of power amplifiers using one crossover network is another advantage of a biamplified system. This arrangement is possible when using power amplifiers with high input impedances. This added bonus becomes very economical in large sound-reinforcement applications.



II'nd only to the III.

The new Shure M95ED phono cartridge combines an ultra-flat 20-20,000 Hz frequency response and extraordinary trackability with an utterly affordable price tag! To achieve this remarkable feat, the same hi-fi engineering team that perfected the incomparable Shure V-15 Type III cartridge spent five years developing a revolutionary all-new interior pole piece structure for reducing magnetic losses. The trackability of the M95ED is second only to the Shure V-15 Type III. In fact, it is the new "Number 2" cartridge in *all* respects and surpasses much higher priced units that were considered "state of the art" only a few years ago. Where a temporary austerity budget is a pressing and practical consideration, the M95ED can deliver more performance per dollar than anything you've heard to date.

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SHURE®

Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

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In terms of acoustical benefits, perhaps the most widely discussed advantage of biamplification is the ability to attain higher sound pressure levels without clipping than with a single amplifier of comparable size. Consider a composite signal with 250-Hz and 10-kHz components and assume the low-frequency component is twice as large as the high-frequency component. If this signal is fed to an amplifier with a 40-volt peak-output capability, the low- and high-frequency components could only reach peak levels of 26.7 and 13.3 volts respectively before clipping. Biamplifying the system, two amplifiers capable of 26.7-volt peak and 13.3-volts peak, respectively, would provide the same undistorted output level with this test signal. Converting these peak voltages to rms values and assuming an 8-ohm speaker system, this suggests that a power amplifier capable of producing 55.6 watts (44.5 + 11.1) provides the same performance as one with a rating of 100 watts. When the low-frequency amplifier clips, the harmonically-related distortion products are isolated to the low-frequency speaker only. These products will be naturally attenuated somewhat by the response roll off of the woofers at high frequencies due to the voice coil inductance.

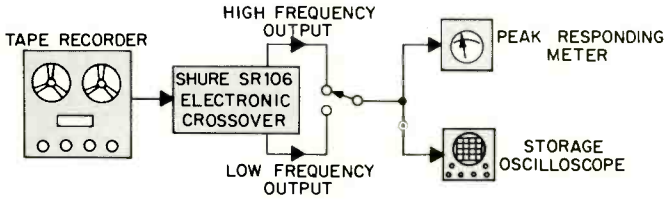

Fig. 3—Setup for biamplified peak-level test.

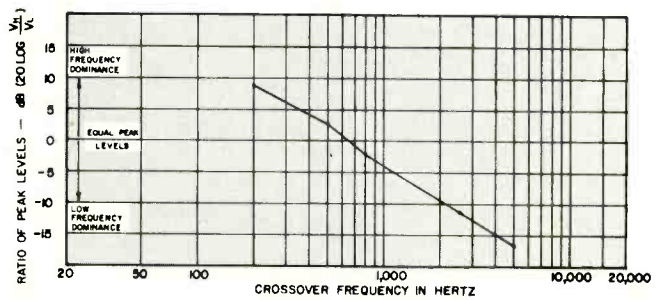

Fig. 4—Ratio of high (VH) and low (VL) frequency peak levels vs. crossover frequency for program material with heavy high-frequency content.

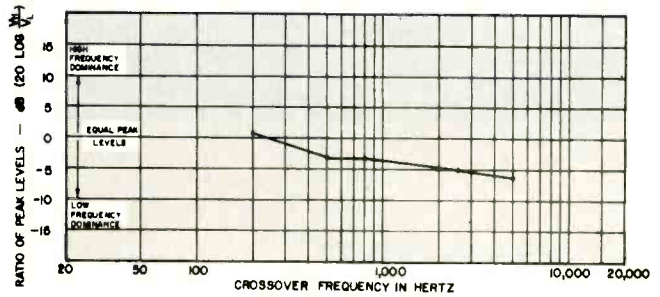

Fig. 5—Ratio of high (VH) and low (VL) frequency peak levels vs. crossover frequency for program material with even frequency content.

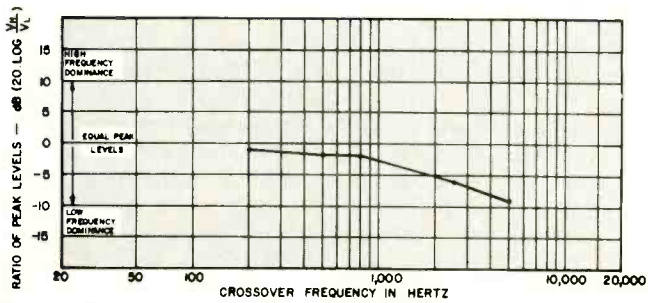

Fig. 6—Ratio of high (VH) and low (VL) frequency peak levels vs. crossover frequency for program material with heavy low-frequency content.

Impressive as the previous power comparison might appear, realistic wide-range musical signals present a more complex problem to the sound system designer. Although no exact formula exists for specifying biamplified system parameters, it seems apparent that crossover frequency, power amplifier size, and musical spectral characteristics must be interrelated. The following experiments were designed to examine the relationships among these variables and to determine basic guidelines for use in designing and optimizing practical biamplified systems.

Biamplified Peak Levels

An experiment was performed in which three spectrally different types of program material were analyzed electrically. The program material for the experiment was separated according to three classifications: heavy low-frequency content, heavy high-frequency content, and that which had an even-frequency distribution. Selections from records were used for the low- and even-frequency distributions, while a tape recording of a female vocalist in a live performance was used for the sample with the heavy high-frequency content. Because this program material would be used later in a listening test, all three program sources were subjectively matched for overall level, and carefully recorded on a tape for convenience and repeatability. Before analysis, the output of the tape was first separated by an electronic crossover with switchable crossover frequencies of 200, 500, 800, 2600, and 5000 Hz. The signal output was then measured with a peak-responding meter and storage-type oscilloscope, so that it was possible to visually observe as well as measure the peak output-voltage characteristics. Peak-voltage measurements were made at both the low- and high-frequency outputs as shown in Fig. 3. Using this equipment, the peak voltage within a chosen spectrum could be measured and tabulated. Graphical representations of the measured results are shown in Figs. 4, 5, and 6.

The curves plotted represent the numerical difference between the low- and high-frequency peak levels expressed in dB, with 0 dB on the graph corresponding to equal low- and high-frequency peaks. The dB values on the vertical axes represent the voltage or power ratios that would be required for uniform clipping of both the high- and low-frequency bands at various crossover frequencies. These ratios all assume identical sensitivities and impedances of both speakers. As expected, the slope of the curve in all cases indicates that low-frequency peak energy is greater than high-frequency peak energy when the crossover frequency is shifted upward. The converse is also true, with the point of equal distribution located at approximately 300 Hz for the low- and even-frequency distribution material and approximately 700 Hz for the material with high-frequency predominance. These results seem to indicate that to efficiently biamplify wide-range program material using identical power amplifiers, a 300-Hz crossover frequency should be used. It can also be seen from these graphs that as the crossover frequency is shifted upwards, for example to 2600

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The 20 BPX is an automated single-play belt-drive turntable. It has the "S" shaped tone arm and features of the deluxe automatic model with a precision machined platter and ADC K6E cartridge. It comes complete with base and dustcover. Model 20 BP is identical but without cartridge.

Model 100 BAX (not shown) automatic belt-drive turntable has a low mass aluminum tone arm with square cross section and a precision machined platter. It is packaged with base, hinged tinted dustcover, and ADC K6E cartridge.

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BSR 200 BAX—Deluxe automatic belt-drive turntable

BSR 20 BPX—Automated single-play belt-drive turntable

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Hz, the high-frequency peaks are as much as 6 dB lower. This indicates that the high-frequency power amplifier used could be smaller, requiring approximately one half the clipping-voltage capability of the low-frequency amplifier. Conversely, the low-frequency amplifier requires a clipping level 6 dB higher than the high-frequency amplifier to faithfully reproduce wide range material. From these results, a theoretical minimum high- to low-frequency ratio may be determined at various crossover frequencies for a given type of program material.

The results of these measurements could be interpreted as a guide for determining amplifier power ratios as a function of crossover frequency. Our experience, however, has shown that substantial amounts of low-frequency as compared to high-frequency clipping are normally tolerable without any apparent deterioration of sound quality. This tolerance to clipping prompted two psychoacoustical experiments to gain additional insight into actual power amplifier requirements for biamp operation.

The first of these experiments was designed to provide information regarding power ratios vs. crossover frequency. A switchable biamp system was devised whereby the listener could compare an undistorted signal with a signal distorted in either the high- or low-frequency section only. Figure 7A shows the setup used for low-frequency clipping, while Fig. 7B shows the setup used for high-frequency clipping.

Amplifiers A and B were both operated well below their output-clipping points. These amplifiers made up the undistorted system. These amplifiers made up the undistorted

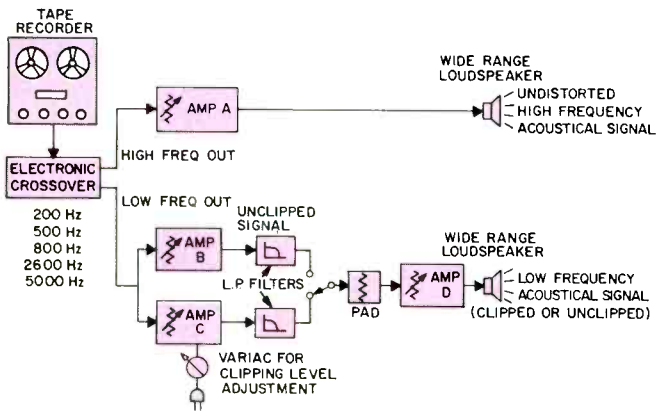

Fig. 7a—Experimental setup for low-frequency clipping psychoacoustic test.

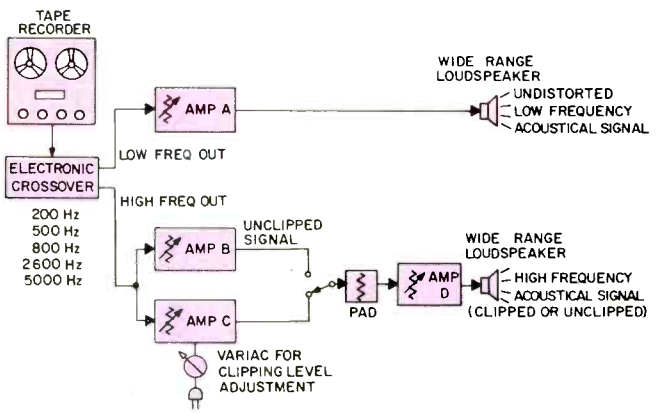

Fig. 7b—Experimental setup for high-frequency clipping psychoacoustic test.

system. The clipping point of amplifier C was made continuously variable from 8 to 40V rms by means of a variable autotransformer on its a.c. power line. Prior to this test the distortion characteristics of this amplifier were verified to be uniformly low over the range of adjustment. Amplifier D was introduced so that the listening level could be easily adjusted while maintaining a predetermined clipping level. The two low-pass filters shown at the outputs of amplifiers B and C in Fig. 7A were provided to simulate the normal high-frequency rolloff typical of low-frequency loudspeaker sections. This filter had a 6-dB-per-octave rolloff slope with the corner frequency located above the crossover point.

During each experiment, the test subjects were asked to lower the clipping point in amplifier C, while comparing it to the unclipped amplifier B until a difference or increase in audible distortion was noted. By combining the results of each experiment, a high-to-low-frequency power ratio was determined for each test subject. Several interesting phenomena were noted from the data obtained. First, the variance of listener tolerance to distortion was quite wide. Some people would accept substantial clipping on peaks and make judgments on average levels only, while others appeared to be sensitive to the slightest differences. This variance was more severe on the live recording which exhibited the highest peak-to-average ratio. Second, with the selection of either a 200-Hz or 500-Hz crossover frequency, low-frequency distortion was essentially inaudible, even with the signals substantially clipped. The bass content of the program would subtly diminish as the clipping became increasingly severe, and only at extremely low clipping voltages would intolerable distortion occur. These observations make sense when one considers that the low-frequency loudspeaker system tends to roll off higher-frequency distortion components. In addition, those high-frequency distortion components that are reproduced are masked by the output of the high-frequency loudspeaker section. This effect diminished as the crossover frequency was raised, but was noticeable for all but the 5-kHz crossover setting.

Considering the degree of clipping observed on an oscilloscope during these tests, it is apparent that biamplification provides a psychoacoustical means of reducing perceived distortion. The power ratios observed followed the same general trend as was previously measured electrically, but the large variation between listeners suggested that an average curve would be of little value. The data presented in Figs. 4 through 6 consequently represent reasonable guidelines for determining amplifier power ratios.

The second experiment was designed to measure listener tolerance to clipping distortion. For this test, the subjects were repeatedly presented the same musical cut and asked to rate the fidelity according to a list of five performance criteria ranging from very clean (unclipped) to very distorted (clipped). Each time the selection was repeated, the low-frequency clipping point was changed in a random fashion while the high-frequency channel remained clean. Five output-voltage clipping levels, spaced 6 dB apart, were selected. During the course of the experiment, each level was used twice to establish if listeners had any measure of repeatability. An unclipped selection was played first as a listener reference and was reinserted later in the random sequence.

As in the last experiment, listeners' opinions varied widely as to the quality of the selections. The ability of the individual to correctly match two selections with the same clipping level when separated by time was rather poor. There was a tendency to be conservative, rating the clean and slightly distorted passages as fair and only the most heavily clipped selections as poor.

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As *Popular Electronics** put it, the RS 4744 "met or surpassed all the published specifications we were able to test" and was "...well above average in the important performance aspects."

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Back or front, any way you look at it, the RS 4744 is one fine stereo receiver.

*Popular Electronics, December 1974 Issue.

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As part of the experiment, the unclipped high-frequency channel was shut off and the listeners were able to compare the apparent distortion level of the clipped amplifier alone. In almost all cases, the amount of distortion perceived increased dramatically when the clean high-frequency signal was removed. This provided further verification that the unclipped channel has a psychoacoustically beneficial masking effect on the distortion products generated by the clipped channel. This effect was greatest at lower crossover frequencies but continued to be substantial even at the highest crossover frequencies. Considering the fact that many sound-reinforcement amplifiers used for high-level applications are clipped a large percentage of the time, this masking effect is most likely the underlying reason for the subjectively lower distortion sound quality and increased levels available when a biamplified system is used.

Summary

When designing sound systems for high-level music reproduction, proper consideration of the effects of masking and high-frequency-driver power limits will produce the desired combination of low distortion and high reliability. The following steps should be considered in order to determine the correct amplifier sizes for a biamp system:

1. The crossover frequency, power handling capabilities, and sensitivites of the various loudspeaker sections should be noted.

2. Figures 4 through 6 should be reviewed with some feeling for the type of program material to be reproduced.

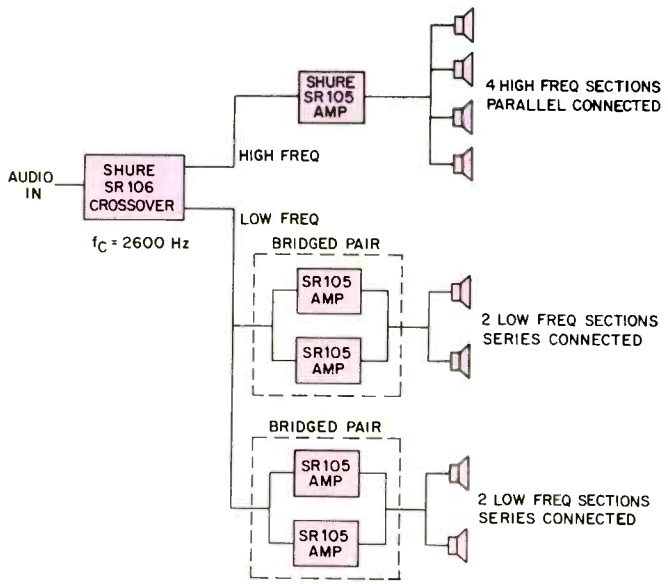

Fig. 8A—Typical biamplified sound reinforcement system for high SPL operation.

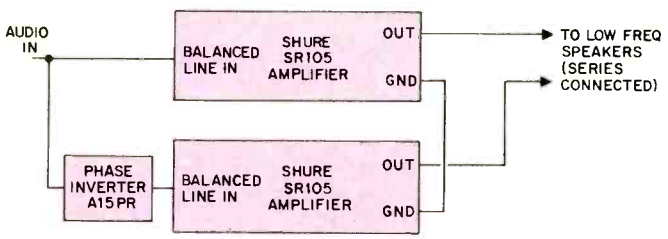

Fig. 8B—Bridged-pair wiring scheme.

Based upon this review, a power ratio should be determined.

3. The above ratio should be modified in accordance with any differences in the sensitivities of the loudspeaker sections being used.

4. The power amplifier sizes are then computed based on the specific sound passages required for the application.

5. If the above power requirements exceed the system capabilities, additional speakers, more efficient speakers, or a change in crossover frequency should be considered.

It should be pointed out that most wide range systems capable of biamplified operation have been optimized for the crossover frequencies stated and degradation of performance or physical damage might result if the crossover frequency is changed.

Figure 8 shows a typical large sound reinforcement system used for wide range program material at high sound pressure levels. The system consists of one electronic crossover with splitting frequencies set for 2600 Hz, five power amplifiers each capable of 28V rms output, and four 16-ohm, wide-range portable loudspeaker systems. One amplifier drives all four high-frequency sections at a maximum of 50 watts each. The high-frequency level can be easily adjusted using the amplifier gain control. The four low-frequency amplifiers are connected to form two bridged-pair (series-connected) amplifiers, with each pair capable of providing 200 watts (57 V rms) to each low-frequency system. A detailed wiring diagram of a bridged pair is shown in Figure 8B. The inputs to the amplifiers are parallel connected out of phase with each other and the outputs are series connected. This arrangement provides twice the voltage swing and four times the power output of a single amplifier. Both output terminals are floating above ground and must not be connected to the chassis. Note that each low-frequency speaker can receive more power than its matching high-frequency driver, while still providing isolation to the high-frequency drivers from 80 V spikes. The sound system could easily be expanded by connecting additional amplifiers and loudspeakers to the crossover outputs.

Conclusions

In conventional wide-range sound reinforcement systems, where single amplifiers are often driven into clipping, the use of biamplification techniques can be beneficial. Biamplification offers audibly lower distortion, decreased amplifier power requirements, and increased speaker protection. The reduction in apparent distortion in a properly designed biamp system is in part due to the high-frequency rolloff of the low-frequency speaker section and to the masking of low-frequency distortion products by clean high-frequency program material.

Peak program measurements indicate that the peak-voltage distribution in the high- and low-frequency bands of a biamplified system are nearly equal at crossover frequencies between 200 Hz and 500 Hz. As the crossover frequency is increased, the peak program content in the low-frequency band increases while the high-frequency peak program content decreases. At higher crossover frequencies, the power demands placed on both the high-frequency amplifier and speaker are reduced. This decreases the chance of high frequency speaker damage.

Biamplification also offers non-acoustical advantages such as flexibility of crossover network design, ease of system expansion, and simplified means for level adjustments of both the low- and the high-frequency sections. It is readily apparent that biamplification offers many advantages worthy of serious consideration in the area of high sound pressure level sound systems.

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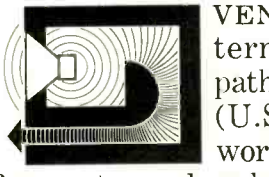
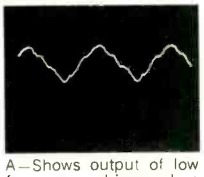
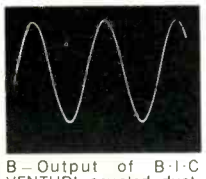




A—Shows output of low frequency driver when driven at a freq. of 22 Hz. Sound pressure reading. 90 dB. Note poor wave form.



B—Output of B·I·C VENTURI coupled duct (under the same conditions as Fig. A) Sound pressure reading 111.5 dB (140 times more output than Fig. A) Note non-distorted appearance.

Oscilloscope photos reveal that a B·I·C VENTURI speaker actually eliminates harmonic distortion from reproduced tones, literally purifying the sound and resulting in clean, tight and extended reproduction. That you can hear!

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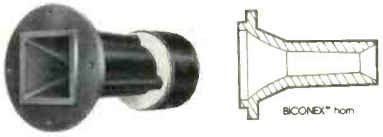


flare. It is made of an inert substance to avoid "ringing" and spurious resonances. But, equally important, it provides wide-angle dispersal of sound in both horizontal and vertical planes, making speaker positioning non-critical. There is a super tweeter that operates in only the last octave for accurate musical timbre.

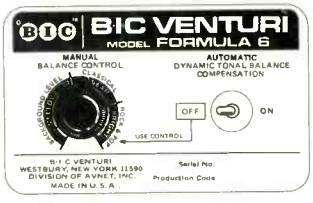
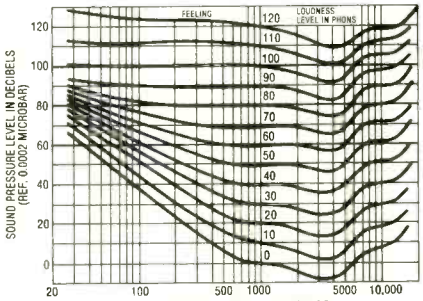


Fig. C

Even the control panel on the front of the baffle board is a surprise. It controls an exclusive built-in device (pat. pend.) which compensates for the normal loss in hearing of bass and treble tones, (figure C) at various listening levels. Regardless of amplifier loudness settings, you hear all the music, all the time. This is accomplished automatically with the switch in the "on" position, or, you can adjust tonal balance manually for the type of music you play or the kind of sound you prefer.



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How Valid is the FTC Preconditioning Rule?

Joseph V. DeMarinis*

SINCE November 1975, the Federal Trade Commission has required that audio amplifier power ratings be based on measurements made after one hour of operation at one third of the intended full-power rating, using a 1 kHz sine wave signal.

This generates a much more severe design requirement than had previously been considered necessary and has raised concern among the audio engineering fraternity regarding the technical validity of the ruling. To determine if there is a basis of realism behind the new requirement, this writer felt it appropriate to examine the peak-to-average power ratio of a wide variety of program material and conduct other experiments to see if (or how) it might be pos-

*Mgr., Audio Eng. GTE Sylvania, Batavia, New York

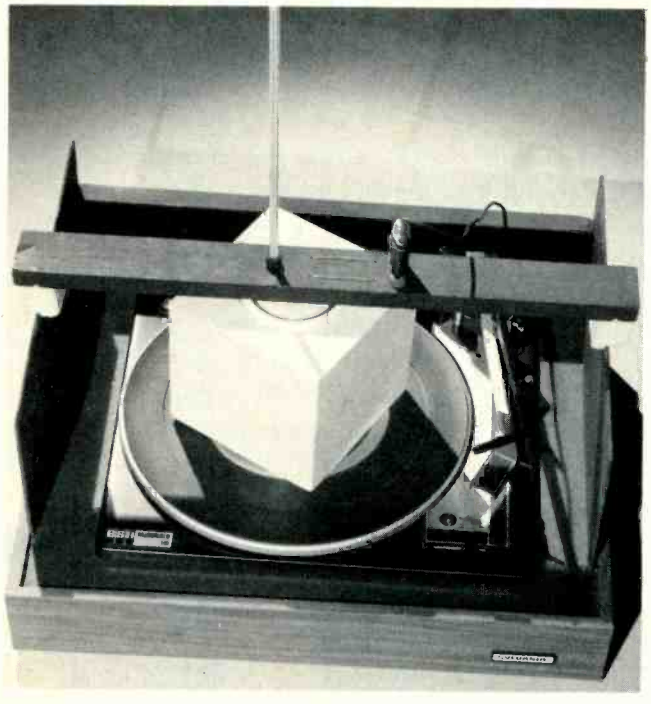

Fig. 1 — Overall view of calorimeter used to measure power dissipation.

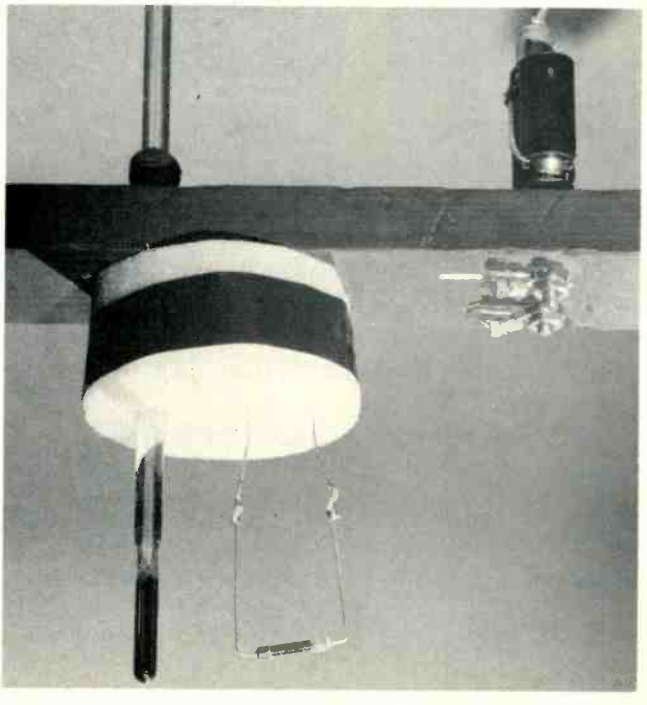

Fig. 2 — Internal view of calorimeter.

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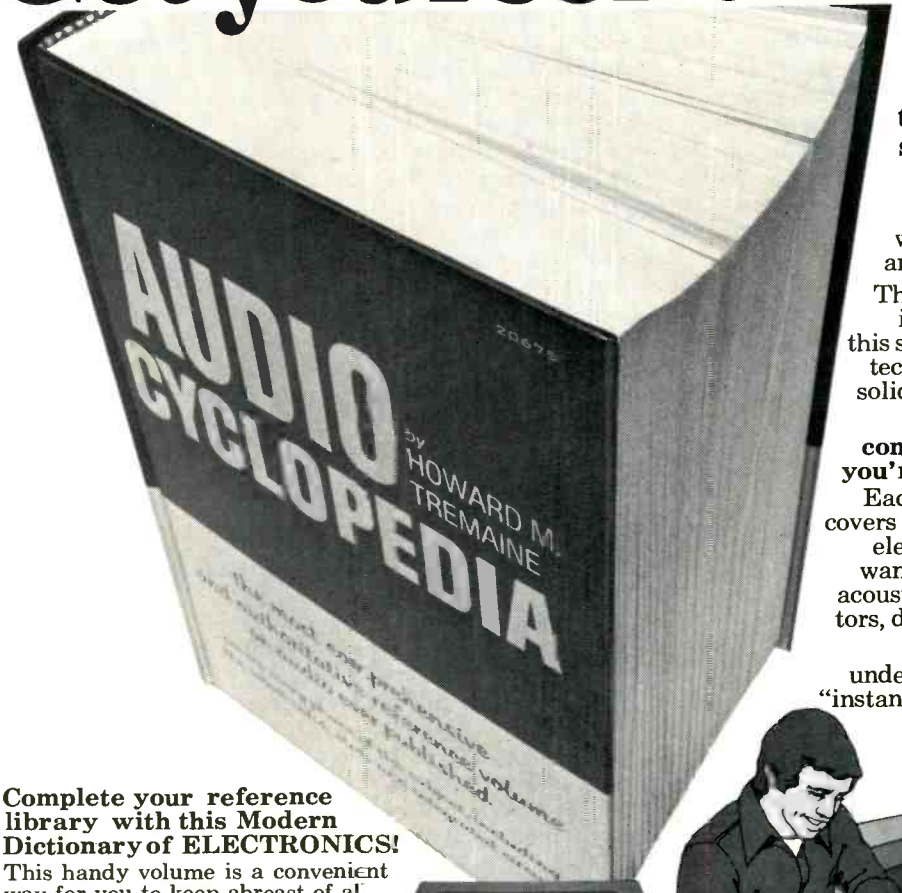

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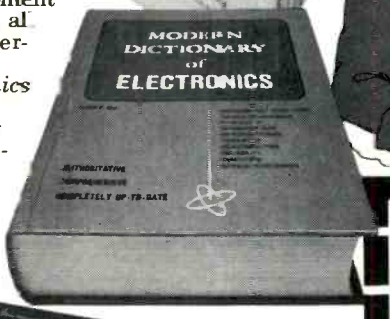

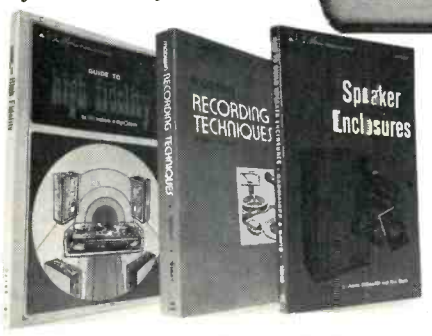

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sible to develop one third of an amplifier's maximum RMS output, for one hour.

A calorimeter was used to measure average power. It consisted of an 8-ohm resistive load and an expanded-scale thermometer immersed in 200 cc of distilled water. The container was made from styrofoam with a minimum wall thickness of one inch. The load was a five-watt wirewound resistor, with the ceramic outer case chipped off. This provided rapid heat transfer and minimum undesired thermal material. To minimize heat loss, fine steel wire was the only electrical and mechanical connection to the load. An inch-thick top cover, which held the thermometer and load resistor, remained fixed, while the water cup was rotated at 78 rpm, to assure uniform heat distribution in the water. Figures 1 and 2 show the calorimeter construction.

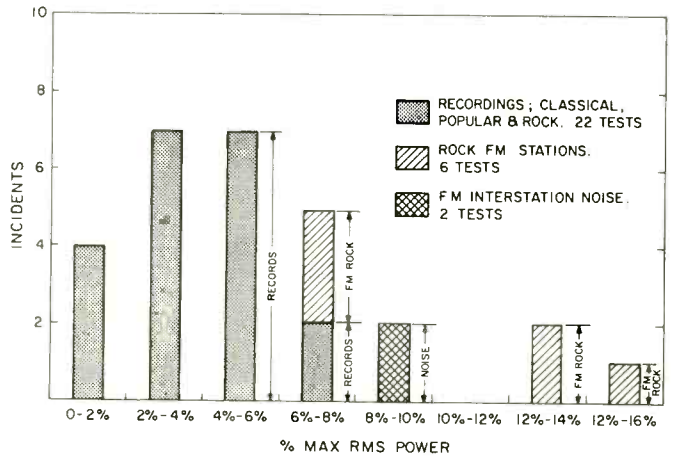

Fig. 3 — Average power content, various kinds of program material.

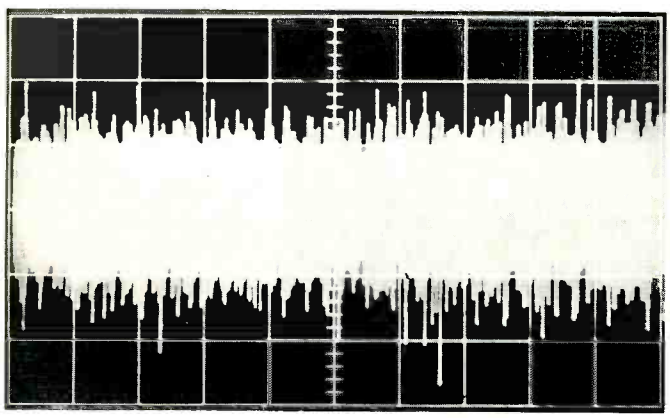

Fig. 4 — Emerson, Lake & Palmer's *Brain Salad Surgery*, as displayed on storage oscilloscope. Two minutes at 1 cm/sec. sweep speed.

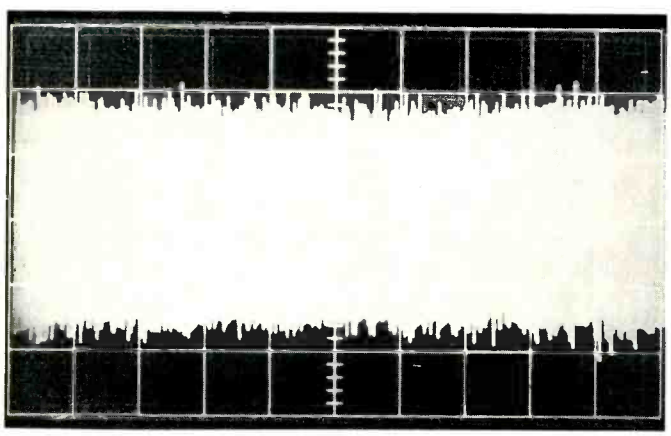

Fig. 5 — FM station, "Rock 102," WBEN, Buffalo, N.Y., as displayed on storage oscilloscope. Two minutes at 1 cm/sec. sweep speed.

Calibration measurements were made at 28 watts and 2.5 watts, with errors of -4% and -3.6% respectively. Appropriate correction factors have been applied to the test results. A Tektronix Model 549 storage oscilloscope was used to record peak information. The oscilloscope was connected across the 8-ohm load and was operated in the storage mode at a sweep speed of 1 cm/sec for the duration of each program selection. The highest peak voltages were clearly discernible. Since amplifiers must be rated in terms of rms power, the peak power information was converted to rms with the equation:

$$\text{Max rms Power} = \frac{(\text{Peak-to-Peak Voltage} \times .707)^2}{2} \times \frac{1}{R_L}$$

While this doesn't necessarily represent the true rms power of transient peaks, it does relate the required clipping level to a sine wave power capability.

Since amplifier clipping would defeat the purpose of the program material study, a large amplifier was used. The one chosen is able to deliver 156-watts continuous rms power and has a transient-peak clipping level of 196 watts, with an 8-ohm load.

Tests were run with an assortment of classical and rock records, with a few rock FM stations, and also with white noise. The results, expressed as a percent of Maximum rms Power, can be summarized as follows:

Average Classical Record	3.5%
Worst Case Classical Record	6.0%
Average Rock Record	4.3%
Worst Case Rock Record	7.2%
White Noise	9.6%
Average Rock FM Station	10.7%
Worst Case Rock FM Station	15.0%

Figure 3 shows the distribution of energy for recorded music and for FM rock programming. The detailed data is shown in Table I. The reason for the high power content of FM stations is, of course, their extensive use of volume compression. It is probably more than coincidence that the highest average power was observed on the station which used Dolby encoding.

Examination of the oscilloscope patterns in Figs. 4 and 5 clearly show the high energy content and flatness of FM rock programming as compared to a typical rock record.

It is quite evident from this analysis of 26 musical programs and two tests with noise that the most severe continuous demand on an amplifier was 15 percent of its maximum rms power rating and with most program material less than 10 percent, provided there is no significant amount of clipping in the output stages.

The obvious question is, "What happens if an amplifier is allowed to be driven into clipping?" To investigate this, the large amplifier was replaced by a small one, which could only deliver 6.5 watts continuous rms power and had a transient-peak clipping level of 9 watts.

Using the rock FM station, which had given the worst case results in the previous study, the volume control was turned up to the highest levels at which the distortion was considered tolerable by non-critical listeners. Under these condi-

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tions, average outputs on the order of 30 to 40 percent of the maximum-continuous rms power capablity were achieved. At maximum volume, readings as high as 89 percent were obtained. However, the audio was distorted virtually beyond intelligibility and this could not possibly be considered normal use of the amplifier.

Table I — Program material vs. power requirements.

Program Selection and Duration	Max. RMS Power (watts)	Average RMS Power (watts)	% Average RMS Power
1. Cat Stevens—**Tea for the Tillerman** *On the Road to Find Out* (5.07)	156.2	3.13	2.0%
2. Three Dog Night—**Golden Biscuits** *One* (2.96)	52.5	2.92	5.6%
3. Three Dog Night—**Golden Biscuits** *Eli's Comin* (2.73)	37.5	2.23	6.0%
4. Carol King—**Writer** *Spaceship Races* (2.96)	121.0	1.46	1.2%
5. Pink Floyd—**Dark Side of the Moon** *Speak to Me, etc.* (19.3)	80.8	2.62	3.2%
6. **Jesus Christ Superstar** *Overture* (3.54)	34.5	1.22	3.5%
7. **Edward's Hand** GRT10005 *Episodes* (3.88)	42.2	3.04	7.2%
8. Rock Opera **Tommy** *Overture* (2.72)	189.0	12.47	6.6%
9. Cat Stevens—**Tea for the Tillerman** *Bitter Blue (3.08)*Slight clipping.	196.0	10.55	5.3%
10. Wurlitzer Pipe Organ AFLP 1828 *When the Saints Come Marching In* (3.34)	36.0	1.87	5.2%
11. Blood Sweat & Tears *Spinning Wheel* (3.98)	95.0	2.9	3.0%
12. Blood Sweat & Tears *Blues Part II (11.73)*	85.6	1.86	2.2%
13. Beethoven **Symphony #9** *Final Movement* (25.45) Seraphim S-60079	27.6	1.02	3.7%
14. Chopin—**Ballad #3** RCA LM 1707 (6.9)	33.0	1.51	4.6%
15. **Carmina Burana**—Side 1 Capitol SPAR 8470 (25.8)	186.0	0.84	0.45%
16. Mozart—**Exsultate Jubilate** Turnabout 4029S (14.75)	110.0	2.74	2.5%
17. Moazart—**Benedictus Sit Deus** (1st 3.43 Min. Only) Turnabout 4029S	186.0	10.97	5.9%
18. Beethoven **Symphony #5** *First Movement* (7.46)	40.6	1.45	3.6%
19. **Switched on Bach** *Brandenberg Concerto #3* (6.36)	22.5	1.37	6.0%
20. **1812 Overture** Westminster XWN 18283 (16.15)	56.0	1.12	2.0%
21. White Noise (FM Interstation (5.0)	25.6	2.45	9.6%
22. White Noise (FM Interstation) (5.0)	33.0	2.89	8.8%
23. *FM-99* 5/9/75 WHFM, Rochester (4.86)	33.0	4.45	13.5%
24. *FM-99* 5/9/75 WHFM, Rochester (12.41)	45.5	3.49	7.7%
25. *FM-99* 5/12/75 WHFM, Rochester (32.0)	15.9	1.13	7.1%
26. *Rock-102* 5/12/75 WBEN-FM, Buffalo (10.5)	124.0	17.28	13.9%
27. *Rock-102* 5/12/75 WBEN-FM, Buffalo (32)	45.55	6.86	15.0%
28. *QFM-97* 5/14/75 WGRQ, Buffalo (15.0)	45.6	3.17	7.0%

It is evident, therefore, that the only way to achieve one-third of maximum rms power on a continuous basis with program material is to drive the amplifier into severe clipping distortion. The result can not, by any stretch of imagination, be classified as hi-fi. However, with small amplifiers, such clipping is a normal fact of life.

It is well known that when an audio output transistor is driven into saturation (clipping), its internal power dissipation drops considerably. In other words, deriving one third of rated output power from intermittent program material, which saturates the output transistors a high percentage of the time, will cause much less output device heating than generating the same average output power with a continuous sine wave which stays below the clipping level.

To evaluate this effect with actual program material, thermocouples were attached to the collector tabs of the output transistors of the 6.5 watt amplifier. The amplifier was then driven to various power output levels with a 1,000 Hz sine wave and then driven to several different average output levels with rock FM program material. The average power output of the program material was measured with the calorimeter. Each test ran exactly 3.5 minutes. Prior to each test, the collector tab and heat sink were allowed to cool to 100 degrees Fahrenheit, then temperature rise was measured during the 3.5 minute operation period. The resulting curves are shown in Fig. 6, and it is evident that the output transistor heating which occurs at one-third rated output

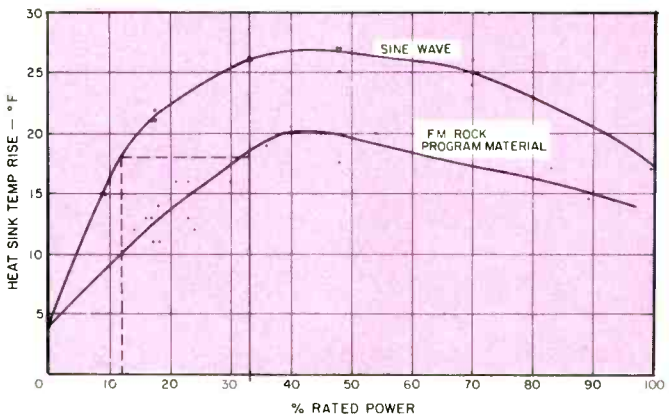

Fig. 6 — Heat sink temperature vs. percentage of rated power for FM Rock station program compared to sine wave dissipation.

with program material can be simulated with only 11 percent of rated power using a continuous sine wave signal. Most important, note that the output transistor heating effect of one-third rated power with a continuous sine wave signal could not be achieved under any condition, with program material.

In the November, 1974 issue of *Stereo Review*, Larry Klein proposed that preconditioning be done at one-third of rated power by driving the amplifier to full output with a 1-kHz tone burst having a one-third duty cycle. Tests with that signal showed that the output transistor heating effect approximates that of 11 percent rated output using program material, while the power supply is stressed to one-third of rated output.

Tests were also made using a 1-kHz tone-burst signal which drove the amplifier to 50 percent of full output at a two-thirds duty cycle. This signal more closely approximates

(Continued on page 50)

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George W. Tillett

Cassette Decks—

How Do They Stack Up?

ONLY TWO OR THREE years ago, the pundits were prophesying the early demise of the open-reel tape recorder, but (as with Mark Twain's famous remark) the reports of its death were highly exaggerated. New models are seen at every hi-fi show, ranging from inexpensive stereo models to semi-professional and quadraphonic machines with such features as logic tape-motion controls, multi-track sync facilities, line and mike mixing, plug-in head assemblies, and much more.

In the same period, however, cassette recorders have been improved almost beyond belief, and the first-line models—those in the $300 to $500 bracket—cheerfully invite comparison with most any open-reel machine. Recent innovations include monitor heads, mixing circuits, variable speed controls, greater choice of bias and equalization, and easier head adjustments. And there are even some luxury machines in the $500 to $1200 range! So, let's see how the cassette deck really stacks up, whether it will kill off the open-reel recorder in home applications.

Before we try to sum up the pros and cons, it would be well to set down the various requirements of a tape recorder, and here are some—not necessarily in order of importance:

1. Wide frequency response;
2. Low distortion;
3. High signal-to-noise ratio;
4. Low wow and flutter;
5. Ease of operation;
6. Monitoring facility;
7. Editing facility, and
8. Additional features, such as peak limiter, mixing, sound-on-sound, track sync, etc.

There are, of course, other factors to consider when actually buying a recorder such as styling, guarantees, servicing, and price, but for the moment we'll ignore them.

Basic Parameters

Frequency response, distortion, and noise are all closely related so they will be considered together. As is well known, the performance of any tape recorder is greatly determined by the tape area and speed. Thus, a cassette recorder, with narrower tapes and working at the slow speed of 1⅞ ips, is basically handicapped relative to the open-reel recorder. Examining the track configuration of cassette tape compared with the larger tracks used by open-reel tape and taking into consideration the speeds, the tape area (or the number of magnetized particles, if you will) for the cassette is only 15 percent of that used by the open-reel machine working at 7½ ips. Thus, it follows that the inherent problems of tape hiss and random particle noise are more difficult for the designer of cassette machines.

Assuming that the signal output is in direct proportion to the track area, it is easy to see that if the cassette output is amplified to the open-reel level, the noise level is, almost certainly, going to be a lot higher. Figure 1 shows the frequency response of a typical quarter-track, open-reel machine costing around $350.00 and using a low-noise tape such as Maxell UD, Scotch HO/LN, or BASF LH Super. Figure 2 shows the frequency response of a typical top-quality cassette deck, and it will be seen that its high-frequency response is somewhat reduced. Note also the difference between the Normal, Low Noise, and CrO_2 tapes. High-frequency response might be extended to some extent with the new ferric-chrome, dual-layer hybrid tapes, but not all machines can use them to advantage at present. Thus, it would seem that 18 kHz is about the top limit for cassette machines at present.

But this is not the whole story. One of the limiting factors presently is the head itself, as most cassette decks use a single head for recording and playback. But the requirements of the different functions are conflicting, as the gap on the recording head needs to be large for efficient signal transfer, and the playback head gap must be small to give a good output at high frequencies (or put another way, the gap must be small compared with the recorded wavelength). A limit is reached when the recorded wavelength is equal to the gap length because the two oppositely-magnetized half wavelengths will cancel and the induced voltage is zero. The wavelength of a 20-kHz signal at 7½ ips is about 8.5 microns, but reducing the tape speed to 1⅞ ips brings down the wavelength of the same frequency signal to about 2.2 microns! Although the effective magnetic gap is a little larger than the actual physical gap, if we want a cassette deck to have a linear response to 20 kHz (without too much high-frequency boosting), then the head gap should be less than half wavelength or about 1 micron. But in this case, recording efficiency would be low. Therefore,

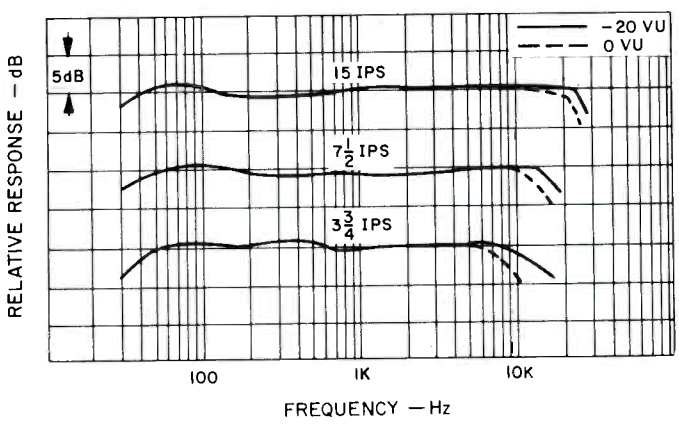

Fig. 1—Frequency response of a moderately priced, three-speed, open-reel tape recorder at 0 (dashed line) and -20 VU (solid line).

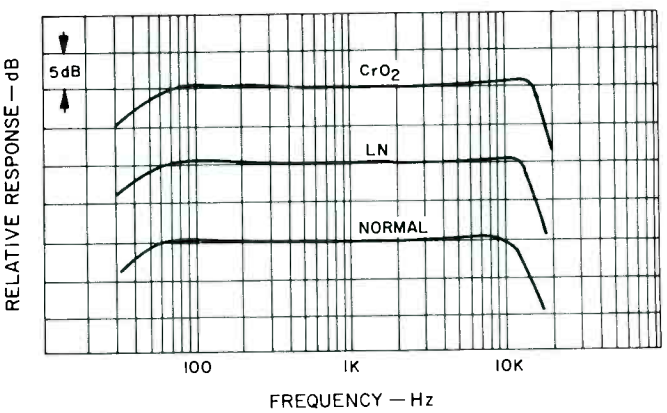

Fig. 2—Frequency response of a typical top-quality cassette deck with three different tapes at -20 VU.

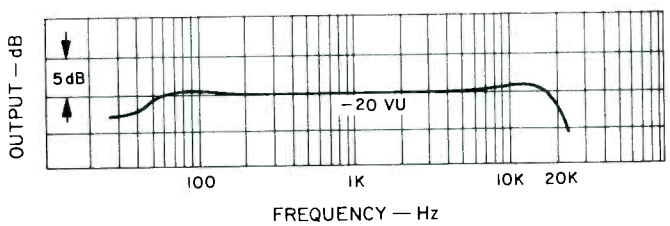

Fig. 3—Frequency response of a Nakamichi 1000 at -20 VU with CrO_2 tape.

machines using combined record-playback heads usually settle for a compromise gap between 2 and 4 microns.

Recently, several three-head recorders have become available, and they do have a rather better high frequency performance. Figure 3 shows the frequency response of a Nakamichi 1000, which uses a 5-micron recording head with a playback head having a remarkably small 0.07 micron gap. The response extends to over 20 kHz, and results are apparently only limited by the tape medium itself.

Frequency response is usually measured at low levels, either at -20 VU or sometimes at -30. The dashed line in Fig. 1 shows the frequency response of our open-reel recorder at 0 VU, and it will be seen that the response at high frequencies falls relative to the response at -20 VU (shown as a solid line). This phenomenon gets progressively worse as the tape speed decreases, and it is called tape saturation because all the magnetic particles have been affected and further signal increases can do nothing except erase what is there already! At 15 ips, the effect is quite small, but it becomes significant at 3¾ips, and, as you might expect, it is even more important with cassette decks working at 1⅞ ips. What does this mean in practice? Simply that care must be taken to keep that VU meter pointer well below the 0 VU mark when making recordings of music having large transient peaks or the sound will lack definition and brilliance. But, there is a snag; if the overall level is reduced by 10 VU as shown on the meter, then the overall signal-to-noise ratio will also suffer. Some cassette machines have peak limiters which do help, but special noise reduction systems, such as the Philips DNL, JVC's ANRS, and Dolby, provide the real answers.

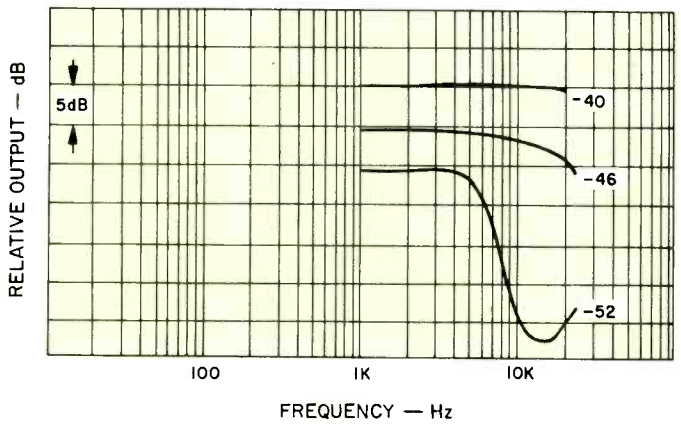

Fig. 4—Action of the DNL system. Note that it is inactive above levels of -40 dB.

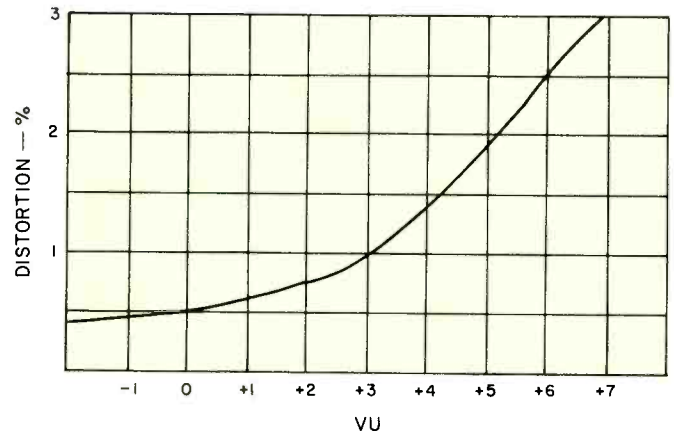

Fig. 5—Distortion versus recording level at 1 kHz for a typical open-reel machine costing about $350.

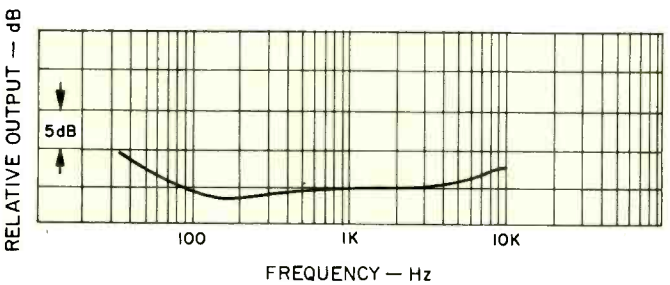

Fig. 6—Distortion versus frequency at 0 VU for the same typical open-reel deck.

How do we score the two sorts of tape recorders on these basic parameters? Well, top marks have to go to the very best open-reel machines, but we also must note that many of the first-line cassette recorders offer a quality of performance superior to the less-sophisticated open reelers. It's a case of paying your money and taking your choice.

Noise Reduction

Most readers are at least moderately familiar with noise-reduction systems, so that a long and involved technical explanation would be inappropriate here. In brief, however, the Dolby and ANRS systems work by increasing the signal level of frequencies above 500 Hz during recording, if they are low, and then reversing the procedure for playback, thus reducing the high frequency signal level to the amplitude of the original and reducing the noise by a like amount. There are two Dolby systems, A and B; the latter is the one used in domestic machines. The amount of high frequency lift is determined by both amplitude and frequency, and the circuitry is quite complex. Although the ANRS also operates above 500 Hz, it is not a dynamic, continously-controlled system, and so recordings made with the two are not directly compatible. The Philips DNL system is not a two-way type, as it functions on playback only to attenuate signals as shown in Fig. 4. Note that the high level signals are not affected and the maximum effect is in the region of 10 to 12 kHz.

A cassette deck using a Dolby system can show an increase of up to 10 dB in signal-to-noise ratio over a non-Dolby recorder, which means that recordings can be made with a lower level and you would still have a low background noise with less danger of tape saturation. A typical high quality cassette recorder thus would have a signal-to-noise ratio of 50 dB without Dolby and 60 dB with (weighted). On the other hand, an open-reel recorder would probably have another 6 to 8 dB at least, more if it also had a built-in Dolby system. But, of course, the cassette's 60 dB does represent a very good signal-to-noise ratio indeed, quite adequate for most purposes. The user, then, must decide for himself whether he has to have that few extra dB greater signal-to-noise ratio. Incidently, a S/N has to be related to a reference point, and unfortunately there is no fully-accepted standard. Some manufacturers use 0 VU, some prefer the 1 percent distortion point, while still others opt for 3 percent which makes the figures look better. Therefore, care must be taken when making comparisons as there might well be as much as 4 dB difference between the cassette machine figures and even more for open-reel machines. It might be thought that 0 VU seems pretty conclusive as a standard, but it isn't. What is 0 VU on one deck might be +2 VU on another, and further confusion is caused by some manufacturers who try to avoid tape saturation by tailoring the VU meter response so it reads higher above 5 kHz or so! All this is be-

Patents issued and pending.

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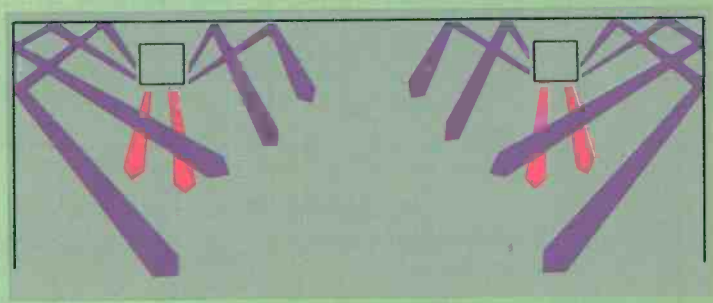

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cause volume units (VUs) only measure relative levels and not absolute levels.

Distortion

Figure 5 shows the distortion (THD) with a typical open-reel recorder, and it will be seen that the 3 percent level is not reached until the signal gets to a level of +7 VU, while at 0 VU the distortion is about 0.5 percent. In terms of distortion vs. frequency, there would be a slight rise at each end of the frequency range (see Fig. 6). The unfortunate cassette deck designer does not have the same leeway to work with, and many cassette decks have a distortion characteristic like that shown in Figs. 7 and 8. In other words, the distortion is higher and the headroom lower, once again emphasizing the importance of a noise reduction system in effectively giving a wider dynamic range. So, in terms of frequency response, distortion, and signal-to-noise ratio, an open-reel recorder working at 3¾ ips can have a 3 to 4 dB better signal-to-noise ratio, an extra 2 or 3 kHz in frequency range, and a bit lower distortion than an average cassette deck fitted with a Dolby system. At 7½ ips, the disparity is greater, and if the open-reel machine also has a built-in Dolby system, then there is scarcely any contest. But we are here talking about a machine that would probably cost at least half again as much as the cassette deck!

In actual practice, though, a cassette machine can make tapes from discs or FM that sound identical in an A-B comparison to tapes made by an open-reel recorder using 3¾ ips or even 7½ ips, but greater care is necessary when using the cassette deck. When it comes to making direct recordings with top-quality microphones, the open-reel recorder will win, especially if the 15 ips speed is used and an ultra-wide dynamic range required.

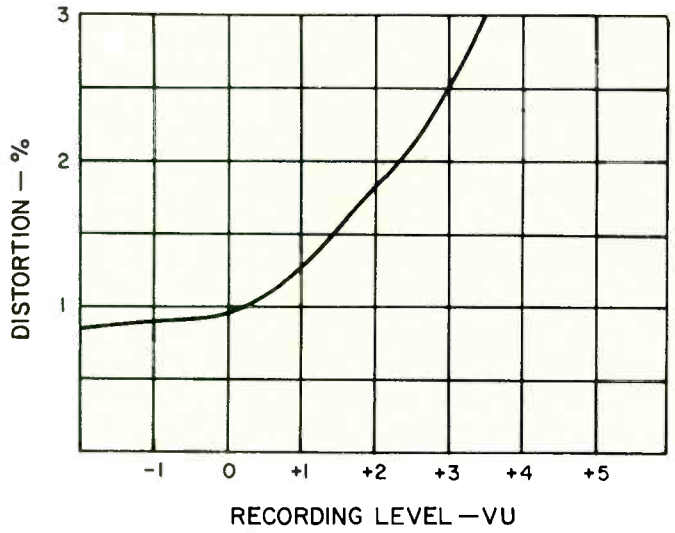

Fig. 7—Distortion versus recording level at 1 kHz for a typical cassete deck.

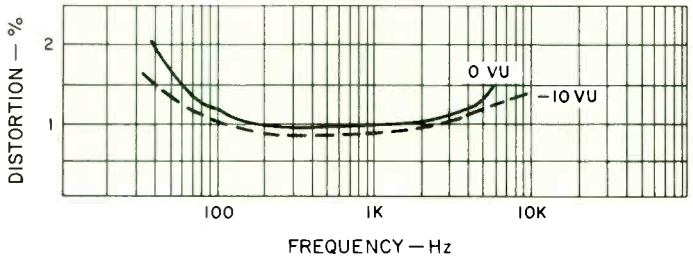

Fig. 8— Distortion versus frequency at two recording levels for a typical cassette deck.

Wow and Flutter

Wow can be defined as a slow variation in speed below 5 or 10 Hz, while flutter is a faster variation. Measurements are now usually made using the DIN or IEEE standard, which give a combined and weighted figure. Wow is frequently caused by capstan shaft eccentricity or by an unstable drive-tension system, and flutter can be produced by erratic tape motion as it passes over heads and guides or between various constricting portions of the cassette. Poorly designed or produced motors can also cause speed variations, but these days both open-reel and cassette decks use hysteresis-synchronous motors which are frequency controlled from the power supply. Both use servo-controlled motors in the higher-priced models, with the speed electronically controlled by feedback circuits which automatically correct for any fluctuations. The big difference between the recorders, cassette and open reel, is the way the tape is held steady so it passes smoothly over the heads. Some open-reel recorders use two motors, others have three, though at least three European recorders use a single heavy-duty motor with a tension clutch arrangement. All use a kind of back torque system to keep the tape under tension. Few cassette decks use anything but the simple pressure pads of the cassette to maintain smooth head-to-tape contact. However, if properly designed, this relatively simple method can work very nicely at the low speed involved. The cassettes themselves often present problems, since unlike tape reels where both tape and reel turn together, the cassette tape moves but the plastic case does not. While the various sorts of liner sheets, steel pin rollers, etc. do help with the friction, it and other variables are still not fully under the control of the deck designer.

Not only will an unsteady tape movement cause annoying flutter, but worn pressure pads or dirt on the heads can produce a poor contact with the tape resulting in a loss of high frequencies. It can also cause modulation noise—a kind of IM distortion. Further, it is not generally realized just how serious this sort of spacing loss can be at the slow speeds. A speck of dust only one-eighth of a mil will produce an attenuation of 54.5 dB or about 99 percent. Furthermore, the loss is compounded when the same head is used for recording. In practice, it is unlikely that the spacing will be that large, but it doesn't take much oxide build-up to produce a loss of 6 dB. The inference is obvious; cassette recorders need a lot more care, TLC, to get the best results, and the heads must be kept clean, *really clean*. And for truly top-grade recordings, only the best cassettes should be fed to the recorder. The cassettes should also be stored in their protective plastic boxes, just as with records, to prevent the accumulation of dust either on the tape itself or in the sprockets and hubs.

A look at the measured wow and flutter figures for open-reel recorders shows results from 0.04 to 0.09 percent, while cassettes run (no pun intended) between 0.04 and 0.17 percent, depending on price. It should be noted that these figures for cassettes are a good more variable than they are for open-reel machines. Even figures for the very same test cassette and recorder combination will vary from day to day. The main point to remember, however, is that the performance by cassette machines in this area make them worthy of serious consideration by the enthusiast.

Ease of Operation

Now here is where the cassette deck really scores! Anyone—even my Aunt Agatha—can load a cassette into a machine without getting into a tangled mess! And the decks are smaller and more portable. Some, such as the Yamaha TC-800GL, the Nakamichi 550 or Sony/Superscope 152 SD, will work on batteries too, and most have easy-to-use push-

(Continued on page 50)

Dear Editor:

Noise Suppressor Improvements

Dear Sir:

Thanks to the many readers who expressed interest in my dynamic noise filter (June *Audio*). Some questions concerned minor printing errors:

1. In Fig. 2, a signal path should be shown vertically between the 2 blocks on the right side.
2. In Fig. 4, "S4" should be "S2".
3. In Fig 7, "-30" was skipped on the vertical axis.
4. In Fig. 8, the uppermost diode labelled "D2" should be "D1".

One reader who built the circuit had trouble with offset and temperature drift in A6 of Fig. 6. This stage is somewhat sensitive to op amp input parameters due to its high d.c. gain. If the output does not follow the voltage at the slider of the *Base Cutoff* pot, A6 can be offset-nulled as shown on a 741 data sheet or a better unit selected. An even better solution would be to revise the circuit as shown. I have increased the a.c. gain before rectification and reduced rectifier gain, making A6 less critical by an order of magnitude. The circuit changes are minimal.

Another reader wanted to shorten attack time with respect to decay time. This can easily be done as shown at the lower right of the revised Fig. 6 of A6. Of course, if attack time is made very short, rejecttion of sharp impluse-type noise will suffer.

I welcome further comments on the circuit design or applications.

Maxwell G. Strange
11710 Wayneridge Ct.
Fulton, Maryland 20759

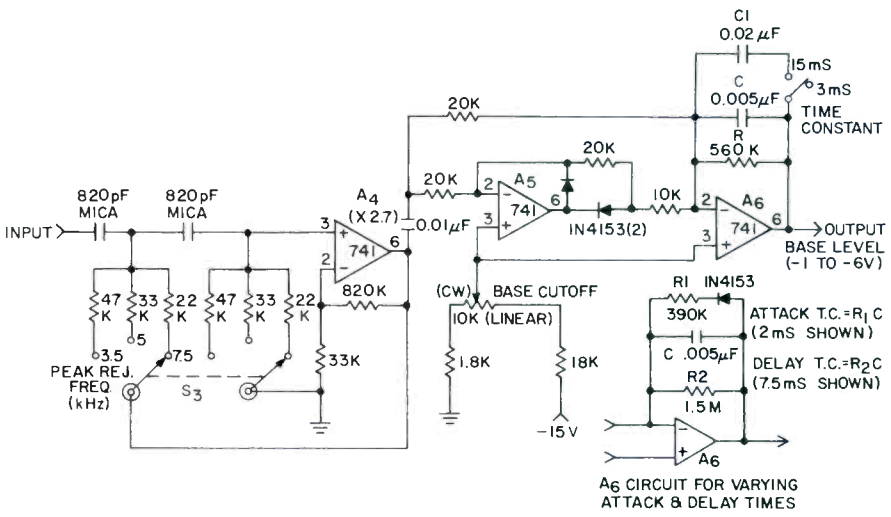

Fig. 6—Revised, including alternate A6 configuration to vary attack and decay times. Note that R1 and R2 also affect the rectifier gain, Thus, time constant changes are partly dependent on the *Suppr. Gain* control settings.

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Marantz 5420 Top Loading Deck.

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What's New in Audio

Beveridge Cylindrical Speaker System

This electrostatic loudspeaker, in a 6½ ft. enclosure, with its own internal power amplifier produces a smooth horizontal polar pattern over a full 180 degrees. The sound output aperture is a vertical slot, six feet long, with an acoustic lens, producing uniform, phase-coherent sound pressure over its entire height. As a result the sound pressure is horizontally uniform from 40 to 15,000 Hz, within ±2 dB. Beveridge says there is no doubling, and that this design yields virtually perfect transient response. It has a less-than-usual decrease of sound pressure as the distance from the speaker increases—the SPL varies in inverse proportion to the distant (1/d), in contrast with the loss of typical loudspeakers, whose loss varies inversely with the *square* of the distance ($1/d^2$).

The amplifier may be driven to full output with one volt input (into 47k ohms), and is direct-coupled to the electrostatic transducer, a capacitive load of only 0.005 μF. The amp can deliver peak instantaneous outputs up to as high as 1,000 volt-amperes. Simulated load conditions only one dB below saturation, it is stated, produce less than 0.1% IM distortion.

The Beveridge Cylindrical Sound System is 6½-ft. H. x 2-ft. W. x 16-in. D. In oiled walnut, amplifiers included, a stereo pair is priced at $4,000. Export versions can be supplied.

Check No. 80 on Reader Service Card

Audio Research Power Amplifier

The D-150 "High Definition Amplifier" employs four power output tubes in each stereo channel and is rated at 150 watts per channel. The rack-mount front panel includes meters for monitoring input a.c. voltage and either power or output-tube bias checking. An input power switch on the panel selects 100,115,125,220, or 240 volts. The D-150 is priced under $2,000.

Check No. 81 on Reader Service Card

Need Old Service Data?

Schematic diagrams and other service information for virtually any stereo or mono component, radio or television receiver can be obtained for a few dollars. Send the make and model number (chassis number also, if available) to Supreme Publications and the firm will tell you at once the cost of the diagram and service material—most sets cost $2.00; some are higher. Included are service manuals from manufacturers out of business as well as out-of-print material from other service data publishers. Supreme's address is 1760 Balsam Road, Highland Park, Ill. 60035

STR Gamma Speaker

STR's Gamma loudspeaker is a three-way, acoustic suspension system designed for efficiency—95 dB output at one meter for one watt RMS white noise input. Crossovers at two and 10 kHz divide the spectrum between a 10-in. long-throw woofer, a 4-in. phenolic ring midrange driver, and a 3.5-in. piezoelectric cone tweeter. The Gamma includes a 2.5-amp. fuse, weighs 43 lbs, and costs $108 in vinyl; $149 in walnut.

Check No. 82 on Reader Service Card

Theater Music

Donald M. Spoto

Stavisky: Stephen Sondheim. Movie Soundtrack, cond. by Carlo Savina, Jacques Mercier.
RCA ARL 1-0952, stereo, $6.98.

Alain Resnais' latest film, **Stavisky,** is a bittersweet look at a notorious French crook whose case became a cause célèbre in the Thirties. It stars Jean-Paul Belmondo, Charles Boyer, and Anny Duperey. Apart from Resnais' always-interesting camera treatment, what I most enjoyed was Stephen Sondheim's music. What a delightful surprise to find this disc waiting for me several days later!

This music has much in common with the composer's most recent movie music, **A Little Night Music,** reviewed last year in this column. There is lilting salon music, a jazzy gavotte (*Auto Show*), and a bit lifted wholesale out of the prelude to **Night Music,** the string and clarinet obbligato, here called *Easy Life*. I note that Jonathan Tunick, Sondheim's orchestrator for all his Broadway shows, has done the task here too. That probably accounts for the foray into near-chamber music, *Secret of Night*, as well as for the lovely counterpoint between woodwinds and strings.

Few composers are as interesting in their sameness as Sondheim. Musical ideas run through all his work. But unlike the ideas of most film composers, his don't grow stale. Most of the 24 cuts (!) here are identified with specific scenes, but they work beautifully even when heard out of context. Friends visiting recently wondered "what the lovely background music" was. Rozsa and Steiner elicited quite different reactions.

I note that **Pacific Overtures** has been announced for next season on Broadway. Is Sondheim's debt to Richard Rodgers coming full circle?

This is a delicious score, crisply performed and recorded carefully, although I heard some distortion on the second side.

Sound: B Performance: A

Spellbound and Other Classic Film Scores: Miklos Rozsa. Charles Gerhardt cond. National Philharmonic Orch.
RCA ARL 1-0911, stereo, $6.98.

And so it goes. RCA's classic film scores, in an apparently endless series of rerecordings of movie music, comes up with a canonization of mediocrity. Miklos Rozsa's scores won him three Oscars (for **Spellbound, A Double Life,** and **Ben Hur),** which shows just how mysterious those awards are. Rozsa's music depends for its effects on volume and tricks (He made a musical fetish of the use of the theremin for **Spellbound** and **The Lost Weekend;** interesting, but overused). And his brass section, his favorite part of the orchestra, is in a state of perpetual warming up, running up and down triads like the ski-slope in Hitchcock's thriller.

This album features selections from **The Red House, The Thief of Bagdad, Lost Weekend, Four Feathers, Double Indemnity, Knights of the Round Table, The Jungle Book, Ivanhoe,** and **Spellbound.** It's hard to tell one from the other; all his music has a sameness and lack of depth. The "romantic" themes are banal, and when he tries to buckle on some swash it comes out bombast. Rudy Behlmer's notes will probably interest fans of movie trivia, for in the final analysis the films Rozsa's scores served are as mediocre as the scores themselves. You tend to remember *faces* when you hear this disc, not scenes. RCA's pressing is splendid, but the effort seems wasted.

Sound: A Performance: A

(Continued from page 34)
the condition of driving an amplifier to one third of rated output with program material.

Figure 7 shows the tone-burst data plotted along with the previously discussed heat-vs-power curves. It also shows the test results obtained using white noise as a signal.

The major points and some conclusions of this study can be outlined as follows:

1. The worst-case program material found in this study would demand a continuous output equal to 15 percent of an amplifier's maximum rms power capability. *Most Program Material Demanded Less Than 10 Percent.*

2. The only way an amplifier can be continuously driven to one-third of its rated power with program material is to disregard distortion as a limitation. If an amplifier is overdriven in this way, one third of rated power does seem to be the maximum level at which distortion is tolerable by non-critical listeners. A discerning listener would be annoyed by that much distortion.

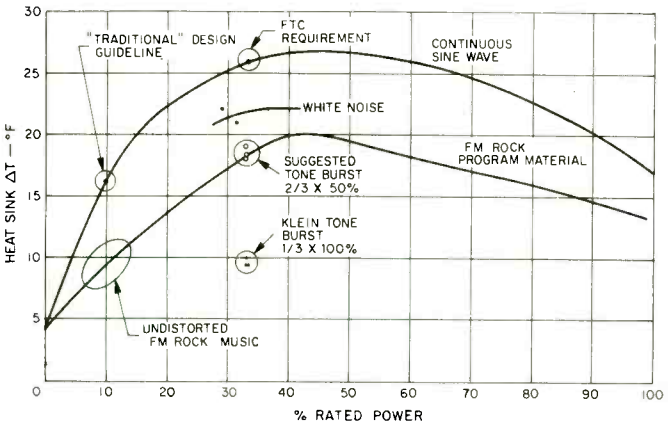

Fig. 7 — Heat sink temperature vs. percentage of rated power, comparing present FTC rule with other test methods.

In the opinion of this writer, driving an amplifier this hard is an abuse which must be reckoned with in terms of reliability and safety, but it is an operating condition far beyond the scope of performance specifications.

3. The power output transistor heating effect produced by preconditioning at one-third rated power with a continuous sine wave signal cannot be achieved under any condition with program material.

The data developed in this study clearly points out the need to revise the present FTC preconditioning requirement. The big question is, how?

Figure 7 shows a few possible conditions. Continuous sine wave operation at 10 percent of rated rms power has been a benchmark of engineering practice for decades. Figure 7 shows that this does accurately simulate the average power demand of program material when an amplifier operates within its rated distortion. An amplifier must be reliable and safe when over-driven or abused in other ways, but those considerations ought to be kept separate and distinct from tests intended to define the power and distortion of a high-fidelity instrument.

For these reasons, this writer would prefer that pre-conditioning be done at 10 percent of rated rms power. However, a 1-kHz tone burst of 50 percent rated power two thirds of the time may be the most convenient way to "repair" the present FTC requirement. It does closely simulate the true one third power overdrive situation and does fall within practical and reasonable design guidelines.

(Continued from page 42)
button controls. The more recent front-loading models, such as the Pioneer CT-7171, Sony/Superscope TC-177 SD, and Technics RS-676 US, are not only simple to operate but they provide facilities previously found only on open-reel decks. For example, the Technics recorder has a memory circuit that can get the tape rewound back to a predetermined point before switching the machine back into the play mode. It also has a Dolby 25 and standard 75 μS de-emphasis network switch for recording from tuners with either time constant, a peak or normal VU reading switch, and provision for CrO_2 low noise, and ferric-chrome tapes. The bar switches have built-in indicator lights, a useful refinement for the non technical user.

Monitoring

In my opinion, this is an essential feature for the truly serious recording enthusiast, and most open-reel machines over the $300 mark do have the three heads necessary. Among the cassette decks with this facility are the Nakamichi 1000 and 700, AKAI GXC-352D, Sony/Superscope TC-177 SD, and the Technics RS-279 US. Curiously, the Technics model uses a separate head for monitoring, while retaining a combined record-replay head. A word of warning; because a deck has three heads, it doesn't always mean that one is available for monitoring. For example, the third head in the Toshiba PT-490 is a second erase head for the reverse tape direction.

Editing, S-O-S, etc.

I stated earlier that it is difficult to edit cassette tapes, and so it is. While it can be done, the process does require a great deal of patience. The 3M Company makes a repair kit, and Editall, among others, makes the right size blocks and tabs for splicing. None of the special effects like sound-on-sound, multitrack sync, and echo are possible with cassette decks, although certain effects are possible with the aid of external units.

The Future

We will undoubtedly see more cassette decks with monitoring facilities. In fact, several were introduced at the recent Consumer Electronics Show in Chicago. Many of these had provision for ferri-chrome tapes and servo motor control. Automatic bias and equalization adjustment for CrO_2 tapes, actuated through sensing an indentation on the cassette, is now standard practice. More and more sophisticated cassette decks will appear with such features as variable speed control, but the biggest advance will be in the tape itself.

The originator of the cassette medium, Philips, recently introduced a super fine-grain iron oxide formulation which they say gives an improvement of 10 to 12 dB in the signal-to-noise ratio. Both TDK and Maxell have even more recently introduced cassette tapes making use of cobalt for improved performance. TDK's is called Super Avilyn (SA) and uses a cobalt ion added to an extremely fine ferric oxide particle by absorbtion. Maxell's UDXL uses cobalt ferrite epitaxially grown on extremely fine ferric oxide particles. Bias and equalization characteristics of these two tapes are similar to CrO_2, so we will be spared a proliferation of bias/eq switches. However, I don't see cassette machines challenging open-reel units very much more seriously than they do now because both benefit from technological advances.

So, then, back to our opening question; how do the cassette recorders of today stack up? And the answer, obviously at this point, is very, very well!

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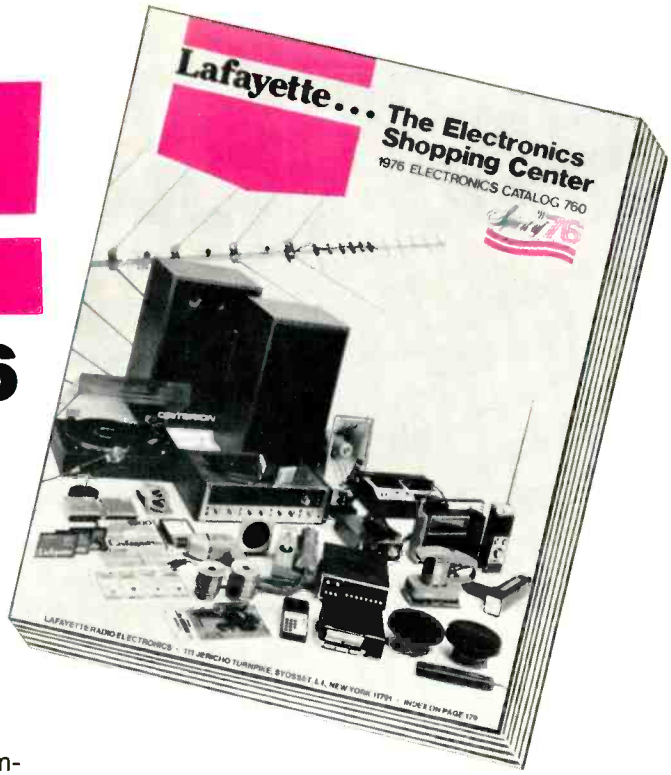

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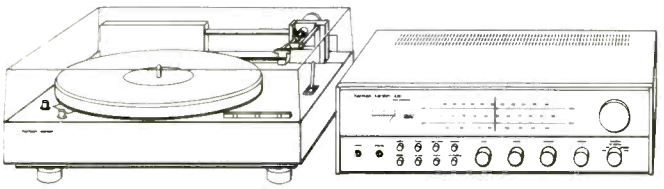
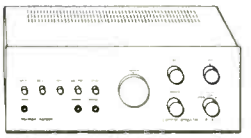


Rabco ST-7



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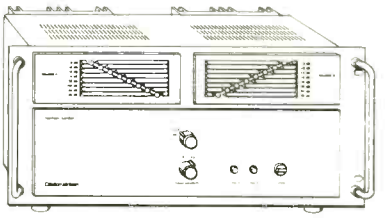

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Diverse and *consistent*. The ST-7 and Citation 16 expand the boundaries of state-of-the-art. The resulting new technology is soon incorporated in other products. The new A401 integrated pre-amplifier and power amplifier does not produce the absolute power levels of Citation 16. But its square wave response, slew rate and rise time reveal its genealogy. We can conceive of no better recommendation for the first time "investor" in high fidelity.

Diverse and *consistent*. As the 430 receiver vies for visual attention on your dealer's shelf, it may seem almost diffident. Don't believe it! For within its graceful contour lies such power as to meet truly demanding dynamic conditions–without compromise of sound quality.

The source of the 430's energy is not the conventional single power supply. It has *two* discretely separate power supplies–one for each channel. Consequently, no matter how much energy is called for by dynamic music passages, performance of one channel is not affected by the other. The features of the amplifier section (twin power, square wave response, phase linearity, instantaneous transient response) and many elements of the tuner and preamplifier sections are inherited from our Citation series of components.

There is simply no comparison between the 430 and other modestly priced receivers. Its performance can be appreciated most by direct comparison with expensive individual components. The 430 demonstrates, upon the very first hearing, that quality need not be sacrificed to achieve the economy of size, convenience and price.

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SYN-AUD-CON: AUDIO TOOLMAKER

Carolyn Davis *

WHAT DOES a professional sound engineer get out of a short (3-day) sound engineering seminar of the type given by Synergetic Audio Concepts (Syn-Aud-Con) of Tustin, Ca.?

The answer in one word is *tools*. Often a professional's tools are rusty from lack of recent use, and many of the tools are actually being misused because of a misunderstanding of their basic nature. Some tools may never have been acquired because many people enter the audio business without specific formal training at the university level. Further, and to a surprising degree, the audio engineer is self-taught because there are few good courses in existence.

A seminar course, like Syn-Aud-Con's, provides the professional sound engineer with a quick, efficient, and very thorough way to review, refresh, and discover the tools essential to the growth of his career in today's rapidly changing, digitally-powered audio world. That all this is accomplished in three days does not require a miracle, but rather individuals with a total previous emotional commitment to being professional about audio. The more experience the engineer brings to the class, the greater the enhancement of his skills he will experience. The progress an individual makes in three days is surprising until one realizes that the three days in class isn't what gave him his talent; the classes just made it more visible. For a newcomer to the audio profession, the class serves as an invaluable "survey course" of what he will have to learn and master if he wishes to honestly use the word professional about his audio skills.

*Co-author of a book to be published in 1975 by Howard W. Sams, Inc., *Sound System Engineering* by Don and Carolyn Davis.

Basic Tools Identified

The most obvious basic tool is the decibel, dB. Ninety-nine percent of the professionals attending the Syn-Aud-Con classes need an updating of their knowledge of the bewildering mass of reference levels, symbols, applications, and conversions that use the dB.

Syn-Aud-Con mounts a three-way attack on the subject using Hewlett-Packard scientific calculators in the class (20 of the new HP-21s), plus instruction in the use of the Texas Instruments SR-50, a special Syn-Aud-Con slide rule system, and a series of nomographs and charts. One of these three paths matches the ability of each student and carries him through the problems presented.

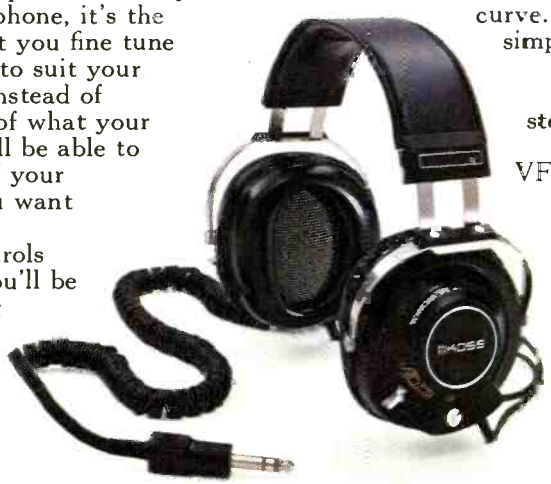
There is no way to understand how loudspeakers work in real acoustic environments without a clear conceptual view of the difference be-

Koss introduces the first stereophone you fine tune yourself.

The Technician™/VFR

If you've been missing the brilliant highs and rich lows you think are in your favorite music, the new Koss Technician/VFR Stereophone is for you. Because unlike any other stereophone, it's the world's first stereophone to let you fine tune the frequency response range to suit your own listening preference. So instead of hearing somebody else's idea of what your music should sound like, you'll be able to shape the acoustic contour of your favorite music to the way you want to hear it.

By adjusting the VFR controls at the base of each earcup, you'll be able to discover a shimmering new brilliance in the highest notes of a piccolo. Or by re-shaping the curve for more bass, you'll be able to feel a new breathtaking fullness in the deepest bass notes of an organ passage. But no matter how you set the VFR controls, you'll be shaping your own response curve. And that's a lot more exciting than simply listening to a frequency response curve pre-set at the factory.



Of course, along with being the first stereophone with a variable frequency response, the new Koss Technician/VFR still offers the superb professional styling and hour-after-hour wearing comfort that Koss Stereophones have always been famous for. So slip into a whole new stereophone experience at your Audio Specialist's. As you adjust the VFR controls you'll discover the shape of things to come . . . the Koss Technician/VFR.

KOSS® stereophones

from the people who invented Stereophones.

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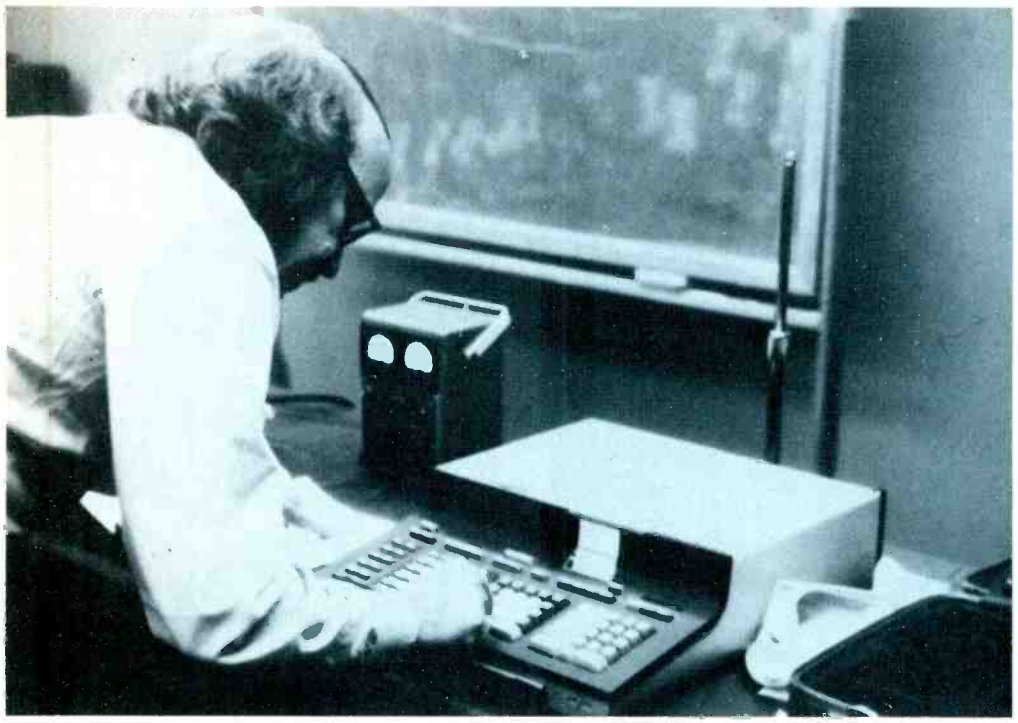

tween the loudspeaker's directivity factor or Q and its coverage angles. The correct choice and placement of a quadraphonic loudspeaker channel absolutely requires this understanding. So does accurate placement of a reinforcement loudspeaker system, and, just as basic, where to aim the system. Syn-Aud-Con uses the most advanced digital, real-time spectrum analyzers available, plus tone burst analysis, to *demonstrate* both the correct and incorrect techniques.

The most neglected tool among self-taught professionals is their knowledge of how absorption and reflections in the acoustic environment interact with the sound system. Syn-Aud-Con therefore provides a unique tool for this and, so far as can be determined, their reverberation time calculator is the only one made. It provides scales for the three basic equations in use today: Sabine, Norris-Eyring, and Fitzroy. Through the use of this slide rule, the scientific calculators, and other such handy tools as the RT60 digital-readout reverberation meter, the class develops both a mathematical and physical feel for the acoustic environment.

"You're loud enough, Charlie, but I can't understand what you are saying" is almost as common a complaint as, "The quality of sound is good but we're hitting feedback before you're loud enough." The slide rules, plus the very latest form of simplified equations, teach the student how to predict *accurately* the *exact* parameters of a sound system design to insure that it's both loud enough and clear enough.

The unfortunate misuse of equalization techniques and the proliferation of incorrectly designed equalizers makes the equalization portion of the class a must for any professional who hasn't been exposed to the inventor of Acousta-Voicing, Don Davis, who teaches the three-day Syn-Aud-Con class. Don demonstrates every proposed technique, and gives valuable insights into why the majority of them don't work. It's here that the best trained professionals can polish their ability to adjust well-designed and properly installed sound systems.

After the 3-day Class

Each graduate receives four quarterly Newsletters (about 20 pages each) the first year and a minimum of four Tech Topics, a large portion of which are written by the graduates. This synergetic action stems naturally from the theme of the Newsletters:

- I met a man with a dollar
- We exchanged dollars
- I still had a dollar;

- I met a man with an idea
- We exchanged ideas
- Now we each had two ideas.

Syn-Aud-Con has received tangible support from the audio industry, and five manufacturing firms presently help underwrite the expenses of providing classes in 23 different cities in the United States. Such support makes it possible to offer the classes in a convenient location at reasonable prices and provide all the materials and continuing support to the graduate. These sponsors are Shure Brothers, Inc., General Radio, U.R.E.I., Sunn Musical Equipment Co., and Crown International. Personnel from these manufacturers receive Syn-Aud-Con training which provides still another link in the communications circuit between the ultimate user and the designer-manufacturer of audio equipment.

The true revolution, being carried on in the audio business today by the younger generation right under the noses of the petrifying "old timers," has brought with it an increasing demand for engineers who are really good at system design, installation, and check out. The latter half of the 1970s will probably see another wave of progress such as the audio industry has not had since the initial development of motion picture sound in the 1930s, only this time it will be sparked by the spin-offs of digital technology developed for the computers and other equipment required to place a man on the moon. (Witness the work of Richard Heyser of Cal. Tech.'s Jet Propulsion Labs in audio, his hobby.) It will seed a veritable revolution in audio technology. More importantly, the wedding of the computer to the synthesizer will once again tie the audio engineer closely to the artist-engineer, just as they were in the early days of motion pictures, and the combining will again have important sociological and technological results for us all. Large (480 speaker), complex (non-acoustic pick-up), digital computer-synthesizer input systems are even now showing those in the traditional music fields that amplified conventional instruments are this generation's harpsichords when compared to the computer-synthesizer-piano. The composer-musician-conductor of the future will control his own expression, free from the mixer-engineer. These artists will cut out the amateur sound men who fail to produce consistent results in highly experimental situations.

It's easy to predict that there will have to be more audio toolmakers, such as Syn-Aud-Con, in the future. The professional sound engineer needs a source of training and updating of information that transcends the expertise of a single manufacturer, a source that tells it straight, and one that does so in classes that are economical both in terms of time and cost.

Equipment Profiles

G.A.S. Ampzilla Basic Power Amplifier

MANUFACTURER'S SPECIFICATIONS

Power Output: Minimum of 200 watts per channel into 8 ohms or 125 watts per channel into 16 ohms, both channels driven, 20 Hz to 20 kHz, with less than 0.05% total harmonic distortion or intermodulation distortion. **Input Sensitivity:** Kohms. **Rise Time:** At 8 ohms, better than 2 μS at full power to 20 kHz, slew rate equal to 40V per μS. **Noise:** Better than 100 dB below full power, unweighted, wide band; 112 dB below full power, wide band with r.f. filter. **Size:** 17½ in. W. x 7 in. H. x 9 in. D. **Shipping Weight:** 50 lbs. **Price:** $599.00, kit.

Ampzilla is the first product of a new audio company—The Great American Sound Co. It is different and unusual in appearance and quite attractive after one gets used to it. It is available as a kit or factory wired; the unit reviewed was factory wired.

Fig. 1—Rear view of G.A.S. Ampzilla.

EDITOR'S NOTE: **Craig's Model 3139 FM & 8—track car radio was erroneously reported in the July issue to have a power output level *MUCH* below its actual level due to an inadvertent error in the testing method. A full addendum will appear in the next issue.**

Refer to Figs. 1 and 2. The package is rugged, solid, and relatively simple. A U-shaped bottom piece serves to mount the power transformer, two filter capacitors, cooling fan, heat sink chimney assembly, and some of the normal front and back panel components. The chimney has the two power-amp circuit boards mounted on opposite sides, with four output transistors at the bottom on each side below the circuit boards. The fan is powered from the main secondary winding of the power transformer. Operating at a low-medium speed, it is reasonably quiet, as fan-cooled amps go.

The rectifier bridge and four supply fuses are mounted on a bracket that connects the ground sides of each filter capacitor to the chassis ground.

On the front part of the bottom chassis piece is a three-position phase-reversing power switch (*Off/On/Off*), two speaker-line fuses, and a green LED *Power On* indicator. On the back part of the main chassis are the line cord, line fuse, two sets of binding posts for the outputs, and a pair of phono jacks for the signal inputs.

Ampzilla has a front protrusion housing the meters and meter switch. In both cases, white end caps, contrasting with the black anodized chassis pieces, fit over the ends of the U sections and are solidly screwed to them to hold the whole unit together. Pemm nuts and machine screws are used throughout Ampzilla, with no self-tapping screws used anywhere.

The meters are calibrated in rms watts into eight ohms with a sine wave and relative dB, with 0 dB equal to 200 watts. The meters are average-responding and appear to have somewhat faster ballistics than a standard VU meter. As this reviewer has mentioned before, decade range switching is very desirable for easy reading of power on the lower ranges, and a 200-milliwatt full scale is a very handy reminder of the fact that a lot of listening on efficient speakers takes place down in the 1-100 mW region.

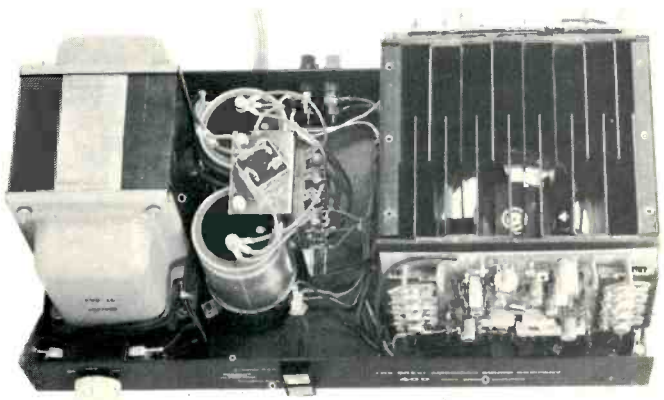

Fig. 2—Internal view.

Circuit Description

As can be seen in Fig. 3, the circuit of Ampzilla is full-complementary from input to output. The input stage consists of a dual-complementary differential amplifier, Q1-4. The output of Q1 drives Q6, a PNP emitter follower. Q6 drives Q7 which is a PNP inverting gain stage and is the plus predriver. In a similar manner, Q3 drives Q8 and Q9 with Q9 being the negative predriver. Q7 and Q9 operate Class A, with a quiescent current of about 25 mA. The signal currents at the collectors of Q7 and Q9 are in-phase but even harmonics are out of phase and will tend to cancel out. These collectors are tied together through the bias regulator. The predrive signal is thus relatively free of even harmonics and can drive the output stage equally hard in both directions. The bias regulator is a special integrated circuit designed to accurately control the idling current of the output stage as a function of temperature. The IC is mounted with its top surface in good thermally greased contact with the bottom of the heat sink where the output devices are.

The output stage is effectively a complementary follower with emitter-follower drivers. Each driver and output composite device is made up of two transistors in series to increase the safe area of the output stage. The inner drivers and outputs (Q13, 14, 17, 18) are driven from the predrive signal, while the outer devices (Q12, 15, 16, 19) are driven as slaves via voltage dividers from the amplifier-output signal. These signal dividers cause the voltage across the series-connected transistors to remain equal over the entire signal cycle.

The emitters of Q17 and Q18 are connected to the output buss through relatively large (0.39 ohm) emitter degeneration resistors that are paralleled by Shottky rectifiers. This assures good thermal stability of the output transistors with minimum drop at high current due to the low foward drop of the paralleling rectifiers. Turn-on thumps are eliminated in this design by causing the emitter currents, and hence the subsequent stage currents, of the input pairs to be zero at turn-on and then to slowly come up to the operating value. This is accomplished by the action of the voltage regulator consisting of Q5, D5, C9, and R18. Upon turn-on, C9 is uncharged and current flow from R19 through R18 down to R20 turns on Q5 causing its collector-to-emitter voltage to be about 0.7 Vg and at about ground potential. As C9 charges slowly, due to the time-constant multiplication effect of Q5, the collector-to-emitter voltage of Q5 increases to its ultimate value of about 52 V when D5 conducts. When this point is reached, the collector will be +26 V and the emitter will be at -26 V, supplying about 3.3 mA to each differential pair. When D5 is in conduction, the voltage drop across the regulator will be constant with changes in line voltage and therefore the emitter currents of the input differential amps will remain constant. A cute circuit trick!

The protection circuit is of the volt-amp (VI) type, sensing both current and voltage in the output stage. If voltage and/or current are considered excessive, Q10 or Q11 will conduct, reducing the current in Q7 or Q9 and hence the output drive. This action of reducing the current in the predrivers is unusual and desirable, and is in contrast to the usual practice of shunting the drive current from predrivers through the protection devices into the output buss.

The power transformer is appropriately large and beefy and has unusually good voltage regulation. Filter capacitors are two 16,800 μF units. Output voltage at idle is about $\pm$ 75 V d.c.

Listening Tests

This reviewer has spent a lot of time listening to Ampzilla, having had one for several months. Speakers have included the reviewer's own arrays, Dalhquist DQ-10s, and Magnepan MG-2167Fs. The conclusion is inescapable. Ampzilla is the best sounding commercially available bipolar solid-state amplifier heard so far. The low end is incredibly tight and solid, the mid range clean and defined, and the high end is light, airy and virtually free of edginess and grit. When listening in comparison to other good solid-state amplifiers, there is a feeling that their sound isn't as transparent and that an amplifier per se is more identifiably in the reproducing chain.

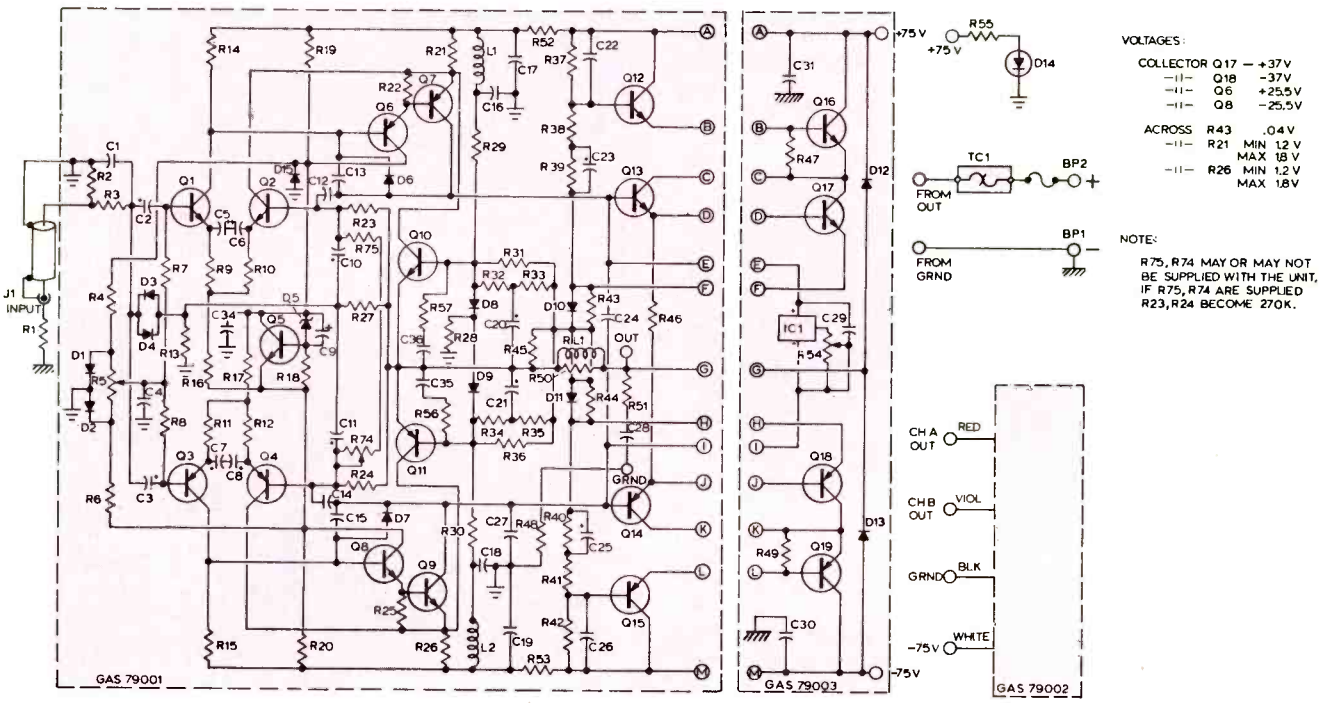

Fig. 3—Circuit schematic.

Measurements

Ampzilla was first run for one hour at one third power, or 67 watts per channel, with a continuous 1 kHz test tone. It passed this test easily getting only moderately warm. Voltage gain was measured and found to be 24X or 27.6 dB in both channels. The input voltage for 200 watts into eight ohms is therefore 40/24 or 1.67 V.

Harmonic distortion at 1 kHz and IM distortion as a function of output power are shown in Fig. 4. Total IM distortion and especially the sum of 5th and 7th harmonics are exceptionally low in this unit. There is no measurable crossover type nonlinearity at low levels (power levels from 1-100 mW). Harmonic distortion vs. frequency and power and one-watt frequency response are plotted in Fig. 5. The aberration in THD near 120 Hz is caused by a beat between the signal frequency and 120 Hz power supply ripple. As has been mentioned in previous reviews on the Dyna 400 and SAE III CM, which also exhibit this phenomena, it is doubtful that this effect is audible.

Scope pictures of amplifier response to various test signals and loads are shown in Figs. 6 to 9. Fig. 6 is for a 50-Hz square wave into eight ohms for a low power and for full power. The lack of tilt in these waveforms is exceptional even though the amp is a.c. coupled at the input and feedback bases. However, the time constants are very long, being equivalent to a cutoff frequency in the region of 0.01-0.02 Hz. Fig. 7 is

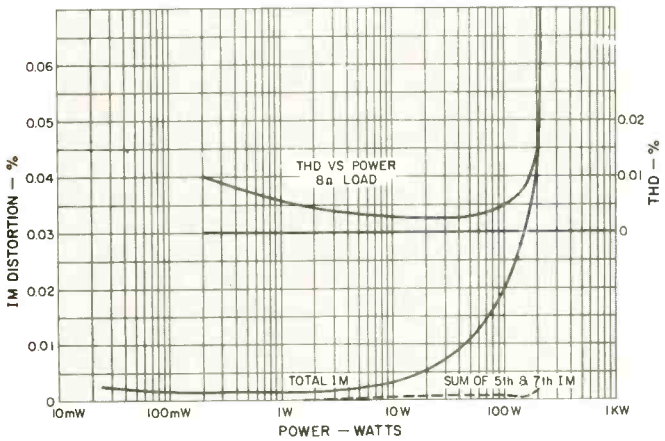

Fig. 4—Upper curve, THD versus power into 8-ohm load (use right-hand scale); lower curve, total IM and sum of 5th & 7th versus power into 8-ohm load (use left-hand scale).

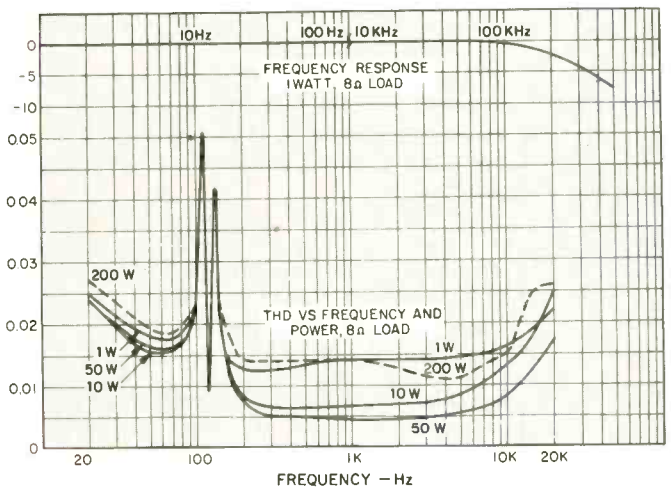

Fig. 5—Upper curve, 1-watt frequency response into 8-ohm load, note break in curve at 100 Hz to 10 kHz; lower curves, THD versus frequency at various power levels into 8-ohm load.

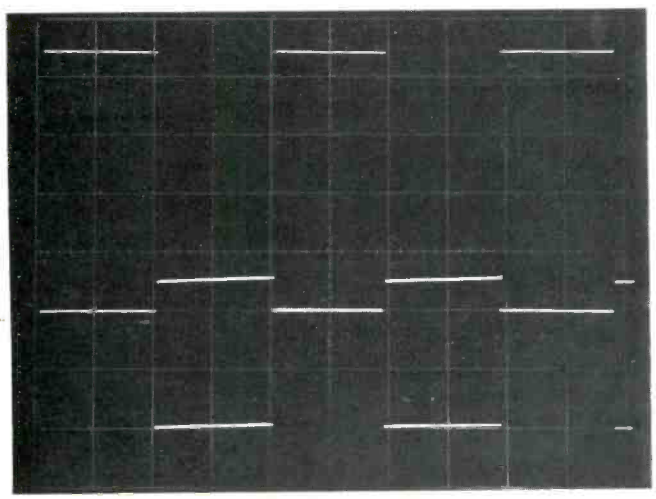

Fig. 6—50-Hz square waves; upper trace, 200 watts into 8 ohms (scale 20 V/cm, 5 mS/cm); lower trace, 3.12 watts into 8 ohms (scale 5 V/cm, 5 mS/cm).

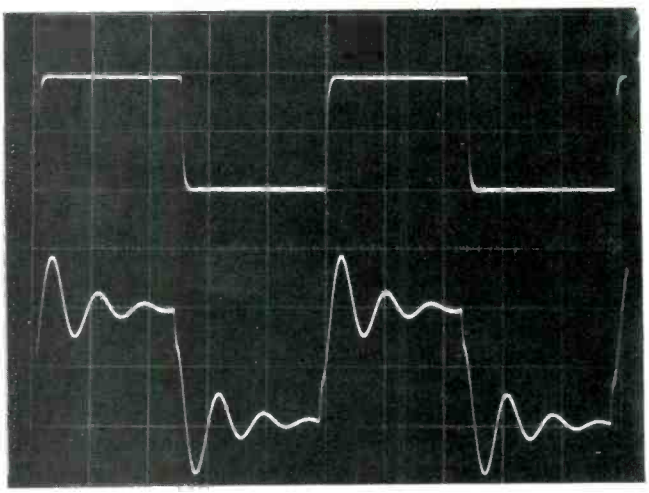

Fig. 7—10-kHz square waves; upper trace, low power into 8 ohms (scale 5 V/cm, 20 μS/cm); lower trace, low power into 2 μF (scale 5 V/cm, 20 μS/cm).

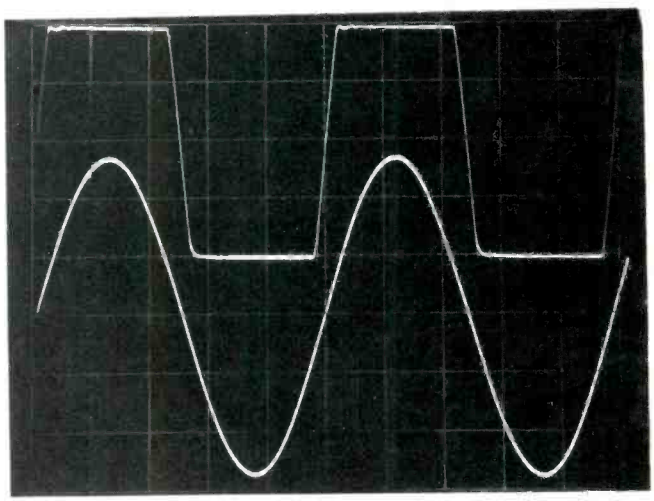

Fig. 8—Upper trace, 20-kHz full-power square wave into 8 ohms, 80 V P-P note text (scale 20 V/cm, 10 μS/cm); lower trace, 20-kHz sine wave, 200 VA into 1 μF, 40 V rms, THD 0.25% (scale 10 μS/cm).

for 10 kHz square waves at low power into eight ohms and 2 μF loads. These responses are typical of most amplifiers that have been reviewed. Fig. 8 illustrates the response with a full-power 20kHz square wave into eight ohms and a 200 VA 20 kHz sine wave into a 1 μF load. (The slight ringing on the +½ cycle is mostly due to a slight aberration on the output of the pulse generator used.) The measured rise time for the square wave is about 3.2 μS and the slew rate is about 20 V/μS. THD for the 200 VA sine wave is about 0.25%.

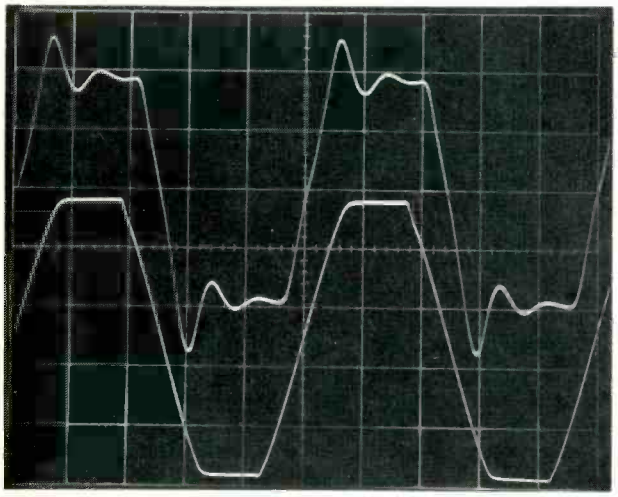

Fig. 9—Upper trace, 20-kHz, 80 V P-P square wave into 1 μF load (scale 20 V/cm, 10 μS/cm); lower trace, 20-kHz sine wave into 8 ohms with 2 dB overdrive (scale 50 V/cm, 10 μS/cm).

Table I—Output noise

Bandwidth, Hz	Left, μV	Right, μV
20 to 20K	325	217
400 to 20K	60	36

Fig. 9 shows the response to a 20-kHz 80 V p-p square wave into a 1 μF load and a 20-kHz sine wave into eight ohms with a 2 dB input overdrive where the input is increased 2 dB over the value that just causes the output to begin to clip. The large signal square wave indicates the amplifier's ability to deliver in excess of 10 amps into a 1 μF load. This qualifies it as a third amplifier in this reviewer's experience that can deliver such a fast large signal into a capacitive load. The response to the 20-kHz overdrive signal is outstanding. Virtually every other solid-state amplifier "sticks" on high frequency clipping. ["Sticking" is where the squared-off portion, when clipping, lasts longer than it should and then suddenly jumps toward zero vertically or very quickly and then finally gets back into the sine wave slope after recovery from clipping.] It is believed that how a power amp clips at high frequencies has some effect on how the amplifier sounds when not clipping. Amps that clip cleanly and don't stick generally do sound better, all other standard measurements being about the same. Damping factor was measured as a function of frequency and found to be about 160 from 20-300 Hz, decreasing smoothly to about 154 at 1 kHz, and 28 at 20 kHz.

Output noise as a function of measurement band-width with inputs shorted is shown in Table 1 below. The highest noise voltage in the 20 to 20 kHz band is about 102 dB below 200 watts into eight ohms and is composed mainly of lower order line harmonics.

In summary, Ampzilla is unquestionably in the state-of-the-art class and takes its place among a small group of fine amplifiers that really do make reproduced music sound more like live music. *Bascom H. King.*

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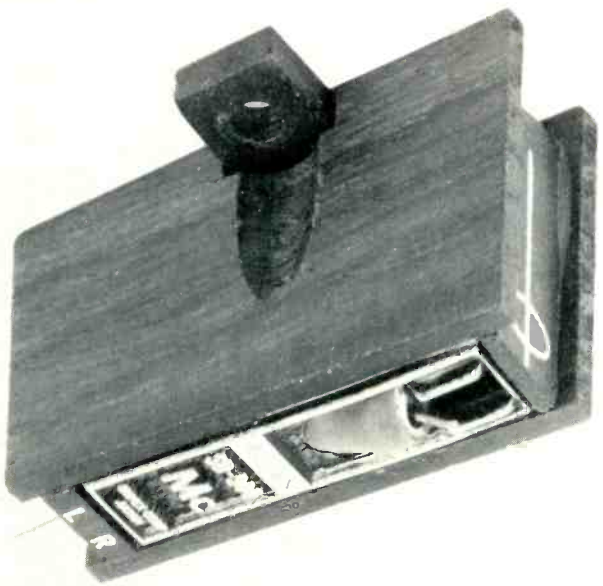
Supex SD-900/E Moving-Coil Phono Cartridge



MANUFACTURER'S SPECIFICATIONS

Frequency Response: 5 Hz to 40 kHz ±1.5 dB. **Output Voltage:** 0.2 mV. **Channel Balance:** ±0.5 dB. **Channel Separation:** Better than 27 dB. **Impedance:** 3.5 ohms. **Compliance:** 18×10^{-6} cm/dyne. **Tracking Angle:** 20 degrees. **Stylus Force:** 1 to 1.5 grams. **Stylus:** 0.3 x 0.8 mil elliptical diamond. **Weight:** 10 grams. **Price:** $125.00.

Although the principle of the moving-coil cartridge has been known for a long time, about the only cartridge of this type marketed in recent times is the Ortofon. Another such pickup that has recently become quite popular with audio enthusiasts is the Supex SD-900/E. This cartridge is manufactured in Japan and distributed in this country by Sumiko, Inc.

Like all moving-coil cartridges, the SD-900/E's output voltage is very low. Most moving-coil cartridges rarely exceed an output voltage of about 70 *microvolts*, thus making them prone to hum and noise problems. The Supex SD-900/E has an output voltage about three times greater than previous moving-coil cartridges, 200 *microvolts*. This increased output voltage reduces the possibility of hum and noise problems. However, an output voltage in microvolts requires the use of either a special cartridge transformer or preamplifier ("head amp"). Our experience indicates that the Supex SD-900/E should be used with a cartridge preamplifier, such as the Mark Levinson JC-1, the output of which is fed to the usual phono cartridge input of an audio system. The JC-1 is an inverting cartridge preamplifier, requiring that the plus and minus leads of the Supex be reversed at the cartridge on each side, i.e., the hot and ground leads be reversed on the left side and similarly on the right side.

The manufacturer recommends this cartridge for CD-4 use despite the fact that the stylus is a nude biradial diamond (0.3 x 0.8 mil). Interestingly, the Supex SD-900/E

scored very high on all the strict parameters used in testing stereo and discrete (CD-4 and UD-4) cartridges with an optimum tracking force of 1.5 grams and 2 grams for anti-skating. However, because of the lack of a Shibata or Shibata-like stylus, which engages a greater area of the record groove wall, we cannot unreservedly recommend it for general use in discrete CD-4 or UD-4 quadraphonic playback, because of the possibility of wiping the carrier off the groove wall.

The Supex SD-900/E is, however, one of the finest stereo cartridges we have ever tested. Sonic clarity is superb with good definition, particularly in the bass. Transient response and applause definition is excellent.

Measurements

As is our practice, measurements were made on both channels, but only the left is reported. During the test period, the temperature was 70° F ± 1° and the relative humidity 52% ± 2%. The following adjustment and test records were used in making the measurements: JVC 4DE-205; WEA PR186; Shure TTR-107, TTR-103, TTR-110; Columbia STR-100, STR-111; JVC TRS-1004, TRS-1005; Stereo Review SR-12; B & K QR-2009; Deutsches Hi-Fi No. 2; Panasonic SPR-111; Denon ST-5003 (UD-4); Ovation OVQS/4000 (QS); Columbia SQT-1100 (SQ), and AEL 100,101. Both the square wave test (photograph) and the 4:1 intermodulation distortion tests reported in this cartridge profile were made using the *new* CBS Laboratories Professional Test Record STR 112, which was released in May 1975 and replaces the now obsolete STR 111. The STR 112 is one of a series of nine updated professional test records recently released by CBS Laboratories. These should prove invaluable in testing the various parameters of audio systems.

Frequency response was flat within ±2 dB from 20 Hz to 10 kHz, + 3 dB at 13 kHz, + 2 dB at 20 kHz, + 1 dB at 30 kHz, 0 dB at 40 kHz and -4 dB at about 48 kHz. Separation is better than 27 dB to 8 kHz and then diminishes to 23 dB at 10 kHz, 15 dB at 20 kHz, 13 dB at 30 kHz, 4 dB at 40 kHz, and 0 dB at about 43 kHz. Channel balance was remarkable, being within 0.3 dB, and trackability is good. A good CD-4 cartridge should produce more than 0.7 mv at 30 kHz from the JVC-1004 test record, where the 30 kHz monophonic signal is recorded at the 5.5-in. diameter of the test record with a peak velocity amplitude of 5 cm/sec. The Supex output voltage at 30 kHz was 1.5 mv. On a test record designed by this reviewer (AEL-100), which contains tracking velocities from 7 cm/sec to 70 cm/sec at 1 kHz, lateral cut, peak velocity, the Supex tracked 30 cm/sec with no difficulty. Signal output *without* the JC-1 Levinson cartridge preamplifier was 53 μv/1-cm/sec and with the JC-1, it was 1.2 mv/1-cm/sec.

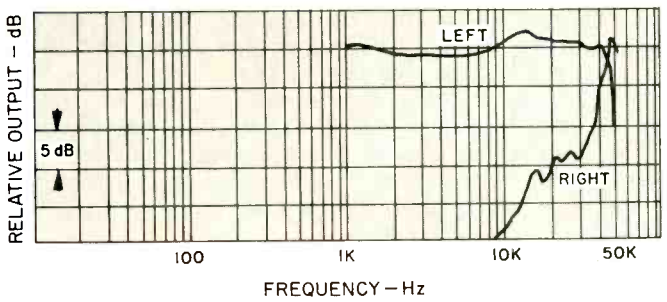


Fig. 1—Frequency response and separation of the Supex SD-900/E using JVC's TRS-1005 test record.

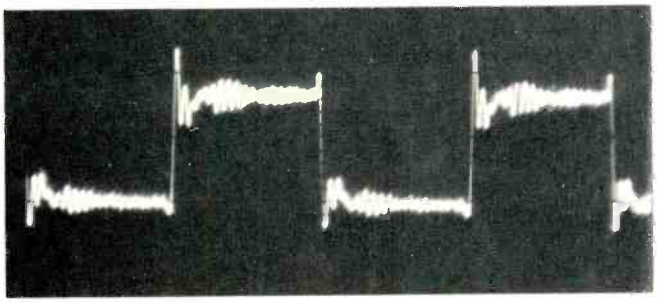


Fig. 2—1-kHz square-wave response of the Supex SD-900/E using CBS Lab's STR-112 test record.

Wt. 9.53 g.; d.c. res., 3.2 ohms; Inductance, 91 μH; Opt. tracking force, 1.5 g.; Anti-skating, 2 g.; Output, 53 μV/1-cm/sec. without the JC-1 cartridge preamp and 1.2 mV/1-cm/sec with the JC-1; IM dist. (4:1) +9 dB lat., 200/4000: 5.6%, + 6 dB vert., 200/4000: 3.0%; Crosstalk, -27 dB; Ch. Bal., 0.3 dB; Trackability: High Freq. (10.8 pulsed) 30 cm/sec.; Mid-Freq. (1000 + 1500 Hz lat. cut) 25 cm/sec; Low Freq. (400 + 4000 Hz lat. cut) 19 cm/sec; 30 kHz mono signal 1.5 mV. Passed all bands of the Shure Audio Obstacle Course Era III test record except for the 5th level of the violin where it just starts to mistrack. Cartridge-arm resonance was less than 10 Hz.

Listening Tests

The Supex SD-900/E cartridge was used with the following demodulators in the listening evaluation: Technics SH-400, Panasonic SE-405, JVC 4DD-5, and Harman/Kardon +44. Separation and 30-kHz carrier signal adjustments (where required) were easily accomplished, though with the Technics SH-400 demodulator, a little extra care was necessary to make certain that the cartridge was properly "locked-in." The Denon (Nippon Columbia) UDA-100 (UD-4) demodulator was also tried, and separation was accomplished in both the UD-4 and CD-4 positions without difficulty. The SQ and QS decoders used were the Lafayette SQ-W and Sansui X-2, respectively, as well as the SQ and QS positions on the Denon UDA-100.

The speakers used in this evaluation were the efficient Cerwin-Vega 211-Rs in the front and the R-26s in the rear. Additional speakers used were four relatively less efficient Micro-Acoustics FRM-1s, and most of the listening evaluation was performed with them. A new, very efficient subwoofer from Janis Audio Associates, 2889 Roebling Ave., Bronx, N.Y. 10461, was used in combination with the Crown VFX-2 crossover network and the Model 207-A Tiger .01 amp from Southwest Technical Products to drive the subwoofer below 100 Hz. Since bass frequencies below 100 Hz are essentially non-directional, only one subwoofer was used in a common mode configuration, which required a summing network added to the Crown VFX-2 crossover network for the speakers serving the stereo or the front quadraphonic pair. Two Phase Linear 4000 preamplifiers and a pair of Crown D-150 amplifiers drove the main speakers. The turntable was the Technics SP-10 with the Audio-technica AT-1009 tone arm installed on the turntable base.

A rigorous listening evaluation of the Supex SD-900/E was made in both the stereo and quadraphonic modes, using all the CD-4 records listed in our report published in *Audio*, March, 1974, p. 39, plus the following additional new records, which demonstrate the capabilities of this cartridge.

Stereo

Organ Music from Westminster—ARK 10251
Choral Music from Westminster—ARK 2123
Lemmens•Vierne•Dupré•Widor—Advent 5009
The Sound of Musical Instruments—ENY/AR-1

SQ

E. Power Biggs: Bach *The Four "Great" Toccatas and Fugues*—Columbia MQ 32933

Quadraphonic Gala—Columbia ASQ-109

QS

Tchaikovsky: *1812 Overture* and *Romeo and Juliet*—Turnabout QTV-S 34554

Gershwin: *All the Works for Orchestra & for Piano & Orchestra*—Vox QSVBX 5 132 (3 records)

UD-4

Bach: *Concertos Brandebourgeois*—Nippon Columbia 40X-9001-N

Pop Pop/4 Dimensions—Nippon Columbia 4KX-9007

A word of explanation about these records is necessary since many of them are not generally available at record stores. Both of the ARK stereo records contain excellent organ music, where the lowest bass pedal note recorded is 27.5 Hz (as measured with a General Radio Spectrum Analyzer). The record is available from Fulton Electronics, 4428 Zane Avenue N., Minneapolis, Minnesota 55422. The Advent record runs the gamut of classical organ music, with some fantastic bass pedal notes, the lowest recorded note being 23 Hz. Surface noise is non-existent on this record, which is available from Century-Advent, 878 Clarence Road, Cleveland, Ohio 44121. The ENY/AR-1 record is a superb recording demonstrating specific musical instruments that the Supex cartridge reproduced with great definition. Surface noise is non-existent on this record. The record is available for $5.00 from Acoustic Research, Inc., 10 American Drive, Norwood, Mass. 02062. *The Quadraphonic Gala* disc is not generally available, and was produced by Columbia Records for the Audio Engineering Society European meeting held in London earlier this year as a showcase sampler of SQ quadraphonic performances by leading recording artists of the world. The QS discs listed are excellent records, particularly the piano renditions, with which to demonstrate the transient response of the Supex cartridge. Since the UD-4 quadraphonic system has not yet been introduced in this country, the Nippon Columbia records are not easily available. Both of these recordings show the Supex cartridge to be capable of reproducing *any* recorded sound—stereo or quadraphonic!

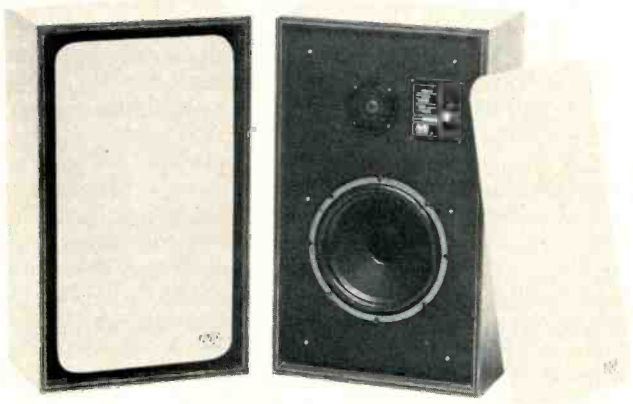
For those who have the Phase Linear 4000 preamplifier, the organ and the symphonic recordings are even more spectacular when the correlator, peak unlimiter, and downward expander (with the unlimit threshold properly adjusted), are in use. The Supex cartridge, in conjunction with the Phase Linear 4000 preamplifier, reproduces the bass spectrum on these records in an exceptionally clear and clean manner.

After listening to the records listed above, plus many others, as played with the Supex SD-900/E cartridge, we believe this cartridge is one of the finest stereo cartridges available today. Certainly the performance of the Supex SD-900/E is evidence why many audiophiles prefer the moving-coil principle.

B.V. Pisha

Circle No. 72 on Reader Service Card

Avid Model 102 Speaker System



MANUFACTURER'S SPECIFICATIONS

Drivers: 1-in. dome tweeter, 10-in. high-compliance woofer. **Nominal Impedance:** 8 ohms. **Power-Handling Capacity:** 100 watts. **Frequency Response:** 35 Hz to 18 kHz ±5 dB. **Crossover Frequency:** 2200 Hz. **Control:** Three-position, high-frequency level switch. **Dimensions:** 25 in. H. x 15 in. W. x 9-5/8 in. D. **Weight:** 36 lbs. **Price:** $130.00.

The Model 102 speaker from the Avid Corp. is a two-way, air-suspension system using a one-in. dome tweeter and a 10-in. high-compliance woofer. The sides of the enclosure are finished in simulated-walnut vinyl. The dominating physical feature is the grille, which is interesting in that the user can not only change it but can select his own design. This feature alone could sell the system to many people.

The grille is a double-knit stretch fabric cut into a rectangle slightly larger than the front surface of the enclosure. The fabric is wrapped over and attached to a press-board frame, which is then snapped into the front of the enclosure. A groove in the back of the press board is used to hold the cloth by pressing the fabric into a slot with a spline.

The standard grille cloth is a dark brown, and replacement cloths are available in several other colors at $3.95 per pair. It should be noted that if one attempts to use some other piece of cloth for the grille, the original grille cloth should NOT be used as a pattern to cut the new cloth. This is because the knit fabric has been stretched during installation for a snug fit, and then trimmed close to the securing spline. If you remove the original cloth from the grille, it might be best to get a partner to help you reinstall it, since getting a good, wrinkle-free surface can be tricky, particularly if one doesn't have experience or tools for working with splines. A changeable grille cloth is a nice feature, but allow yourself a little time to do a proper job.

A three-position tweeter-level control is available behind the removable grille. This is a slotted-shaft control that can be moved easily with a coin or screwdriver. Maximum clockwise position is minimum tweeter level. As the control is well labeled, this should not cause any confusion.

A tweeter-protecting fuse is mounted in a holder immediately above the level control. Electrical connection to the speaker is made to push-type connectors in a recessed cavity on the rear of the enclosure. The terminals are well marked and color coded.

Avid supplies a very complete instruction manual and is to be congratulated on providing intelligent and readable instructions. The speaker is covered by a five-year warranty, which is transferable to later owners.

Technical Measurements

The plot of impedance versus frequency is shown in Fig. 1. The impedance is virtually unchanged for all settings of the level control. The minimum value is low enough that paral-

lel operation is not recommended. The characteristic of this impedance curve suggests a well-designed sealed enclosure with a 50-Hz low-frequency cutoff.

The anechoic sound pressure level at one meter for one-watt drive is shown in Fig. 2. Except for a minor peak at 450 Hz, this measurement is almost exactly what Avid claims it to be in their printed operating instructions which accompany the unit. If Avid doesn't watch out, they may be cited for unwarranted honesty in specification.

Efficiency is moderate for a bookshelf system, as the Model 102 produces 85 dB SPL for one-watt average power throughout most of the usable audio range. The bottom end starts to roll off below 55 Hz and does so in a well-behaved fashion. Some mild peaks appear in the upper midrange.

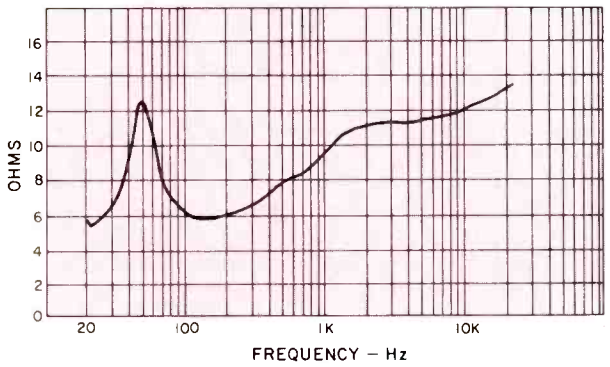


Fig. 1 — Impedance.

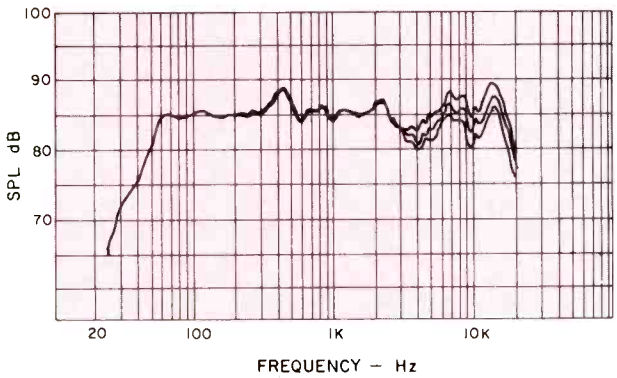


Fig. 2 — Anechoic frequency response for the three positions of the balance control.

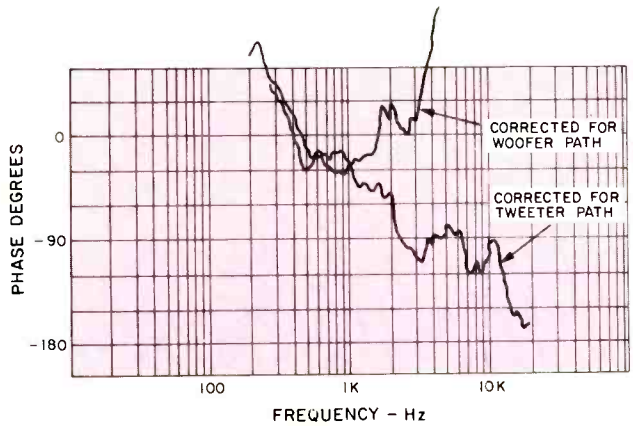


Fig. 3 — One-meter anechoic phase response.

Acoustic crossover very clearly starts at around 3 kHz, and small sibilant-emphasizing peaks are evident in the 7-to-9-kHz range and again at 14 kHz. Response, even for moderate off-axis angles, holds up well past 15 kHz. The three balance positions only affect the range above 3 kHz, and the difference between settings is very small. All in all, the response is very good for a speaker in his price range.

Figure 3 shows the phase response measured one meter directly on axis. Phase breaks occur at 500 Hz and at the 3-kHz crossover point. Because of the difference in acoustic position of the woofer and tweeter, the phase measurement is shown twice, once corrected for woofer air path and the other for tweeter air path. This speaker has non-minimum phase characteristics at 500 Hz and 3 kHz.

The three-meter room response, shown in Fig. 4, is a more direct measure of how the Avid 102 might sound in a typical listening situation. The speaker was placed against a wall and one meter above the floor. The measurement position is three meters away and also one meter above the floor. The first 10 milliseconds of "early" sound are measured and plotted for positions directly in front and 30 degrees off the center of the speaker. The plots of Fig. 4 are displaced 10 dB for clarity. The response holds up very well to 20 kHz for all

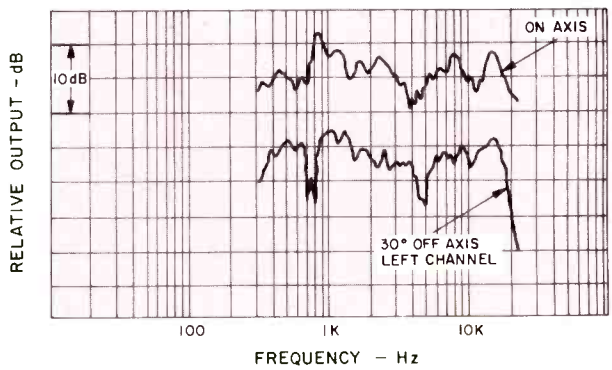


Fig. 4 — Three-meter room response.

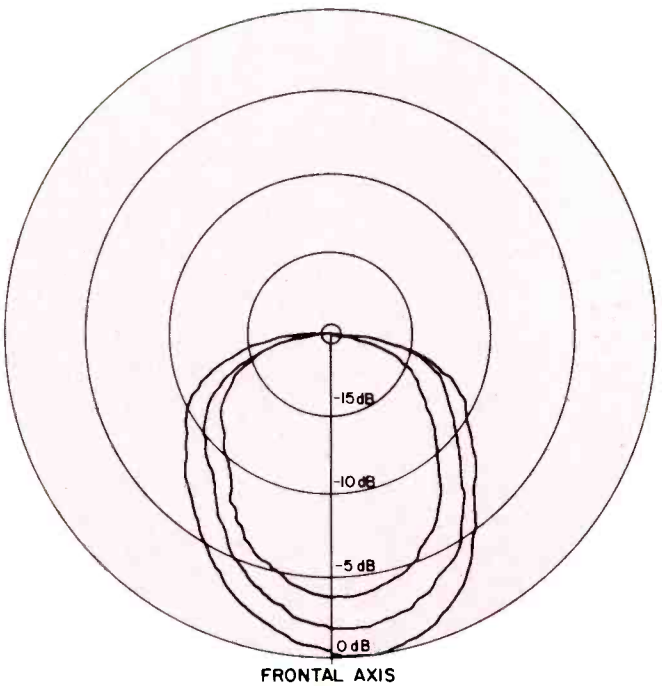


Fig. 5 — Horizontal polar response.

normal listening positions. Since this curve was taken in the centermost of the three response-control settings, the sound is moderately strong in the upper frequencies. There is a dip in the stereo position, centered around 5 kHz, with a smaller peak in the 14 kHz region. While this extended response should be good with most program material, there are a few phono cartridges and records with high distortion levels in the upper frequencies that will show up clearly, and perhaps unpleasantly, with the 102. This situation, however, can be helped by lowering he high frequency tone control. This occurs because of the extreme top-end response of the speaker and the minor peaks which are almost periodic on a logarithmic frequency basis and thus might emphasize higher order harmonics of an already distorting program. This characteristic will also tend to emphasize record background noise to some extent.

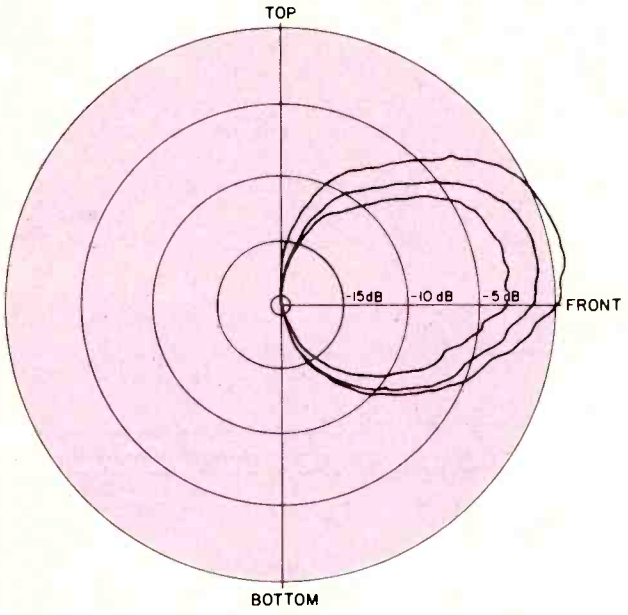


Fig. 6 — Vertical polar response.

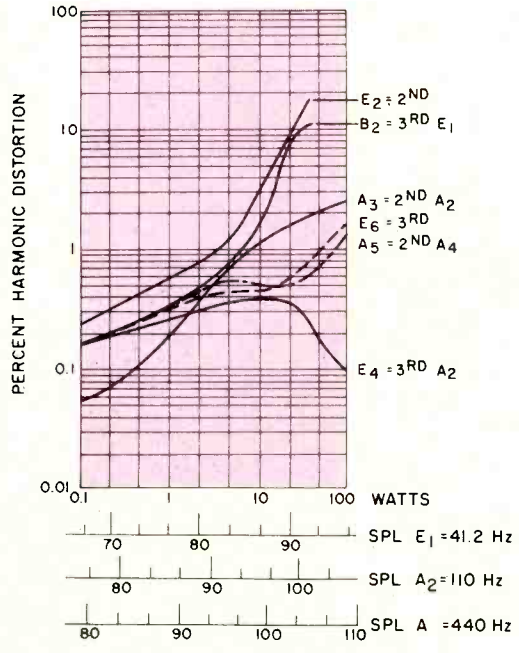


Fig. 7 — Harmonic distortion for musical tones E1 or 41 Hz, A2 or 110 Hz, and A4 or 440 Hz.

Figure 5 is the polar response for all components from 20 Hz to 20 kHz and is a view looking down on the top of the speaker when mounted as Avid recommends. Plots are included for each of the three equalizer positions. The difference in energy between the control settings is approximately 2 dB. According to this plot, a left-channel-stereo speaker position will be slightly stronger than the right-channel position if the speakers were rotated toward the listening area. Since the polar response becomes equal for angles greater than about 30 degrees, these speakers should be mounted flat against a wall for best stereo imagery.

Figure 6 is the vertical polar response. These speakers should be mounted at or below normal listening level for best sound, because a large ceiling reflection can be expected due to the high launch angle of the sound, as can be seen in the chart.

Harmonic distortion for the musical tones of E1 (41 Hz), A2 (110 Hz), and A4 (440 Hz) is shown in Fig. 7. The distortion is very low at moderate and low listening levels. The lowest register runs out of steam at levels in excess of 20 watts average. Midbass and upper frequencies can be handled up to 100 watts with no difficulty. An interesting property is the drop in third harmonic of A2, i.e. E4 (330 Hz), as well as the very shallow increase in all partials above B2.

Acoustic intermodulation of A4 by E1, or 440 Hz by 41 Hz, is plotted in Fig. 8. The major contribution to this distortion is phase modulation. The crescendo handling test was passed easily. The Model 102 can handle random peaks up to 300 watts without suppressing inner musical voices more than 1 dB.

The energy-time response of the Avid 102 is shown in Fig. 9. Since the 102's tweeter response is so excellent, a detailed explanation of this chart can be made to aid in understanding the energy-time measurement. What is shown in this chart is a plot of time on one scale, while on the other is the magnitude of the impulse response for a perfect signal containing only components from 20 Hz to 20 kHz. This plot is related to the impulse response in the same manner as the SPL measurement of Fig. 2 is related to the complete frequency response. The energy-time curve is computed from the one-meter anechoic frequency response and covers the time from just before receipt of the first sound to a period two mS after. The major contributor to this measurement is the tweeter, which handles a wider frequency range than does the woofer. The peak at 2.9 mS is the direct sound from the tweeter. The subsidiary peaks at around 3.1, 3.2, and 3.3 mS are reverberant signals due to scatter from the tweeter-

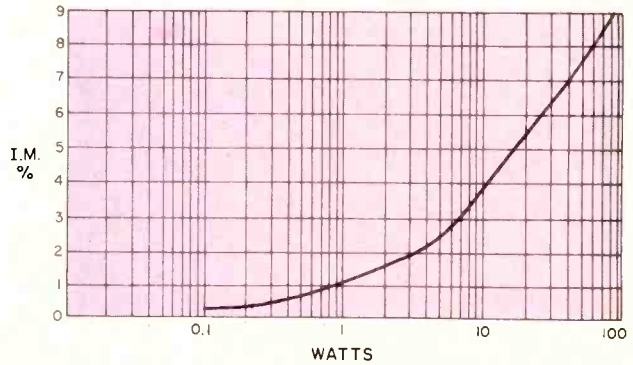


Fig. 8 — IM distortion of A4 or 440 Hz by E1 or 41 Hz mixed one to one.

mounting structure. The logarithmic decrease of these peaks, shown as a constant dB per time, is further indication of reverberation species. The broad irregular peak from 3.3 to 3.6 mS is diffraction from the physical loudspeaker enclosure. The peak of this diffraction occurs at 3.4 mS and is due to sound reradiating from the top edge of the enclosure. Tweeter sound scattering from the woofer surface discontinuity causes the irregular diffraction at 3.8 mS, and the energy at 4.3 mS is due to sound scattering from the bottom of the enclosure. Comparison of this data with the SPL data of Fig. 2 reveals that most of the response irregularities above 2 kHz are due to sound scattering from the enclosure and not due to tweeter problems.

The 10-dB difference between direct and first reverberant sound 0.1 mS later translates to about 3 dB frequency response irregularity at 10 kHz, which is consistent with measurement. Reverberant sound due to the speaker enclosure that is 14 dB down can give rise to 2 dB variations with a major influence at slightly above 2 kHz.

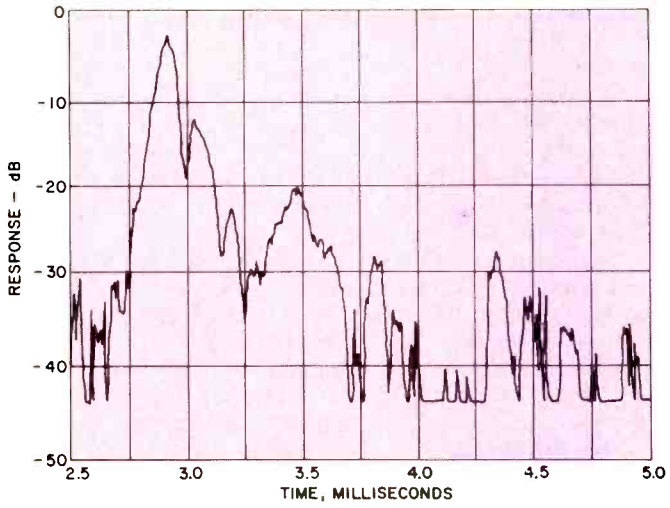


Fig. 9 — Energy-time response (see text).

Listening Test

The Avid speakers were mounted against a flat wall at ear level for the listening test. Spacing between speakers was around three meters.

The top end of the Avid 102 is quite good and appeared stronger than the midrange and bottom end, which are handled by the 10-in. woofer. In attempting to achieve the best balance of overall sound, this reviewer lowered the high frequency level both with tone controls and with the Avid's tweeter level control.

There was no boom to mar the performance of the bass end, though percussive bass, such as tom-tom and kick drum, seemed a bit thin. However, a mild bass boost with tone controls would probably bring the sound up to the standard of many listeners. The mid-bass seemed to have some mild peaks, a slightly "grainy" sound in a frequency range which can emphasize record scratches and ticks.

Stereo imagery is very good with no "wandering minstrels" caused by moving from one sitting position to another. Super brass (Lincoln Mayorga's Vol. III direct-transfer disc on Sheffield) had clear overtones but the fundamentals are not completely realistic. Vocals sound reasonably accurate if a bit distant, and massed choral groups come over well.

The Avid Model 102 puts out a lot of good sound for a rather modest price tag. As such, it can be recommended as a primary system for those on a modest budget. In addition, it can make an excellent preliminary investment for those wishing to go on to four-channel since the Model 102 with its good upper frequency characteristics can serve well in the important rear-channel positions. *Richard C. Heyser*

Circle No. 73 on Reader Service Card

Kenwood KP-5022 Turntable

MANUFACTURER'S SPECIFICATIONS

Speeds: 33 1/3 and 45 rpm. **Motor:** Direct-drive servo type. **Turntable:** 12-in. die-cast aluminum alloy. **Wow and Flutter:** Less than 0.05%. **Tracking Error:** ± 1.5 degrees. **Stylus Pressure:** 0 to 4 grams. **Dimensions:** 19 in. W. x 13 in. D. x 6 in. H. **Weight:** 19.8 lbs. **Price:** $319.95.

These days, the most expensive turntables almost invariably use some kind of servo-control system to keep the speed constant and relatively free from wow and flutter. The drive methods vary; one is to use a high-speed motor with a belt reduction drive, and another is to have a slow-speed motor directly connected to the turntable spindle. The Kenwood KP-5022 works on this latter principle, and the motor is a brushless type, servo-controlled by a switched amplifier to give speeds of 33 1/3 and 45 rpm. The unit has several novel features, and its specifications put it among the best half dozen turntables now available.

The baseplate is very solid looking, finished in dark brown which makes a nice contrast with the satin-aluminum knobs and other fittings. It is mounted on a low-profile wooden base finished in light walnut. The arm is tubular and is counterbalanced. It is tapered to an elliptical shape near the pivot, and the plug-in head is held by an ingenious clamping device. The cartridge is mounted on a slotted base which permits accurate tracking adjustment. All you have to do is to move the cartridge backwards or forwards until the stylus is immediately above a tiny indicator light on the baseplate, and that's it. Pressure is adjusted by rotating a collar just be-

hind the pivot after the counter-weight is adjusted so the arm balances. The collar is calibrated in grams from 0 to 4, and there is an anti-skating control with similar calibrations.

At the front of the unit on the left is a small raised panel on which is mounted a speed-change lever for 33 1/3 and 45 rpm together with a pair of neat thumb wheels that give a speed variation of plus and minus 3%. On the right hand side is a large push-button marked *Play/Cut* and a smaller one for *Repeat*. Behind that is a cue lever and then the anti-skating control. At the back is a slide-selector switch marked 30,25,17, and *Manual*. The figures are, of course, in centimeters, and refer to record sizes of 12, 10 and 7 inches, but whether we like it or not, we will soon have to get used to that metric system! The baseplate is spring mounted to the wooden base, which in turn has four spring-loaded feet—what Kenwood calls "insulators." Thus, there are two mechanical compliances in series to prevent acoustic feedback—a method I have long recommended. The time constants must be different for the scheme to be really effective, and I was pleased to note that this is the case with the 5022.

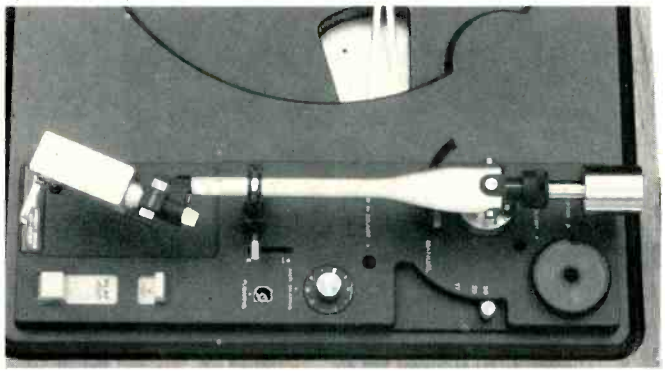
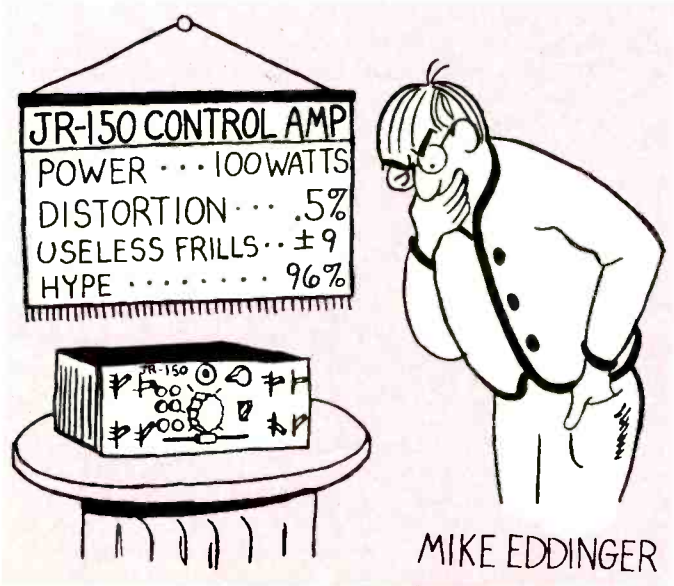


Fig. 1 — Close-up view from above, showing arm and operating controls.

The turntable weighs 3 lbs. 5 oz. and its metal parts are made from non-magnetic material. It has a heavy, ribbed rubber mat, and there are four strobe markings around the perimeter of the platter, two for 50 Hz and two for 60 Hz. A voltage selector is located underneath, and it is a simple matter to change the unit for operation on 200-240 volts. The dust cover is made of strong plastic about 3 millimeters (all right, 1/8 inch!) thick, and the hinges enable it to "stay put" in any position.



For automatic operation, the selector lever at the rear is set to the appropriate record size and then the *Play/Cut* button is actuated. At the end of the record, the arm returns to its rest position and the turntable comes to a stop. If you wish to stop playing the record before it is finished, you have to operate the *Play/Cut* control again; if you wanted to stop the playing for only a short period, you would use the cue or pause lever. The *Repeat* button needs no further explanation. Finally, if you want manual operation, the select lever must be turned to *Manual* in which mode the arm has to be moved by hand to the required position before operating the Play/Cut control. The arm will then descend to its playing position and at the end of the record the automatic return functions as before. Thus, manual operation would be used when it is desired to play only a part of a record.

Measurements

The first measurement was for wow and flutter, and the figure was 0.06% using the DIN 45-507 peak rating. The specifications quote a figure "less than 0.05%" which would correspond to a peak rating of about 0.08% W rms, so it would seem that Kenwood is rather conservative in its rating. The rumble figure was also better than the specified -58 dB as the measurement came out at -64 dB using the ARLL standard. Speed variation was approximately -4% to +3% on both ranges, and there was no change in speed when the line voltage was reduced to 90 or increased to 130 volts. Arm resonance, using an Audio-technica AT-20 phono cartridge, was 8 Hz, and both lateral and vertical friction were insignificant. Tracking error is given as 1.5 degrees, and measurements confirm that it was within the 0.5 degrees per inch common to well-designed offset arms. The automatic stop needed significantly less than 0.5 gram to operate, so high-compliance cartridges tracking at one gram or so can be used. The stylus-pressure control was found to be about 10% low above one gram, that is, a scale reading of 3 grams measured 3.3 grams. The connecting cables, which incidentally plug into standard phono plug sockets at the rear, are special low-capacity ones measuring less than 50 pF, so CD-4 cartridges will give optimum results. Ordinary cables have around 200 pF capacity, which would attenuate the CD-4 high frequency carrier, causing some disconcerting effects.

As mentioned earlier, an Audio-technica AT-20 phono cartridge was used for the tests—mostly with CD-4 records which are more critical as to tracking than are stereo discs. The cartridge was quite easy to line up—although I *did* remove the arm rest (it's held by a thumb-screw) so the stylus would come nearer the alignment-indicator light. Both the arm rest and the pivot column heights are adjustable, and the directions in the instruction book are easy to follow.

As with all turntables, it is essential that it be perfectly level, and here Kenwood helps you by providing adjustable feet. A turn to the left increases the height and a turn to the right decreases it. I find a small round level invaluable for this adjustment. It should be placed on the platter or mat and *not* on the baseplate. I found the controls easy to use, although cue lever operation was not so heavily-damped as I would like. The motor is extremely quiet, and the automatic stop operation was completely foolproof during the testing.

Summing up then, the Kenwood KP-5022 is a well-made, attractively-styled unit that should be considered by all who want a really good single-disc automatic turntable.

George W. Tillett

Circle No. 74 on Reader Service Card

Sony TC-755 Tape Deck

MANUFACTURER'S SPECIFICATIONS

Speeds: 3¾ and 7½ips. **Tracks:** 4, 2 channels. **Heads:** 3. **Motors:** 3. **Frequency Response:** 30 to 25,000 Hz ±3db at 7½, 30 to 10,000Hz ±3dB at 3¾ips. **S/N Ratio:** 56 dB. **Distortion:** 1.2%. **Bias Frequency:** 160kHz. **Wow & Flutter:** 0.07% and 0.1% DIN. **Headphones:** 8 ohms. **Dimensions:** 17 in. W. x 17¾ in. H. x 8¾ in. D. **Weight:** 53 lbs. **Price:** $699.00

If you ask somebody in the street, just anybody, to name a make of tape recorders today, chances are he'll immediately say "Sony." This is not surprising since Sony makes more tape recorders than anyone else and that mythical man in the street could be in America, Europe, Asia—almost anywhere in the world. Sony recorders range from inexpensive cassette portables to very expensive professional grade open-reel machines with logic control, sync sound, and all kinds of gadgets to please the enthusiast. The model reviewed here, the TC-755, is a sophisticated 4-track machine with logic control, provision for 10-in. reels, monitor heads, and many other interesting features.

Styling is similar to other Sony machines with a brushed satin aluminum panel making a nice contrast with the charcoal black head cover and VU meters. On the extreme left, at the bottom, are two microphone sockets, and just above is a three-position attenuator—an unusual but most useful feature. To the right are two pairs of concentric controls for microphone and line inputs, and above those are two *Record* buttons and two lever switches for *Tape Equalization* and *Bias Selection*. To the left of the head assembly are three small black switches, one for *Reel Size*, one for *Tape Speed* (3¾ and 7½ ips), and the third for *Pause*. This switch has an illuminated indicator as do the *Record* buttons. Under the head assembly is a timer switch and the two large VU meters, and to the right are four tape control buttons. Underneath those are separate tape *Monitor* switches for each channel, a dual-concentric line output control, the *Power* on/off switch and a *Headphone* socket. A digital counter is located between the tape reels. At the rear are the *Line In* and *Line Out* sockets plus a spare a.c. power outlet. The tape controls use a logic system and the merest touch is sufficient to operate them. That timer switch locks the machine in the *Record* mode so it can be switched on by an inexpensive commercial timer.

Fig. 1 — Head assembly, viewed from above, with cover removed.

Three motors are used, a servo-controlled capstan motor for the capstan drive, and two induction types for the reels. There are actually two capstans, and this dual drive is mainly responsible for the exceptionally low wow and flutter. NAB reel adaptors are supplied for 10-in. reels—as can be seen from the photograph.

Figure 3 shows the playback response with standard 7½ and 3¾ test tapes, and Fig. 4 shows the *Record/Play* response from Sony 180 SLH tape at 7½ ips. It will be seen that the 3 dB point is at an impressive 30 kHz with a gradual rise from about 5 kHz. Response at 3¾ ips is seen in Fig. 5, and here the 3 dB point is at 22 kHz—which would be considered quite remarkable for 7½ ips not that long ago! Headroom at the faster speed is better, of course, and tape saturation is not significant below 20 kHz at the higher speed, as compared with 12 kHz for 3¾ ips. Figure 6 shows the distortion at 1 kHz, and it will be noted that the 3% distortion figure is not reached until the meters read +7VU and it is well below 1% at 0 VU. Distortion versus frequency is shown in Fig. 7; note that the increase at both ends of the frequency range is very low indeed.

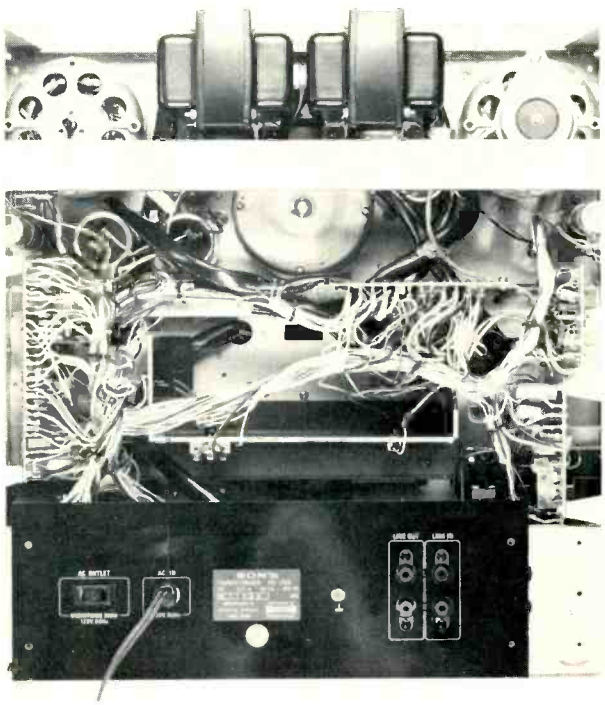


Fig. 2 — Rear view, with cover removed.

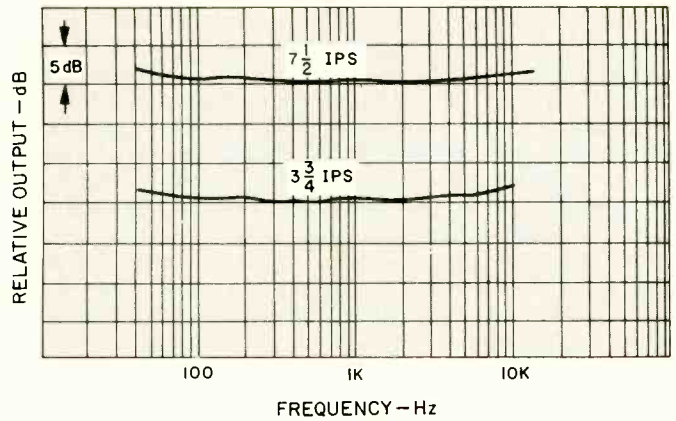


Fig. 3 — Playback response at 3¾ and 7½ips, using standard test tape.

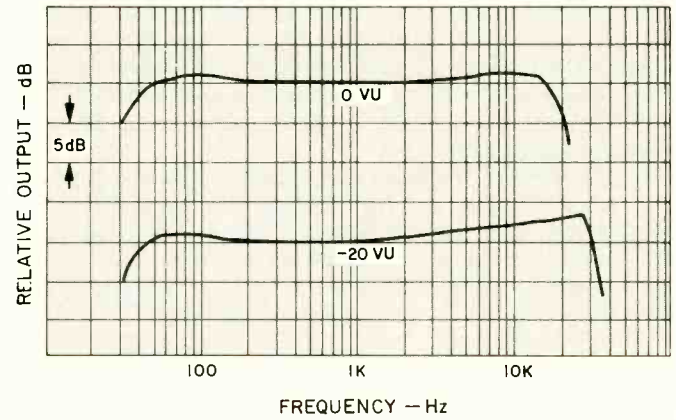


Fig. 4 — Record/Play response at 7½ ips with Sony SLH 180 tape.

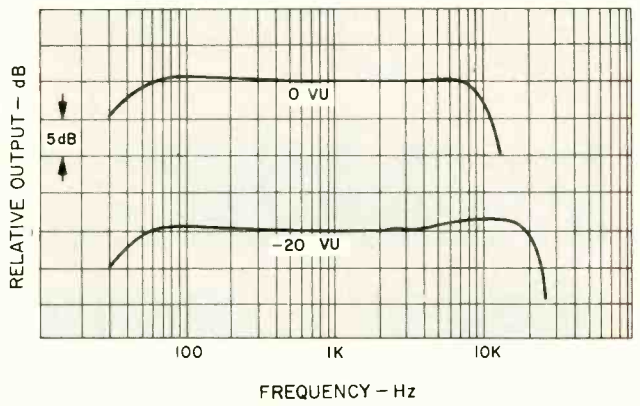


Fig. 5 — Record/Play response at 3¾ ips.

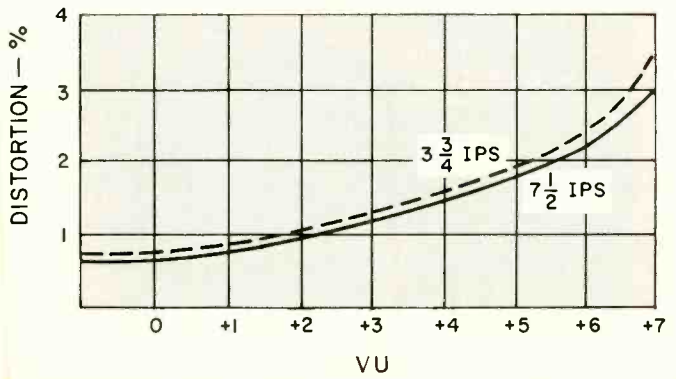


Fig. 6 — Distortion at 1 kHz.

Wow and flutter were the next measurements to be taken and they were among the lowest yet recorded (!) being less than 0.05% at 7½ ips and 0.08% at 3¾ ips using the DIN standard. The specifications give DIN figures of 0.07% and 0.10% which would seem rather conservative—but this is not surprising as makers of top-quality equipment rarely make extravagant claims. In fact, H.W. Hellyer's Law states, "the specifications of a recorder are inversely related to its cost." And thus you can find unbranded "orphan" recorders boasting performance figures better than studio machines costing fifty times as much! The next measurement of the 755 was S/N ratio, and the figures were 67 dB at 7½ips and 64.5 dB at 3¾ ips, referred to 0 VU using the standard A weighting. If the 3% figure is preferred, then both figures should be increased by 7 dB. The microphone input stage reduced the figures by 10 dB (A weighting). Input required for 0 VU was 55 mV for line and 180 microvolts for microphone with the attenuator switch at 0 dB. At this position, the overload point was 70 mV. The other two positions of the microphone attenuator switch gave cuts of 15 and 30 dB—more than adequate for dynamic microphones. Output, for 0 VU recording level, was 800 mV with the output level control at maximum. Amplifier gain was 5 dB, so in practice the output control would be turned down slightly so input and output signals could be compared by a flip of the tape monitor switch. Tape erase efficiency was checked last, and the average using three different tapes was 67 dB.

Listening Tests

Operation of the 755 is simplicity itself and those feather-touch logic control buttons make it completely foolproof. There is little danger of breaking the tape—even if the wrong button is pressed by mistake. The line and microphone mixing facility was found to be most useful, and several tapes were made with speech introductions fading into music taken from discs and FM broadcasts. The 3¾ ips speed is perfectly adequate for most purposes; after all, a response extending well above 20 kHz is better than most program sources! However, the faster speed is audibly superior with music having high transient content.

The instruction manual gives bias and equalizer settings for a number of different tapes and among those tested with good results were Maxell UD35-7VP, Capitol FDS-1800, Fuji FG-150-7H, and Scotch Classic. It was not found necessary to use the microphone attenuator but it would certainly prove an advantage when recording an enthusiastic high-decibel rock group for instance—or even for close miking. It's really surprising to see how high transient peaks are on a monitor 'scope!

The TC-755 is not cheap, at $699.00, but it is a well-engineered piece of equipment with fine performance. Not only that, it is beautifully-made, with first-class components, and should give many years of trouble-free service. What more could anyone want? *George W. Tillett*

Circle No. 75 on Reader Service Card

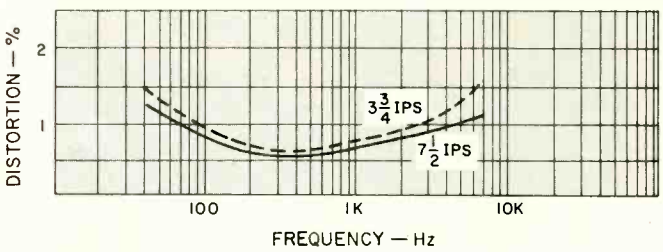


Fig. 7 — Distortion vs. frequency.

Canby's Capsules

Edward Tatnall Canby

Anthony Newman/Bach: The Well-Tempered Clavier Book 2. Organ, harpsichord, clavichord. **Columbia M2 32875,** 2 discs, stereo, $13.96.

When Newman first tried jumping—via tape edit—from organ to harpsichord and back in midstream, the effect jarred. Too sudden! But now he and the engineers have got the technique down, with a small (air) organ to match up to the big harpsichord and tiny clavichord. It works! And so a new genre is created, which never was before. Bach would roll in his grave. Maybe even with delight. You'll enjoy it too.

On the Pedal Harpsichord, E. Power Biggs. Scott Joplin Vol. No. Two. Columbia MQ 33205, SQ quadraphonic, $6.98.

Pardon the title—it's Columbia's. The company seems to lose its organists one by one to the outlandish pedal machine! So be it—E. Power Biggs plays Joplin marvelously, as tho born to it (in England). I'd put this ahead of at least 50 proper piano Joplin discs. E. Power, you've found your (latest) métier.

Catalan Music from Medieval & Renaissance Spain. Ars Musicae Ensemble, Barcelona. **Candide CE 31068,** stereo, $4.98.

I like the way these Spaniards do this typical "old" music, dozens of little works, with old instruments, bells, drums, plus solo voices. It's of the *Pro Musica* sort, now familiar in hundreds. These people, though, sing and play gently, thoughtfully and very musically. A pleasure after too many loud, harsh, noisy recordings. Most of us couldn't tell Catalan from Swedish in this period—who cares!

Brahms: Symphony No. 3; Variations on a Theme by Haydn. Vienna Philharmonic, Kertesz. **London CS 6837,** stereo, $6.98.

The ultimate tape edit! In 3 seconds, near end of this LP, the conductor dies and is buried, orchestra plays on, conductorless. You'd never know. (It was a tribute to him, edited onto incomplete earlier session.) A curiously bland Brahms, sweetly lyric but minus tension, and sometimes even uncertain. This generation no longer hears the Brahms architectural urgency, the trick, tension-making enharmonic key-changes.

Schubert: All the Works for Piano and Strings. Vox Box SVBX 600, 3 discs, stereo, $10.98.

Vox's budget boxes, the complete this and that, are a long and worthwhile tradition, often superb bargains. This one is mixed—two different American-recorded groups. The Trout Quintet, Eugene List at piano, is excellent. But the four works for piano trio are not good: poorly phrased, badly balanced, strident in sound.

Michael Tippett: Four Ritual Dances from "The Midsummer Marriage" (1952); Concerto for Orch. (1963). Orch. Royal Opera House, London Symph., Davis. **Philips 6580 093,** stereo, $7.98.
Tippett: Piano Sonatas 1, 2 and 3 (1938, 1962, 1973). Paul Crossley. **Philips 6500 534,** stereo, $7.98.

To my pleasure, I have just "discovered" Tippett, who looks 45 and has turned 70. An extrovert professional, lean, brawny, he writes tough, complex, independent music of enormous drive, yet astonishing clarity—it isn't forbidding at all. No fanciness, just layers of muscle; his later stuff, even more dissonant, is the easiest to absorb.
The big orchestral Concerto puts Bartok's similar work into near-shade; fantastic effects. The piano music, incredibly well played by Paul Crossley, does things you would not believe could be done with a straight piano (no John Cage stuff here). You might line Tippett up with our own Elliott Carter, though Tippett is the more flamboyant.

Americana for Solo Winds and String Orch. (Barlow, Rogers, Copland, Kennan, Keller, Hanson). Eastman Rochester Symph., Hanson. **ERA 1001,** mono, $5.98.

Goateed Howard Hanson dominated Rochester music for a long generation. For some, his influence was oppressive. This Hanson-directed series, once on Mercury mono, is revived by Eastman-Rochester—and here is Hanson all over again, the overbearing personality, the heavy, turgidly pro, late-Romantic compositions, the similar music by others of a now elderly generation. Even Copland *(Quiet City)* sounds heavy. Nice mono recording, but musically you can have it.

Ysaÿe: 6 Sonatas for Violin Solo, Op. 27. Ruggiero Ricci. **Candide, QCE 31085,** QS quadraphonic/stereo, $3.98.

A superb recording of unexpectedly fine music for unaccompanied violin, gorgeously played by one of our great (and not-enough "sung") virtuosos. Every fiddler should study him. Ysaÿe, also a virtuoso, wrote late-Romantic equivalents of the Bach solo violin works, like Paganini's technical tricks but warmly expressive and personal. A stunning disc! And good QS (or almost any matrix) for four speakers, too.

Canby's Capsules

Edward Tatnall Canby

Stravinsky: The Rite of Spring. Chicago Symphony Orch., Solti. **London CS 6885**, stereo, $6.98.

Wow—this is the finest **Rite (Sacre)** I have ever heard. No wonder they talk about Solti! Where others pound or plod out the savage old piece, Solti makes it music, which is something new. Sounds less modern this way—but shouldn't it?—the thing is already 62 years old. London's characteristic close-to sound in a big reverb is ideal for this huge orchestra—such sonic drama you'll jump a dozen times.

Beethoven: Piano Trio, Op. 1, No. 2; Clarinet Trio, Op. 11. Wilh. Kempff, H. Szeryng, Karl Lester, Pierre Fournier. **Deutsche Grammophon 2530 408**, stereo, $7.98.

A "million dollar" trio here, a la RCA (with alternative clarinet)—a group of top rank soloists. Does it work? Decidedly yes. The big-timers do Beethoven with consummate expertise and perfect mutual understanding, not a trace of superstar rivalry. The clarinet (side 2) is a bit thin, not quite up to the superstars on piano, violin, and cello, but he does plenty OK. Adds up to superb early Beethoven.

Schoenberg: Pelleas und Melisande (1903). Berlin Philharmonic, von Karajan. **Deutsche Grammophon 2530 485**, stereo, $7.98.

A youthful **Death & Transfiguration**, young Schoenberg on the Strauss track—but richer, warmer, more fanatic, less well organized for the ear—and monster-big and long. You'll love it if you like big Strauss (or big hi fi). (Also part of a 4-disc set, **New Vienna School**, with Berg, Webern & Co., if you want the larger picture.)

Zsigmondy Plays Bartok, Vol. 1. Klavier Patrician KS 535, stereo, $6.98.

Male chauvinism? This is actually the Zsigmondy Duo, wife on piano, husband violin; she gets no cover credit. Ask me, I'd say she is the powerhouse here. His playing of this 1920s-style Bartok isn't raw and gutsy enough for my taste but she really lights into the piano. Superb, and between them they carry it off beautifully. Some banding mixup on side 2—you figure it out, I can't.

Hilde Somer Plays Carl Czerny. (Sonata, Op. 1 No. 7; Fantasy and Vars. on Persiani's "Inez di Castro", op. 377.) **Genesis GS 1057**, stereo, $6.98.

Every piano student, 5 to 50, knows the little Czerny pieces, 150 years' worth of music lessons. But he did write bigger, lusher early-Romantic piano. Maybe too lush. The early Sonata here is like soft-margarine Beethoven, left out on the stove. It's from 1810 and foreshadows Mendelssohn, too. The later Variations—Opus 377!—(on an opera tune) are Paganini for the piano, super-brilliant but musically shallow, if nice. Hilde Somer dug these up in Vienna out of the dusty archives. Interesting.

The Golden Sound of Jean-Pierre Rampal. (Marcello, Krebs, Peputsch, Bach.) With M. Duschenes, fl.; K. Gilbert, hps.; Paris Festival Strings. **Orion ORS 73114**, stereo, $6.98.

Definitely golden! France's finest Baroque flutist (also anything-flutist) recorded in big, handsome liveness for a splendid sound. An attractive Baroque sonata (Marcello) then a giddy rococo bit (Krebs) and a semi-British item by the man who did up the famed **Beggar's Opera** (Peputsch). Also, a 2-flute Telemann duo, rich and thick. The final Bach (*G String*) with orch. is a mistake—out of a different recording session. It jars, sonically.

Delalande: Simphonies. Mouret: Fanfares; Simphonies. A. Scherbaum, trumpet; Orch. de Ch. Paul Kuentz. **D-G Archive 198 333**, stereo, $7.98.

Yes, you'll catch the *Masterpiece Theatre* theme in the Mouret, side 2, as per cover. Lots of trumpet, both sides, from famed Adolf Scherbaum; but this is hard, didactic playing, too self-consciously "musicological," and the Delalande music, for the *soupers* of Louis XIV and XV, is ultra-repetitive and musically dull—just a lot of fanfare. I'd call this one below the usual Archive standard.

Classical Reviews

Edward Tatnall Canby

Guillaume Dufay and His Times. Syntagma Musicum, Otten. **Telefunken 6.35257,** 2 discs, stereo, $13.96.
Music at the Time of the Crusades. Florilegium Musicum of Paris. **Vanguard Everyman SRV 317 SD,** stereo, $3.98.
Musica Iberia 11-1600. Studio der Frühen Musik (Early Music Quartet). **Telefünken Das Alte Werk 9620/21,** 2 discs, stereo, $13.96.

It is worth listing three of these, if only to show you how lavishly the music of the earliest written-down Western tradition is now being refurbished and reconstituted as living art and entertainment. Musicology, the scientific study of the remaining evidence of past music (not only decoding the cryptic written notes, but collating the visible music with thousands of written accounts of musical performance and history, plus indirect evidence such as music in paintings, existing old instruments preserved and so on . . .) — musicology is the basic key to the whole renewed art, and musicology is always advancing towards firmer and more precise ground. But musicologists generally are poor performers, being of a different sort of mind, just as librarians aren't very often great writers. By the same token, most performing types tend to make poor musicologists—they haven't the patience. Thus, it is only in recent years that all of this uncovering zeal has begun to lead to real *music*—to artistry, a product of performing technique as applied to known facts with both knowledge and feeling.

The human voice, alas, is the last frontier in this synthesis. We in America still generally assume that those big, rich tones which do so well for grand opera are good enough for any old music, especially the ancient stuff. Not so in Europe! The voice, too, is an ancient instrument and, as we ought to know, can be made to sound in all sorts of ways. The Syntagma Musicum group is in this respect ahead of them all. Incredible voices, which sing without vibrato, with enormous accuracy and brilliant tone color, to match the more familiar sounds of the old instruments. At last—the whole music is one, indivisible! About time. Here is a vast range of top-rank music, of an unthinkably early time for most music listeners, done with such conviction and knowledge that, at last, you will understand what anybody ought to realize—that people are people in *any* age, and new, living musical art is always going to be exciting and vital! Just hear the incredible countertenor, here, who sings Dufay like a veritable Mick Jagger, beginning of side 1. A stunningly good and *entertaining* album—for anybody with an ear.

You can try the Crusades inexpensively via Vanguard and the Florilegium Musicum of Paris—they have the right idea, that this 13th century music should have a vital, raw, intense, and almost savage sound, like the gargoyles on the French cathedrals. But their sound is on the harsh side, and the voices go the whole way (away from opera) towards an ugly, bawling noise which is too crude for such basically sophisticated sonic constructions. They are *not* crude! Just gutsy. Still—better this, enroute to the truth, than the American-type modern voice.

The Fruhen Musik people (Early Music Quartet) have been in the business a long time, and in that time have progressed from somewhat rough but convincing tones in their singing towards a far lovelier and more convincing sound that *must* be right —because it is (a) NOT modern-sounding, (b) blends perfectly with the instrumental sounds in the same music, and (c) is superbly accurate, lovely in tone, highly professional. Can anyone imagine the original singers were not all of this? Listen in particular to Andrea von Ramm, the Ms.

(Continued on page 77)

Advertising Index

(Continued from page 71)
of the Quartet. How she has developed, in some 15 years of this special sort of singing! The "Iberia" album covers a much wider chronology than the other two and the music is all of Spanish origin.

Claude Molénat—Trumpet/Organ/Rhythm. Vanguard Everyman SRV 319 SD, stereo, $3.98.

If you hear trumpet coming out of the cockpit of an Air France 707, it might be this guy. Not too likely, but he is, in fact, a 707 pilot though most likely does not play on duty. He also is one of those incredibly expert trumpeters who dazzle the trumpet fans both live and recorded in a fully fleshed second career—or first, if you wish.

Here we have an extension of a familiar principle of Baroque music, applied to a batch of typical Baroque works (Martini, Handel, Albinoni, et al.) arranged for his solo instrument. It says in the books that when you play the repeats, you're supposed to ornament them ad lib. So this fellow plays the first time straight Baroque, then dives into a jazz idiom for the repeat. Plucked bass and drums assist, plus an electric organ for the continuo (normally a harpsichord). Not exactly a new device, these days, but then France tends to be a decade or so behind in these matters. I found the music acceptable but not exactly startling. Beautifully played, and no two ways about that. The six-works, actually three sonatas, two concertos, and a toccata, sound pretty much alike under the Molénat treatment, as arranged for the same small instrumental group throughout.

Mozart: Die 4 Hornkonzerte. Concentus Musicus Wien, Harnoncourt; Hermann Baumann, natural horn. **Telefunken SAWT 9627,** stereo, $6.98.

Still further astonishing progress in the restoration of older musical instruments and the technique of playing them! This delightful disc of the ever-familiar Concertos for horn (three out of the four are familiar, anyhow) goes the limit. *All* the instruments are "authentic," dating from the late 1600s (violins) through 1800 (natural horn), including oboes, clarinet (1760) and a violone (instead of the usual string bass), the seldom-heard bass member of the violin family. But the real pay-off here is the extraordinary playing by Hermann Baumann of the solo horn parts, on 18th century instruments totally without valves (though they have "crooks" to change key). All the notes are produced by the mouth and lips plus a hand in the bell of the horn for the in-between tones that do not fit into the overtone series—the so-called stopped notes.

In earlier recordings—Beethoven horn music, for instance—the natural horn was not entirely satisfactory; the stopped notes were violently different in tone color from the natural overtone-series tones, to a degree that indicated to my ears, at least, a still existing deficiency in the lost and extremely difficult technique of playing the instrument. But here, the same stopped tones, still with a nasal quality, nevertheless are much better integrated with the open notes—as anybody could have guessed would be necessary before we could hear this music as Mozart's hornist played it. I would guess that in this recording, done with so much artistry in all the playing, we have 95 percent of the original Mozart sound, as it might have sounded in Vienna in the 1780s. I'd call it definitive.

The Column

Fred DeVan

Tonto's Expanding Head Band: Robert Margouleff & Malcom Cecil **Atlantic SD 18123,** stereo, $6.98

Before those of you who know about the phenomenon called **Tonto's Expanding Head Band** break down doors and awaken record dealers in the middle of the night, let me announce that this is a rerelease of the original and only album. Nevertheless, it is a most important and welcome rerelease.

Tonto's Expanding Head Band is not a band at all in the concept of performers making music. It is the product of Robert Margouleff and Malcolm Cecil's experimental work with an expanded Moog series III synthesizer. Experimental, because at the time when it was made Morton Subotnick had just blazed new trails for the synthesizer with his **Silver Apples Of The Moon (Nonesuch H-71174)** and **The Wild Bulls (Nonesuch H-71208).** Walter Carlos was getting his act together with **Sonic Seasonings (Columbia KG 31234)** only to be subverted by the madness that followed **Switched-On-Bach (Columbia MS 7194).** I doubt that the Arp synthesizer was fully developed at the time and the synthesizer had not become a standard Jazz/Rock fixture, yet unprecedented things were happening.

It is from this brief, vital period in the history of electronic music and synthesizer development that this album originates. In its time it was lost to all but afficionados and chroniclers of recorded synthesizer music. In its original release it probably got buried in record stores between the tweeks and splatters that were being recorded by the Electronic Music Department of ye local university. The reason this record was so important then (and so remains now) is that it is so musical. The public did not then have Tomita, Herbie Hancock, Chick Corea, Jan Hammer, Mike Mandle, Roger Powell, Robert Mason, and all the rest proving that the synthesizer can be a musical instrument of the highest order. In short, the Age of the *Arpmooginet* (my own word) had not yet arrived. The reason for the availability of most of the early recordings of computer or otherwise-synthesized music was that it could only exist via tape recording. Making a disc was simply a marketing decision. The music just did not happen in real time. There was not yet a performing synthesizer. The latest Arps, the Mini-Moog, and the RMI digital keyboard are just now becoming full-performance, real time, musical instruments. This was where Margouleff and Cecil's work blazed new trails. They used the synthesizer to produce music that did not *have* to come from a synthesizer. This was not an exhibition in the latest in exotic synthesizer creations. It was unique and different, but very

musical. Age has not diminished it at all. If anything time has allowed our tastes to be far more receptive to the music, as music (the 2001 effect, credit Walter Carlos). Tonto's Expanding Head Band's time has come.

I have been searching for the original release (**Embryo SD 732,** which carried the title **Zero Time**) for the better part of a year, to replace the awful tape dub I have. No luck, I couldn't find one anywhere. Now, finally, Atlantic has seen fit not to let this fine recording remain unavailable. It's nice to know that somebody in that mammoth operation is listening. We needed this record back; our current music is almost catching up with it.

The sound is incredible. Playback systems with good transient response will finally have something to work with. Big, full speakers will finally let you know what you plunked down all that cash for. You will thank the day you bought your matrix decoder.

My pressing unfortunately had a few places where it broke up a bit. Not enough to be irritating, just bothersome, especially on an otherwise-splendid record. Apparently they recorded at a high level to minimize the surface noise. My pressing is just barely acceptable. Perhaps my copy was unusual. If you get one with high surface noise, drop Atlantic a note.

Sound: A+ Performance: A+

The Beatles: An Illustrated Record, by Roy Carr and Tony Tyler. Harmony Books. $12.50 cloth, $6.95 paper.

At last, an intelligent Beatles book for the Beatles fan! For those who don't have all of the Beatles' records in their original covers, here are tons of reprints of such goodies, as well as one photo after another of the lads from Liverpool at home, at work, and at play. There are quotes from relevant figures spiced throughout the book to help the Beatlemaniac recall the general feeling towards the boys at the time; there are discographies which have only a minimum of omissions (Paul producing the Bonzo Dog Band, for one). But on the whole, the book is not only amusing, entertaining, and heartwarming, it is accurate as well. Carr and Tyler are well-schooled rock journalists who never say something unless they've got the punch to back it up. They consistently come through with the right items at the right time.

Rather than tread knee-deep in sociological waters or try to explain the

Beatles phenomenon in scientific or ethnomusicological jargon, Roy Carr and Tony Tyler have delivered the goods in vaguely hip, rock prose, loaded with critical overtones. Not content to merely depend on the typical public views of the Fab Four (i.e. John is the artist, Paul the money-hungry drip, etc.) or any other devices which have made all other Beatleographies instantly obsolete, this team have well-thought-out, logical rundowns on each of the Beatles, covering both their spans with the group and as solo artists.

No theories as to why or how the Beatles were made into something more than just another rock group are offered. Not once is it claimed that Stu Sutcliffe, Pete Best, George Martin, or Brian Epstein was actually the moving force behind the Beatles. This is a book dominated by the Beatles themselves.

It's obvious both from the wording of the text and the care taken with assembling **An Illustrated Record** that both Carr and Tyler are indeed Beatles fanatics of the first order, as well as intelligent music journalists who are aware of their share of rock music technology. Their attentive attitude regarding the Beatles as not only innovative composers but as instrumentalists far ahead of every one else around (George's use of feedback, Ringo's drumming on *Ticket To Ride*, John's chord structures, and Paul's facility for the hit single) is quite refreshing. They call attention to important points which previous books of this nature neglected entirely, but they don't try to impress the reader with obscure points of reference. I can honestly say there's no item here that doesn't belong.

As far as the *real* story behind the Beatles, if there is one, that'll have to be told by producer George Martin, publicist Derek Taylor, or one of the four lads themselves, because there have been no dark secrets of the Beatles revealed in this Beatle book nor in any other save *Lennon Remembers*. But if you want a personal, concise, and fair evaluation of the Beatles career, this book is the only choice—it's certain to appease the wants of the Beatlemaniacs and turn the casual fan into a possible fanatic. True, it's only rock 'n' roll, but I like it. —*Jon Tiven.*

Satin Doll: Bobbi Humphrey
Blue Note BN LA344-G, stereo, $6.98

I don't know what all the fuss over this record is all about. It may be an okay record if you use all the mediocre things around as a yardstick. But if you compare it to Bobbi Humphrey's other albums, it is a trite waste of talent. Whether you like this one or not, try her previous **Dig This,** an album superior in every way.

Sound: C Performance: C

Jazz & Blues

Various Early Jazz Recordings: Olympic Gold Label Series
Bix Beiderbecke 1924, 7130. *Jelly Roll Morton Plays Jelly Roll,* 7131. *James P. Johnson 1921 - 1926,* 7132. *The King Oliver Creole Jazz Band* 1923, 7133. *Blind Lemon Jefferson: Early Blues,* 7134. *The Roots of Modern Jazz,* 7135. Mono, $4.98 each.

Caveat Emptor! This peculiar series duplicates a good deal of material available elsewhere in much more complete (and often better-sounding) and fully annotated form.

Many of the Olympics (this is just a sampling) appear to be copies of previous releases on the French Byg label, which apparently had leased the rights to the original masters (mostly from the ancient Gennett and Paramount catalogs) for European issue; it's a moot point if this entitles Olympic to release these albums in the U.S.

In any event, the Beiderbecke, Morton, and Oliver stuff, plus most of the Jefferson, was recently issued in Milestone's excellent series of specially priced two-record sets, in which, for less than twice the price, you get three times the music. The Olympics average a paltry five tracks per side, the Milestones seven or eight, and the Milestones have intelligent, informative, and extensive liner notes, while the Olympics have either short, dated encyclopedia entries or total hogwash.

An exception, and the only record in this batch I can recommend, if only to devotees of classic Harlem stride piano who don't mind the mechanical restrictions of music which is taken from piano rolls, is the Johnson collection. James P. was perhaps the greatest of all stride men, and though the rhythmic stiffness imposed by the roll machine is a handicap, his artistry shines through. For some reason, Johnson's lovely waltz *Eccentricity* is credited to one "R. Irving," though it appears in a listing of Johnson's compositions in the "liner notes." This roll, by the way, is pumped much too fast, as are some of the others. But there's a delightful *Sugar* and an interesting 7-minute medley from the show *Runnin' Wild.*

There seems no reason to go into detail about the other vintage material. The Beiderbecke Wolverines, the Oliver Creole Jazz Band, the Morton Gennett piano solos and Jefferson's blues are indispensable to the classic jazz library, but, as I've hopefully made clear, not in these slipshod

packages. (The Jefferson LP, with only nine tracks, has three performances not included among the 32 on the Milestone.)

The **Roots of Modern Jazz** collection is a joke. Two of the 12 selections barely live up to the title's pretentions: Charlie Parker's *My Old Flame* (the oft-reissued Dial version), and a crudely truncated Lester Young performance of *How High The Moon*, taken from a 1948 broadcast. The rest, from the catalog of the short-lived Charlie Parker Records label ranges from respectable trifles (Yusef Lateef's *Soul Blues*, Duke Jordan's *No Problem*) to superfluous trivia (tracks by singers Kevin Gavin, Alice Darr, and Jerri Winter), not to forget the ephemeral (Cozy Cole and a studio band in the *Chorus of Street Boys* from **Carmen**). The **Chutzpah of Schlock Merchandising** would be a more fitting title.

Olympic gets no gold medals from this reviewer. *Dan Morgenstern*

Sound: B Performance: Various

Expansions: Lonnie Liston Smith and the Cosmic Echoes.
Musicians: Smith, electric and acoustic pianos, electronic keyboard textures; David Hubbard, soprano tenor sax, alto flute; Donald Smith, flute, vocals; Cecil McBee, bass; Lawrence Killian, congas; Leopoldo Fleming, bongos; Michael Carvin, percussion, clavinet; Art Gore, drums.
Songs: *Expansions, Desert Nights, Summer Days, Voodoo Woman, Peace, Shadows, My Love.*
Flying Dutchman BDL1-0934, $6.98.

It's not unusual for yesterday's innovations to become today's mainstream, and finally tomorrow's cliches. What *is* surprising, as well as unsettling, is the rapidity with which the electro-percussive jazz style associated with the Herbie Hancock-Norman Connors-Lonnie Liston Smith axis has become almost totally stylized. What was, only two or three years ago, a challenging new way of adapting electronic keyboard wizardry and an expanded Afro-Latin percussion section to a creative-yet-mass-accessible improvisational style has degenerated already into stagnant predictibility.

If you've been following this subclass of jazz even slightly, you'll know what to expect from this record. Bassist McBee sets up syncopated, modal bass riffs, the percussionists (usually including jingling bells or light shakers to color the cymbals and pounding congas) fall in polyrhythmically, the electric piano shimmers and vi-

brates, the horns play a minor-key melody couched in warm, high-pitched woodwind voicings and the winds take their solos followed by the keyboard, while the rhythm section builds to a climax, signalling a return to the theme and relaxation of tensions; if a singer is added, (s)he sings saccharinely and somewhat above the normal range. Musical interest comes not from the exhilaration which accompanies upset expectations (because there are few such here), but from satisfaction at how thoughtfully the musicians manipulate their material within their agreed-upon restrictions.

There are few surprises on this recording, yet it's enjoyable with excellent keyboard work, charming compositions, and effective moods. Lonnie Smith (Liston added to avoid confusion with the other Lonnie Smith, the organ funker) has a distinctive electric piano touch, heavy on the wah-wah pedal (hear the title cut), but sticks to funky riff-type lines. He's much more at home on acoustic piano, displaying a beautifully-controlled attack on his powerful, carefully-harmonized, chordal comps, spicing his work with rippling glissandos. His solos are glorified thematic variations. On *Desert Nights,* with its pleasingly floating melody and buoyant bass line, his solo examines chordal textures derived from his comping, with a bell-like ring to his lovely higher-octave chords. He also has a pretty, thematic solo on the vocal ballad, *My Love,* which again demonstrates his awesome control over attack and volume. On this track and *Shadows,* he also fills spaces with well-conceived electric piano fills, complementing the "electronic keyboard textures" which add eerie touches to several tracks.

Lonnie's brother Donald, is a fair singer with a pleasant, expressive voice, who tends to sacrifice tonal control for precise enunciation (as on *Peace,* the album's low point). While *My Love* shows he is not without vocal potential, his gritty flute work, influenced by both Rahsaan Roland Kirk and Hubert Laws, is more interesting at present. Reedman Dave Hubbard's solos always sound vaguely familiar, though he does manage original moments on *Summer Days,* a happy Latin tune with Lonnie's most melodic acoustic piano solo. The percussionists play capably, sometimes adding a dash of excitement, never detracting.

Tom Bingham

Sound: A — Performance: B

Raise Up Off Me: A Portrait of Hampton Hawes.
Hampton Hawes and Don Asher, Coward, McCann, Geoghegan, New York. $7.95

In this autobiographical account of what it's like to be Black, a jazz musician, a sometime junkie, and later a prisoner (for the crime of being a heroin addict), Hampton Hawes, talented musician and articulate human being, reviews his life up to last year. Co-authored by professional writer Don Asher, it is a revealing tale of music, music-making, and musicians in that subculture inhabited by one of the least understood of creative artists, the jazz musician.

Hawes tells it like it is, complete with four letter words (always in place, never for shock value), accounts of the sex mores of his world, and the double (or triple or quadruple?) standards by which musicians, Black, junkies, and prisoners are judged and treated in this country today. He has some advice for his "brothers" when he says "The thing that black cats do, the mistake they make, is to try to use their skin to stay cool." He touches various sides of the race question in as unbiased a way as is possible.

Telling of one downfall he writes "... from $1,500 a week the year before to sitting on a park bench, stone broke." He was found there by Thelonius Monk and the jazz lover-philanthropist Baroness Nica Koenigswarter, who take him home and feed him. Monk lectures him, "You're an important figure in jazz and you ought to set a better example." They give him money to help him get straight. But two nights later he's drifted right back to the same park bench!

Hawes permanently kicks his drug habit while imprisioned, and writes hundreds of letters which culminate in an unprecedented Presidential pardon (from JFK). The book also deals with two other themes important to Hawes: women and music. He also tells what it's like to be (temporarily) well-known and highly paid. He blames no one, it seems, for his problems but himself (and perhaps our society). Well-written, unpretentiously factual, realistic, this book is something you can read in one session—and probably will.

One objection, with which readers familiar with Ross Russell's scholarly **Bird Lives: The High Life and Hard Times of Charlie Parker** will likely concur; why does the book include neither index nor discography?

Eric Henry

Classified

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