A DYNAMIC NOISE FILTER

AUDIO

JUNE
1972 60c

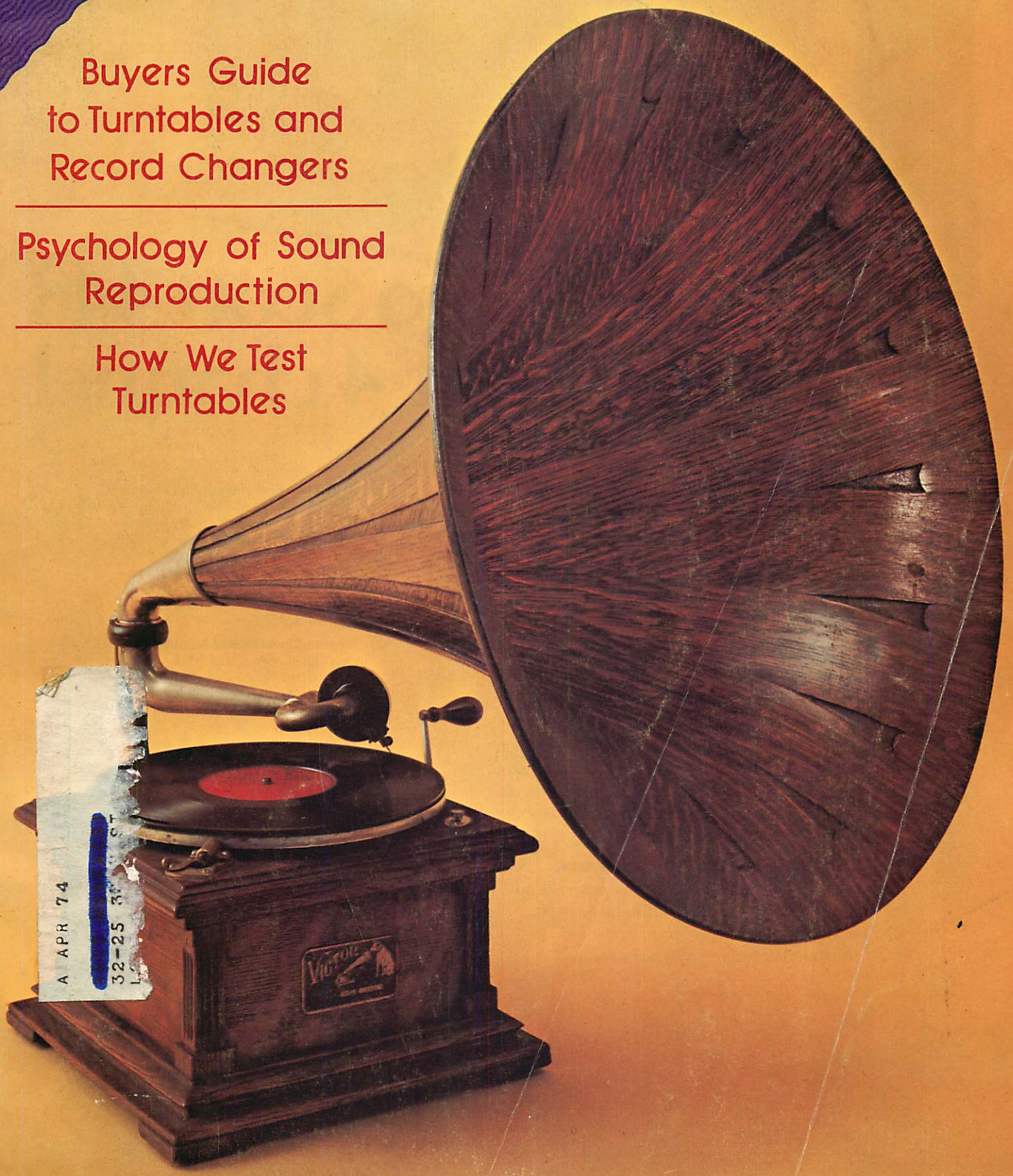
The Authoritative Magazine About High Fidelity ® A

23602

Buyers Guide to Turntables and Record Changers

Psychology of Sound Reproduction

How We Test Turntables



When you go 4 channel...

go Scott 443 Quadrant® 4 channel

It's Got The Features You Want. The 443 AM-FM Quadrant Receiver makes its own 4 channel programs from any 2 channel source using Scott's exclusive DvR matrixing circuitry. And Scott's flexibility allows combining 4 outputs into 2 for doubled output power when the 443 is used for conventional 2 channel listening. You may select 4 x 18 or 2 x 35 watts by a convenient front panel control.

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Interested In 4 Channel Amplification Only? *Scott offers a choice of two integrated control amplifiers. There's the 495 at 4 x 25 or 2 x 50 watts at $349.90. Then, there's the powerhouse 499 with which Scott officially started the whole 4 channel industry in 1969. It puts out a conservative 40 watts per channel into 8 ohms for $459.90.*

When you go 4 channel, remember that H.H. Scott offers more models and more performance per dollar than any other manufacturer. We needn't say more.

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H.H. Scott, Inc., 111 Powdermill Road
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Check No. 100 on Reader Service Card

AUDIO

JUNE 1972 *Successor to* RADIO *Est. 1917* Vol. 56, No. 6

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Experts agree...

(Seated left to right) Fred Petras, Contributing Writer, Tape Recorder Annual and Stereo & Hi-Fi Times □ Michael Marcus, Acoustics Editor, Rolling Stone □ Harry E. Maynard, Commentator, Men of Hi-Fi, WNYC-FM □ George W. Tillett, Editor, Audio Magazine □ Steve Katz, Guitarist, Blood, Sweat & Tears □ Bobby Colomby, Drummer, Blood, Sweat & Tears □ Ken Ketch, Pres., Sound Room, Grand Rapids & Kalamazoo, Mich.

Pioneer has mo

SX-727 AM-FM STEREO RECEIVER — 195 WATTS IHF

SX-828 AM-FM STEREO RECEIVER — 270 WATTS IHF

re of everything.

Four new and completely
different AM-FM stereo receivers
with increased performance,
greater power, unsurpassed precision
and total versatility.

SX-525 AM-FM STEREO RECEIVER — 72 WATTS IHF

SX-626 AM-FM STEREO RECEIVER — 110 WATTS IHF

Long before the current wave of consumerism, Pioneer had established its reputation for superior quality craftsmanship. This reputation has been continuously augmented by our commitment to building high fidelity components with a measurable extra margin of value. Our four new receivers — SX-828, SX-727, SX-626, SX-525 — are designed to meet a wide range of requirements and budgets. Yet each unit incorporates a significant array of features and refinements built into the top new model—the SX-828. Regardless which new Pioneer receiver you finally select, you are assured it represents the finest at its price.

Conceptual diagram

Consistent power throughout the bandwidth.

Not This

More meaningful power.

When it comes to power, each model provides the most watts for your money. This is meaningful power. Power that is consistent throughout the 20-20,000 Hz bandwidth (not just when measured at 1,000 Hz.) Especially noticeable at the low end of the spectrum with improved bass response, the overall effect is greater frequency response and low, low distortion.

Model	IHF Music Power 4 ohms	RMS @ 8 ohms Both channels driven @ 1KHz
SX-828	270 watts	60+60 watts
SX-727	195 watts	40+40 watts
SX-626	110 watts	27+27 watts
SX-525	72 watts	17+17 watts

Direct-coupled amplifier circuitry and twin power supplies improve responses.

Of course, having power to spare is important; but directing it for maximum performance is even more vital. In the SX-828 and SX-727, you will find direct-coupled circuitry in the power amplifier combined with two separate power supplies to maintain consistent high power output with positive stability. This means transient, damping and frequency responses are enhanced, while distortion is minimized. In fact, it's less than 0.5% across the 20-20,000 Hz. bandwidth.

You can't expect great music without great specifications.

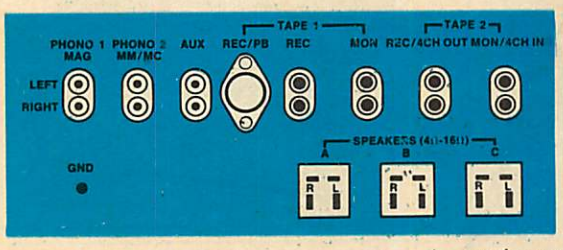
Pioneer's reputation for high performance capability is thoroughly reinforced in these four receivers. Listening to them substantiates it; the specifications tell the reasons why. Since Field Effect Transistors increase sensitivity, they're incorporated into the FM tuner section of each unit. For example, the SX-828 uses 4 FET's. You get greater selectivity and capture ratio with Integrated Circuits and Ceramic Filters in the IF stage. Here's a mini spec list.

	SX-828	SX-727	SX-626	SX-525
FM Sensitivity (IHF) (the lower the better)	1.7uV	1.8uV	2.0uV	2.2uV
Selectivity (the higher the better)	+75dB	+70dB	+70dB	+45dB
Capture Ratio (the lower the better)	1.5dB	2.0dB	2.5dB	3.0dB
Power Bandwidth	All exceed by a wide margin the usable sound frequency spectrum			

Inputs and outputs for every purpose including 4-channel sound.

Depending on your listening interests and desire to experiment in sound, each receiver provides terminals for a wide range of program sources.

Inputs:	SX-828	SX-727	SX-626	SX-525
Tape monitor	2	2	2	2
Phono	2	2	2	Phono/Mic.
Auxiliary	1	1	1	1
Microphone	2	1	1	Phono/Mic. (as above)



Outputs:	SX-828	SX-727	SX-626	SX-525
Speakers	3	3	3	2
Headsets	2	1	1	1
Tape Rec.	2	2	2	2

Someday, if you want 4-channel sound, all models have 2 inputs and 2 outputs to accommodate a unit such as Pioneer's QL-600 Quadralizer Amplifier. With it, and two additional speakers, perfect 4-channel sound is simply achieved.

Exclusive protector circuit for speakers.

Another example of Pioneer's advanced engineering is the automatic electronic trigger relay system designed into the SX-828 and SX-727. Since the signal is transmitted directly to the speakers because of the direct-coupled amplifier, this fail-safe circuit protects your speakers against damage and DC leakage, which can cause distortion. It also guards against short circuits in the power transistors. It's absolutely foolproof.

Versatile features increase your listening enjoyment.

Our engineers have outdone themselves with a host of easy-to-use features. All four units include: loudness contour, FM muting, mode lights, click stop bass/treble tone controls with oversize knurled knobs, and an ultra wide linear FM dial scale that takes the squint out of tuning. Except for the SX-525, they all employ high and low filters. Enlarged signal strength meters make tuning easier than ever. Center tuning meters are included as well in the SX-828 and SX-727. Further sophistication is offered on the top two models with a 20dB audio muting switch — the perfect answer to controlling background music. As the senior member of the family, the SX-828 is endowed with speaker indicator lights (A,B,C,A+B,A+C) and a tuning dial dimmer for creating a more intimate lighting atmosphere.

Some day other stereo receivers will strive for this total combination of power, performance, features, precision and versatility. Why wait? Pioneer has more of everything *now*.

See and hear these magnificent receivers at your local Pioneer dealer. SX-828—$429.95; SX-727—$349.95; SX-626—$279.95; SX-525—$239.95 Prices include walnut cabinets.

U.S. Pioneer Electronics Corp.,
178 Commerce Road, Carlstadt,
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West: 13300 S. Estrella Ave.,
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Canada: S. H. Parker Co., Ontario

Ultra wide linear FM dial scale takes the squint out of tuning.

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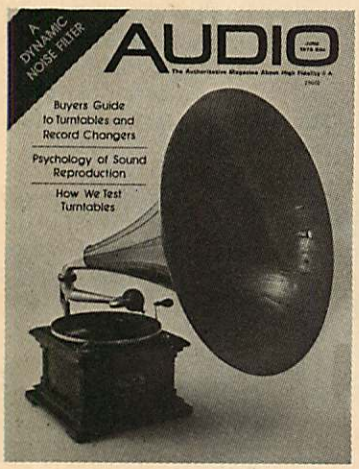
when you want something better

What's New in Audio

coming in July

Quadraphonic Progress Report
Add-On Decoder-Amplifiers Reviewed
The Language of High Fidelity —Part III

Equipment Reviews Include:
Fisher 801 Quadraphonic Receiver
Sony 277-4 Tape Recorder
Lenco L-75 Turntable



ABOUT THE COVER: This shows an early phonograph—Victor II which first appeared in 1902. It used a single spiral spring motor, hand wound, of course, and the horn had a 13¾ in. bell. It sold for $32.50 with a choice of soundboxes. Incidentally, a phonograph with *three* horns was demonstrated at the Paris Exposition in 1898. It was called "The Multiplex Grand" and was undoubtedly the first stereo reproducer!

AKAI GXC-40D cassette deck

In addition to playing regular tapes, this cassette recorder has a bias switch which allows the use of chromium dioxide tapes for a broader frequency response and a higher signal-to-noise ratio. An over-level switch activates a low-noise circuit to cut distortion. Other features include piano key controls, pause button, slide volume controls, tone control, 3-digit counter, and 2 VU meters. Price: $190.00; with amplifier, $240.00.

Check No. 2 on Reader Service Card

Pioneer QL-600 Quadralizer

This four-channel synthesizer can supply either of two different four-channel effects from existing two-channel sources or can accomodate discrete four-channel sources. A pair of power amplifiers for driving the rear speakers deliver 10 watts of continuous power per channel across 8 ohms, with less than 0.5% THD and 1.0% IM distortion claimed. Other features are four level controls, a master level control, and four illuminated level meters. Bass and treble controls are also included. Price: $199.95.

Check No. 3 on Reader Service Card

Lafayette RK-760A cassette deck

This unit has 10 transistors and 10 diodes and features a front panel bias equalizer switch for selection of standard or CrO_2 tape. New push-pull bias circuitry helps lower harmonic distortion. Manufacturer specifications are: Frequency response, 30 to 12,000 Hz; S/N, 48 dB; separation, 30 dB. Price: $99.95.

Check No. 4 on Reader Service Card

Norman Labs Model 5 acoustic equalizer

This acoustic equalizer incorporates circuitry for 10 specific bass equalization curves, all selected by the maker to allow the extension of bass response by an octave or more. Five position bass, midrange, and treble controls are also included to accommodate personal listening preferences. Price: $87.00.

Check No. 5 on Reader Service Card

Metro Sound control console

This audio control unit will handle up to 10 low impedance microphone inputs, with volume, reverb, monitor, bass, treble, and variable attenuator from 0 to 22 dB on each channel. There are master volume and monitor controls and a five band graphic equalizer. Options include up to 400 watts rms amplification with limiter circuits. Price: $1,100.00 approx.

Check No. 6 on Reader Service Card

HERE IS THE WORLD'S ENTIRE SELECTION OF AUTOMATIC TURNTABLES WITH ZERO TRACKING ERROR.

There they are. All one of them.

Garrard's Zero 100, the only automatic turntable with Zero Tracking Error.

Not that there haven't been attempts by other turntable makers. Many have tried. This is the first to succeed. And it has succeeded brilliantly. Expert reviewers say it's the first time they've been able to hear the difference in the performance of a record player...that the Zero 100 actually sounds better.

It's all because of a simple but superbly engineered tone arm. An articulating auxiliary arm, with critically precise pivots, makes a continuous adjustment of the cartridge angle as it moves from the outside grooves toward the center of the record.

This keeps the stylus at a 90° tangent to the grooves. Consequently tracking error is reduced to virtual zero. (Independent test labs have found the test instruments they use are incapable of measuring the tracking error of the Zero 100.) Theoretical calculations of the Zero 100's tracking error indicate that it is as low as 1/160 that of conventional tone arms.

Zero tracking error may be the most dramatic aspect of Zero 100, but it has other features of genuine value and significance. Variable speed control; illuminated strobe; magnetic anti-skating; viscous-damped cueing; 15° vertical tracking adjustment; the patented Garrard Synchro-Lab synchronous motor; and exclusive two-point record support in automatic play.

The reviewers have done exhaustive reports on Zero 100. We believe they are worth reading, so we'd be happy to send them to you along with a 12-page brochure on the Zero 100. Write to us at: British Industries Co., Dept. F12, Westbury, N.Y. 11590.

GARRARD ZERO 100

$199.95

less base and cartridge

Mfg. by Plessey Ltd. Dist. by British Industries Co.

Check No. 7 on Reader Service Card

Audioclinic

Joseph Giovanelli

Boosters and Weak Signal Reception

Q. I noticed your column in the October, 1971 issue of AUDIO. *I am wondering about your statement that weak signal reception will be decreased with the use of an r.f. booster. I have been using one or another of these boosters for years. I regularly listen to stations as far as 200 to 300 miles away, weather conditions permitting. Everything I read indicates that this is not supposed to be possible; FM is supposed to be limited to a distance of 50 or 60 miles.*

Is it possible that conditions are so much different out here from what they are in the East, where most of the testing, etc., is carried on that reception over greater distance is possible?

Is it possible that the boosters have not been helping as much as I thought? Note that in western Kansas there is no problem from overloading by strong stations. We strain for every tenth of a microvolt we can get.—John F. Wieland, Liberal, Kansas

A. A booster, used with a tuner of modern design, may degrade reception rather than improve it by adding more noise than signal.

Have you tried listening with the booster disconnected? You may find an improvement. If your tuner is a tube unit or one of the early solid state units, the booster may then be a decided improvement.

With the booster disconnected, signal strength will be less, but if the noise is still less, reception will be improved. Do not judge reception merely by readings on the signal strength meter. Listen to *stereo* signals when making your observations.

When we talk of FM reception being limited to line of sight, we mean normal, reliable reception. Weather conditions, especially temperature inversions, can and do play an important role in bending VHF signals, causing them to stay close to the ground rather than going out into space as they would normally tend to do. It is definitely possible and in fact likely for you to pick up signals from 200 to 300 miles away, assuming that there are few obstructions between your receiver and the source of the signal. This is probably the case in your part of the country.

Changes in atmospheric density can also result in signal bending, or refraction. (Actually, a temperature inversion is just one manifestation of such changes in atmospheric density.)

Assuming that your present antenna is the best possible, obtain another one and stack it. This will produce a three dB increase in wanted signal, plus added rejection of unwanted signals and external noise. By adding two more antennas, making a total of four, an additional three dB improvement will result.

Information for vertical and horizontal stacking is probably available from the manufacturer of your antenna. If not, you can find the information you need by writing to the American Radio Relay League, Newington, Conn. 06111.

Triac Power Handling Capacity

Q. My question concerns the use of triacs, specifically the RCA 40526 and 40527. According to the RCA transistor manual, they are identical in every respect except the off-set voltage. The 40526 is rated at 2.5 A with an off-set voltage of 200 V. The 40527 is rated at 2.5 A with an off-set voltage of 400 V. I know that the 40526 can be used at 120 V at 2.5 A for a total power of 300 W. The 40527 can be used at 240 V at 2.5 A for 600 W. It seems to follow that I can use the 40527 at 120 V at 5 A and have 600 W of power available through the device. Is this correct? —W. B. Voosen, San Diego, Calif.

A. You cannot use the 40527 rated for 240 V operation, run it on 120 V, and expect to be able to draw twice the current. Triacs have maximum current rating which must not be exceeded regardless of the voltage applied to the device. It is the current and its resulting internal voltage drop which causes some heating within the triac. The operating temperature must be kept below its design limits. In your application, therefore, if you need a triac which can handle 5 amperes, be sure that its current-carrying capacity is at least this value or you will lose the device in short order.

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.

Entente Cordiale

A friendly understanding.

A phrase that perfectly describes the relationship between Revox tape recorders and Beyer microphones. One fine piece of equipment uniquely complementing another.

Wherever you go, you'll find these two thoroughgoing professionals working together. On location and in the most demanding studio situations.

Both Revox and Beyer are expressions of the same European dedication to meticulous craftsmanship and superior technology.

For example, take the new Revox A77 Mk III. It's the successor to the critically acclaimed Revox A77, the machine that moved Stereo Review to comment, "We have never seen a recorder that could match the performance of the Revox A77 in all respects, and very few that even come close."

Or take the new Beyer M500 microphone. You've never used anything quite like it. It combines the sharp attack of a condenser and the sturdy reliability of a moving coil with the unduplicatable warmth of a ribbon.

And Beyer makes a number of other microphones to satisfy virtually any broadcasting or recording requirement.

Together or separately, these sophisticated instruments provide the ideal solution to the problem of versatile, high quality, low cost recording.

Your nearest Revox-Beyer dealer will be pleased to demonstrate any of these fine products for you.

After that, you can arrive at your own friendly understanding.

For additional information and complete technical specifications, write: Revox Corporation, 155 Michael Drive, Syosset, New York 11791.

California: 3637 Cahuenga Blvd. W., Hollywood 90068 Canada: Revox Sales and Service, Montreal

Check No. 9 on Reader Service Card

Dollars for Tapes

THIS MONTH, first prize of $50.00 goes to James K. Jobson of Atlanta, Ga., for his magnificent recording of two pianos in "Dynaquad." Two AKG C-451E (cardioid) microphones were used for the front channels and two AKG D-119ES mikes were placed 20 feet away for the rear signals. These were wired in anti-phase to get the correct Dyna perspective. Recorder was a Crown CX 822 and James used Scotch 203 tape. Pianos were a Conover and a Yamaha, both 7-ft. grands, and the pianists, Sue Walker and Walter Ross. The tape was entitled "Four Hands in Four Channel"—what else? The program ranged from Bach and Brahms to Mancini, and very well played it was, too. The second choice, by a narrow margin, was another brilliant recording—but this one was in mono. It was sent by Michael T. Kobal of Washington, D.C., who wins $25.00. The recording—which must have been difficult to make—was of a church organ and the occasion was its dedication. The church is St. Thomas More in Arlington, Va., and the player, John Fenstermaker. Michael used a single Neumann U-87 mike mounted on a tripod about 6 ft. from the floor and placed some 30 ft. from the nearest organ pipe. Recorder was a Nagra IV-L.

Consolation prizes of Maxell reels of tape or cassettes go to the following: Alan Omer, age 11, of the Flossie Valley School, for a cassette tape on ecology. Nice try, Omer, keep up the ecology studies! Edward Dybas, of Chicago, for a nicely recorded vocal-instrumental session with his sister (who has a nice voice). To Frank Ruhl, of Fairfield, Ohio, for a recording of three songs—all originals. Frank used a TEAC TCA-42, Shure 67 mixer, and Shure microphones. Also to Frank Farmer, a Dixieland fan, for his recording of an amateur jazz group using a Revox A-77; to Tony Iacovelli, of Framingham, Mass., for a most interesting cassette tape made underwater! From a submarine, in fact, and the recording includes all kinds of fish noises, groans and screams from sperm whales and porpoises, as well as the more mechanical noises of torpedo firing and destroyers passing overhead!

Closing date for this competition is June 16, so hurry up with those tapes!

Tape Guide

Poor Erasing

Q. I purchased a TEAC 4010S tape deck in Singapore, and it plays beautifully with one exception. It only partially erases previously recorded material on a tape. What needs to be done?—Dick Prokopowich, Asheboro, N.C.

A. Your difficulty seems due either to misalignment of the erase head (that is, the gap of the erase head doesn't span the same portion of the tape as do the other heads) or to insufficient oscillator current getting to the erase head. Possibly the erase head itself is defective.

Too Much Recording Hiss

Q. My problem lies in recording from records to tape. I seem to record with a large amount of hiss, which is quite annoying at times. I record just below the 0 dB level on the VU meters, but it seems that the hiss is not overcome at any particular recording level. If you can prescribe a method of recording which will alleviate some of this noise, I will be grateful.—Robert Sadowsky, Brooklyn, N.Y.

A. The hiss of which you complain could be due to poor design of your tape machine, including failure to use low-noise components in the case of resistors and transistors. It might be due in part to magnetized heads, and this can be overcome by demagnetizing the heads. It might be due to a misadjusted record-level indicator, causing you to record at too low a level and therefore to reduce the signal-to-noise ratio. Switching to low-noise tape should help. If you are operating at 3¾ ips, you will probably get better results at 7½ ips.

Duplicating

Q. I have a Revox A77 biased for low-noise tape, and a Tandberg 64X biased for regular tape. If I wish to duplicate a tape that has not been made on low-noise tape, am I better off going from the Revox to the Tandberg or vice versa? What apparent differences will show up when a tape is recorded on a machine not *biased for low-noise tape, and played on a machine biased for low-noise tape? Can you use your preamp treble and bass controls to compensate for losses or gains in either treble or bass when dubbing? I have thought of biasing my Tandberg for low-noise tape, but I have a large library of tapes recorded on regular tape, and I dislike the idea of losing any playback quality.*—Daniel S. Karsch, New York, N.Y.

A. When shifting from regular to low-noise tape, the only required changes are those in *recording* (more bias, more signal to the recordhead, less treble boost). There are no changes in playback. Therefore in duplicating it would not matter whether the pre-recorded tape was made on regular or low-noise tape. What counts is the tape on which you wish to make the copy. If the copy is to be made on low-noise tape, use your Revox; use your Tandberg if the copy is to be on regular tape. If you plan to record on low-noise tape from now on, there is no reason not to adjust your Tandberg for this kind of tape. It will still properly play all your tapes; and so will the Revox. With respect to using your tone controls to compensate for frequency deviations in duplication, this depends upon your audio preamplifier. Most such preamps provide a flat signal at the tape output; a few permit you to tailor the signal being fed into a tape recorder. If your preamp provides only a flat signal at the tape output (in other words, a signal taken before the tone controls), it would be necessary for you to modify the preamp in order to provide a signal for the tape recorder following the tone controls.

High Input Impedance

Q. I have a Sony TC-355 purchased overseas and with European specifications. The major difference between this and the American version is its input impedance of 560 K ohms, compared with 100 K ohms for the U.S. model. My amplifier manual states that for the tape output the minimum recommended load resistance is 200 K ohms. Should I change the load resistance, and if so to what value?—M. C. Harrell, Timberville, Va.

A. Inasmuch as the amplifier requires a *minimum* load resistance of 200,000 ohms, and since your tape recorder provides a load impedance *above* 200,000 ohms, there is no apparent advantage in changing the input load resistance of your tape recorder.

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.

We doubt that anyone will be overly surprised to learn that our newest loudspeaker sounds terrific. Most people really expect KLH to make terrific sounding things. But at $62.50† a piece, our new Model Thirty-Eight delivers an amount and quality of sound that we think will astonish even our most avid fans. The bass response is absolutely staggering; the transient response is flawless; and the Thirty-Eight's overall smoothness matches anything we've ever heard. Most important, you can use a pair of Thirty-Eights with virtually any modestly priced receiver. (What good is an inexpensive pair of loudspeakers that need a $400 receiver to effectively drive them?)

The Thirty-Eights are at your KLH dealer now. After hearing them, we think you'd pay $125 for just one. But $125 buys you *two*. Which has got to make the Thirty-Eights the biggest stereo bargain since ears.

For more information, visit your KLH dealer or write to KLH Research and Development, 30 Cross Street, Cambridge, Mass. 02139.

The New KLH Model Thirty-Eight. Two for $125.†

KLH RESEARCH AND DEVELOPMENT
A Division of the Singer Company

†Suggested east coast retail price. Slightly higher in the south and west. *A trademark of The Singer Company.

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Dear Editor

Crossfeed Circuit

Dear Sir:

Those of your readers who made up the stereo-crossfeed circuit for headphone listening in the December, 1971, issue, will wish to extend thanks to Mr. Siegfried Linkwitz.

At moderate cost it certainly makes a welcome improvement. However, I for one would like even more forward depth added to my headphone enjoyment of stereo records. Until such time as I can listen through the AKG K-180 headphones with their knob-adjustable drivers, I must be content with the vast improvement Mr. Linkwitz's circuit makes with my admittedly cheaper Sony DR-5A's. It even reduces their hiss!

However, is my hearing in any way unique? Prior to assembling this device, it felt as though I were squatting on the floor of the orchestra pit with at least one soloist sitting on my shoulders. Now I am happy to say, it sounds as though I had fallen through into the theater basement and the musicians were scraping, tooting, and banging through the hole above my head!

Of genuine forward sounding perception of distance there appears to be very little—or is that largely due to the ridiculous way the record companies go about producing stereo recordings? Oh, that we had the choice of genuine ungimmicked binaural stereo! We might not then need the newer quadraphonic set-up, save for added echo and reverberation!

Probably one answer is to try and find those recordings where, as Mr. Linkwitz suggests, some semblance of balance between the soloist and the orchestra is retained!

John Matthew
Toronto, Canada

Stimmung Revisited

Dear Sir:

I should like to comment on William N. Agosto's article on Stockhausen's *Stimmung* performance at Alice Tully Hall (AUDIO, Feb., 1972, p. 63).

The taped sounds of the performance were more than reference pitches. They included narrow-band filtered harmonic-containing waveforms, subtly mixed in ensemble with the singers, and were clearly audible to the audience.

The overtone separation was not achieved "with the human voice alone," but by the interaction of the vocal-cavity resonances with the non-linear characteristics of the microphones and amplification system.

These technical procedures, as well as the coincident issues of musical continuity demonstrated by *Stimmung*, have been used by various American composers (La Monde Young, Alvin Lucier, John Cage, and others) for at least a decade. Up to the composition of *Stimmung*, Karlheinz Stockhausen dismissed these procedures as decadent in his lectures and writings. By his use of these procedures Mr. Stockhausen has produced an impressive work, but it does not deserve to be called "pioneering."

Gordon Mumma
Cummingham Dance Foundation
New York, N.Y.

Mr. Agosto comments:

The composer's notes on Stimmung *imply no direct electronic alteration of the vocal parts, but I don't know that for a fact. Mr. Stockhausen and his staff left for Boston immediately after the concert and were not available for comment.*

It's certainly true that the flexible narrow-band sound and remarkable overtone separation we heard that night are consistent with the audio mix Mr. Mumma describes. I think we could all profit from further clarification of that point by Mr. Stockhausen, which I hope to obtain in correspondence.

On the point of "pioneering," I stand fast. A pioneer doesn't have to discover the territory he settles, and I think there's general agreement that Stockhausen has staked a legitimate claim with Stimmung *no matter what he may have said about drome music or its like in the past. A composer's ultimate statement is, after all, his music. It must transcend what he speaks if he's to amount to anything.*

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Horse's Breath, Montana

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Tony Laurie
Longueuil, Quebec

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Audio/Video Products

Behind The Scenes

Bert Whyte

AS YOU KNOW, last month AUDIO celebrated it's 25th birthday and the occasion was duly noted by an effusion of nostalgia and much reminiscing about the progress of the hi-fi industry in the last quarter of a century. Space limitations being what they are, the story of my involvement with the people, the places, the events, and the developments in the world of audio during those years could not be covered in one issue of this esteemed journal. Thus the story has "spilled over" to this month's edition and with your kind indulgence, I will bring this saga to its conclusion so we can return to the realities of today's audio scene.

When we left the story last month, I was telling you about a phone call I had received from Major Edwin Armstrong, the "father of FM," in which he informed me about his new development in FM broadcasting called stereo multiplex. He wanted my co-operation in furnishing him with stereophonic recordings for his experimental multiplex transmissions. Naturally, I agreed to help the Major, as I was quite excited by the potential of his stereo broadcasting, to say nothing of the fact that I was thrilled at the prospect of meeting this almost legendary figure. It just so happened that when the Major called me in Chicago, I was within a few weeks of returning to New York, where among other things, I was to be an audio columnist and associate editor for "Radio TV News" (later "Electronics World").

I shall never forget my first meeting with the Major in his opulent penthouse in the fabled River House apartments on East River Drive in New York. I found him to be a kindly, affable man, singularly free of any pretentious mannerisms or airs of hauteur. As I sat in the living room sipping on the excellent Scotch the Major had thoughtfully provided, he gave me a detailed explanation of his FM stereo multiplex process. He outlined his need for stereo tapes, since the only alternative would have been to do live broadcasts, and due to the experimental nature of the transmissions and their point of origin, this would have been impractical. At that time Major Armstrong was broadcasting stereo multiplex from his huge personally-owned transmitting tower atop of the high palisades at Alpine, New Jersey, across the Hudson River to his laboratory at Columbia University. For the benefit of those who may not know the story of the Major's tower, a word of explanation. The Major was the quintessential audio purist. He simply wanted the very best in sound quality and was rigidly uncompromising in this respect. As you know, FM propagation is limited to "line of sight" (hence broadcasting from places like the Empire State building for maximum area coverage), so to ensure that he would broadcast a good signal, the Major had this very high, complex tower erected at the reputed cost of several hundred thousand dollars. If I remember correctly, the height of the tower plus the height of the granite palisades at Alpine added up to better than 800 feet. Major Armstrong had this experimental monophonic FM station (whose very famous call letters elude me at the moment) and there is little doubt that some of the highest quality FM sound ever broadcast emanated from his station. Consider this . . . there would be a concert by the Marine or Navy Band, or the National Symphony Orchestra in Constitution Hall in Washington, D.C. and a top-notch engineer would set up the best microphones available at that time (very often the Western Electric 640AA calibration standard condenser type). Then the Major would *personally pay the charges for a 15 kHz equalized line all the way from Washington to his tower at Alpine!* The sound of these live concert broadcasts was fabulous. Those in the know made tape recordings of the broadcasts using a special "black box" which enabled one to use a McIntosh amplifier for recording purposes. I have heard many of these tapes and there was a "Firebird Suite" performed by the National Symphony Orchestra which was simply stunning in its sonic impact. As noted, the broadcasts covered the full audio spectrum and with a signal-to-noise ratio that was quite a bit better than the S/N ratio afforded by the tape recorders of that day.

At that first meeting, the Major asked me about the mike placements I had used on my various stereo recordings. Then he wanted me to make stereo recordings with special mike placements with regard to spacing, height, and distance from orchestra. (This was subsequently accomplished in Carnegie Hall with the help of the late Hal Sherman, a good friend and knowledgable recordist.) In the following months, if one had owned a multiplex adapter, he could have listened to Major Armstrong's stereo broadcasts and heard such diverse things as the bands of Woody Herman and Stan Kenton, and the Chicago, Detroit, and Minneapolis Symphony orchestras. I want to emphasize that from the beginning and in our subsequent meetings, Major Armstrong *told me that* he considered his stereo multiplex system a straightforward, high quality A-B (left/right) system. "Storecasting" and other SCA services had no place in his stereo scheme of things. Of course, in retrospect, one is bound to say that his A-B system would have eventually run afoul of the FCC.

Somewhat less than a year after my initial meeting with Major Armstrong, I received a letter from Murray Crosby, another FM expert who was also experimenting with stereo multiplex. His "sum and difference" method of multiplexing made it possible for the monophonic listener to receive a left/right balanced signal. Mr. Crosby told me of his difficulties in demonstrating his system, because of a lack of stereo recordings, and lamented the fact that the musicians union was against stereo recording (unless you paid a *double fee* for the two tracks!). More about the union a little later. I found out that Mr. Crosby lived less than 5 minutes from my home and his laboratory was also nearby. I met with Mr. Crosby and agreed to furnish him with stereo tapes. Not long afterward he gave me a closed circuit demonstration of his stereo multiplex system and I was much impressed. Murray Crosby knew of my association with Major Armstrong and just a week previous to the Crosby demonstration I had been visiting the Major at River House. We had been discussing the improvements in S/N ratio with the new high output tape oxides, and in all respects the Major was his usual self, affable, assured . . . the perfect host. You can imagine my utter shock when I walked into the Crosby labs the day after the demonstration and Murray told me a bulletin had just come over the radio that Major Edwin Armstrong had "apparently committed suicide" and his body was found 13 floors below on a roof-terrace of River House. I tell you I was really shaken. The Major had seemed absolutely rational to me with no evidence at all of the kind of trouble that would precipitate such an act. A tragic untimely end for such a great man. Some time later it was my

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sad lot to go up to his Columbia laboratory to pick up my stereo tapes he had been using.

Some months later, although informed engineers rated the Crosby stereo multiplex as the "system of choice," Mr. Crosby was not having much luck in placing his equipment in an FM station for experimental transmissions, even on a totally free basis! Having become convinced of the worth of the Crosby system, I had allied myself with Mr. Crosby. I suggested that we "go to the top" and see if this approach would get some results. My reckoning was that we should try RCA, since they had all the requisites . . . broadcast facilities, a record company, and manufacturing capabilities for multiplex equipment.

Dr. Oliver Reed was Editor of "Radio TV News" and a friend of the late General David Sarnoff, head of RCA. He was kind enough to write the General on my behalf, with a brief explanation of stereo multiplex. Dear friend Leopold Stokowski also contacted the General, telling him what I had in mind. The upshot of all this was an appointment with a Dr. Jolliffe, technical director of RCA. I had my trusty Magnecord along, complete with earphones and stereo tapes, as Dr. Jolliffe had never heard stereo, let alone multiplex stereo. Dr. Jolliffe liked what he heard and had me contact various executives in the broadcast, consumer, and manufacturing divisions of RCA. After a period of negotiation and planning, late in 1954 a group of 14 RCA executives made the journey out to Crosby Labs on Long Island, for a closed circuit FM stereo multiplex demonstration. They were suitably impressed with the multiplex demonstration, and more so with stereo which no one in their group had ever heard before. For over a year after the demonstration there was much "backing and filling," "foot-shuffling," and "wheel-spinning," typical of big company inertia, and nothing was ever accomplished on behalf of multiplexing. However, the exposure to stereo evidently was worthwhile for early in 1955 RCA Victor became the first major record company to issue stereo prerecorded tapes. As an aside to this, I pointed out the trouble we were having with the musicians union and decided to try and resolve the problems. Through the truly herculean efforts of a lesser union official with whom I was quite friendly, I finally met the recording secretary of the union, who turned out to be a very reasonable man. Once he understood the situation, he arranged for me to demonstrate stereo to James C. Petrillo himself! Armed once again with Magnecord, phones, and tapes, I invaded the union headquarters on Lexington Avenue in New York. After listening intently, and after I told Mr. Petrillo that *everything* in the pop or classical catalogs would have to be re-recorded if people wanted these items in the stereo medium, he smiled and relaxed, said the sound was terrific and invited the girls in his office to "come have a listen." The most immediate result of this encounter was that the recording secretary gave me a blanket letter of permission to record union musicians in stereo for "experimental purposes." This, needless to say, was worth any amount of trouble. A short while after the Petrillo demonstration, the union lifted its demand for double fees, and stereo recording began in earnest.

The first RCA Victor stereo tape was the Chicago Symphony performing Richard Strauss' "Also Sprach Zarathustra," (famous today through the "2001" movie). It was, and is, a superb recording and it was used as part of a famous promotion. Ampex came out with the Model 600 stereo tape playback deck and a pair of small suitcase-sized matching speaker/amplifiers. All around the country, in stores and at shows, they would set up the speaker/amps with the proper spacing for the size of the room, and conceal them behind draw drapes. When the audience had assembled, they would start "Also Sprach Zarathustra" and from behind the curtains would come this spectacular sound. The audience swore they were listening to some huge new super-speaker, when the drapes would be dramatically parted and there were these puny little units pumping out this startling sound. Stereo was "in" with a vengeance! That first RCA Victor stereo tape and the others that soon followed sold a great many Ampex 600's. Today, after 17 years and over 35,000 units sold, the Model 600 has record facilities, a new two-speed motor and is still going strong!

I have been involved with many other audio situations over the years and . . . well shucks, fellas, I could write a book! One of the most satisfying and yet frustrating experiences in audio was my Everest Records affair. Mr. Harry Belock, at the time President of Belock Instrument Corp. of New York, a high-precision electronics manufacturer and defense contractor, and I founded Everest Records in 1958. The name was my idea, "the peak of achievement"! Mr. Belock is one of the most remarkable men I have ever met, a veritable dynamo, with great drive and awesome perseverance. His organizational and production genius earned his company Navy "E's" and financial rewards for himself. He had one credo—everything had to be the best available, and this was reflected in the fabulous array of recording equipment we quickly acquired. First we used Ampex three-channel half-inch recorders, specially modified in the Belock plant and later on, drawing on Mr. Belock's extensive experience in the sound departments of Columbia and Paramount Pictures, we introduced the use of 35mm magnetic film. Westrex made the machines with Belock-modified electronics for full spectrum audio recording, rather than their usual 50-7500 Hz cinema equalization curve. In four months time we had built a recording studio complex in Bayside, New York, with the main studio so big that I recorded Leopold Stokowski and the entire N.Y. Philharmonic doing "Peter and the Wolf," with Captain Kangaroo narrating! The studio was equipped with its own pair of Scully lathes, and the Westrex stereo disc cutter, and the cutting was in charge of Robert Engler . . . formerly of Westrex. Our Chief of Engineering was John Livadary, former head of the sound department of Columbia Pictures. Most of our 35mm recorders were three-channel, but we had a special six-channel unit, with which we did the recording in Rome for Mike Todd, Jr.'s picture "Scent of Mystery." This was the odd-ball picture that had "Smellavision" . . . actual scents keyed to the story and the score. The picture was a bomb, but the six-channel stereo was great! I still have a photo somewhere that should make KLH happy . . . showing six of their speakers being used as monitors. We recorded extensively in this country and in England and the Continent. My bailiwick was the classical recording, and we had a notable series which, if I may be slightly immodest, has been characterized as some of the best recordings ever made . . . this praise coming from some pretty hard-nosed and rather blase recording engineers. Yes, at Everest we had the best of everything . . . everything but an understanding board of directors of the parent company. It takes a long time for a record company to establish itself, and the money return is necessarily slow. Impatience set in . . . the board pulled the plug, and Everest was sold. It is a sort of record conglomerate these days, still under the banner of Everest Records, doing little if any original recording, but by all reports thriving in its particular milieu.

So it goes. Win some, lose some. Audio is ever fascinating and I've had my fun, and sometimes a little glory in the past 25 years. Maybe some other time I can dredge up a lot of other audio tales, that must for now stay untold.

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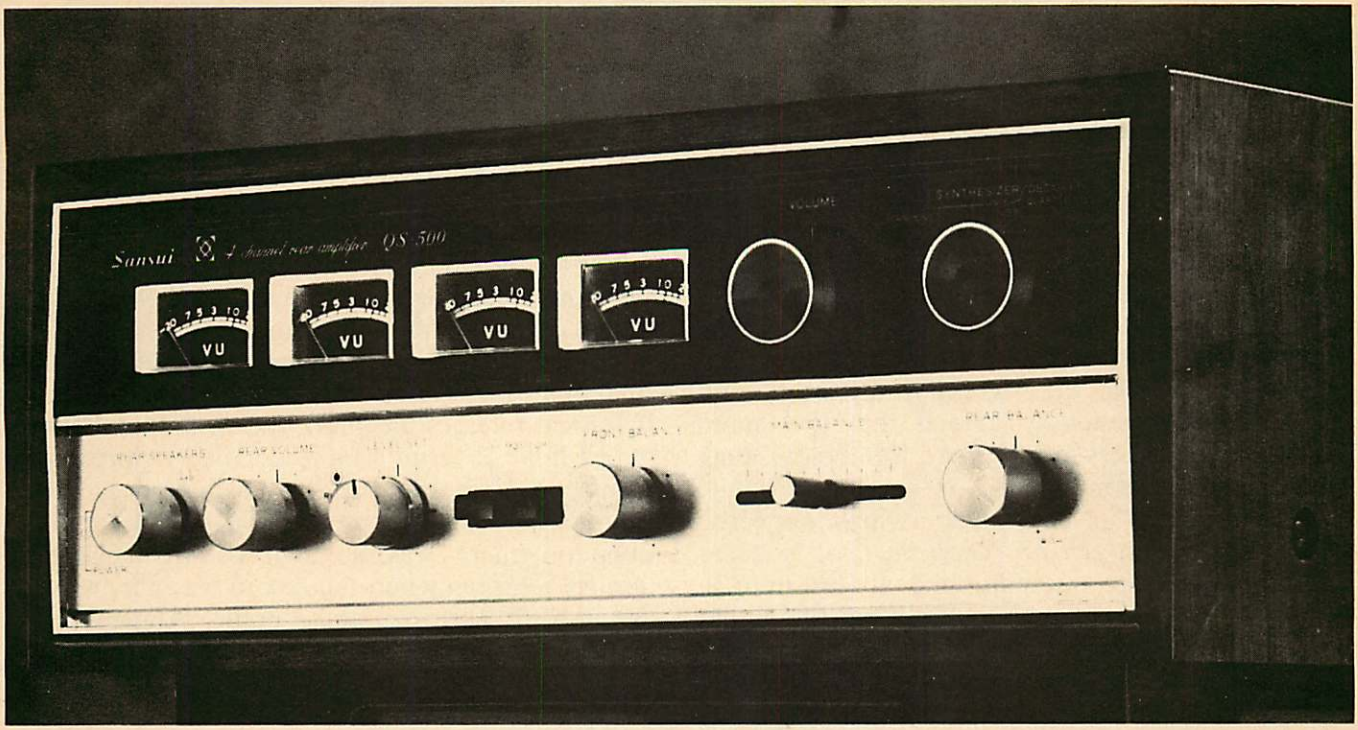

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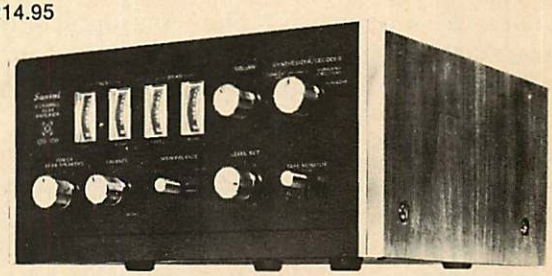
The QS500 features three balance controls for front-rear and left-right, separate positions for decoding and synthesizing, two-channel and four-channel tape monitors, electrical rotation of speaker output, alternate-pair speaker selection, and four VU meters. Total IHF power for the rear speakers is 120 watts (continuous power per channel is 40 watts at 4 ohms, 33 watts at 8 ohms), with TH or IM distortion below 0.5% over a power bandwidth of 20 to 40,000 Hz. In its own walnut cabinet, the QS500 sells for $289.95

An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $214.95



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Editor's Review

THE HI-FI DEALERS Association of Delaware Valley has accomplished a number of praiseworthy things—campaigning against misleading Music Power and other phony ratings, educating the public about compacts and component systems, and so on. But, their recent communique—if that is the right word—regarding quadraphonic sound is to be deplored. Some of the criticisms are valid enough, i.e. the shortage of records, few stations broadcasting in the medium, the discrete vs. matrix confusion, but when Ed Gorak, the executive director, says "Retailers are generally agreed that the sound from four speakers offers very little more than present stereo sound," he is talking absolute nonsense. Later in the article (which appeared in the *Daily News Hi-Fi Supplement*), it is stated ". . . retailers are not equipped at this time to demonstrate four-channel sound," and this might well be the clue. An array of speakers on wall-shelves might be good enough to demonstrate ordinary two-channel stereo but quadraphonic sound must be demonstrated under home conditions. It is no use putting four speakers all in line, as I saw a few weeks ago in a Philadelphia store—no use whatever. Care must be taken with speaker placement but results are well worth the extra effort. Quadraphonic sound can recreate a sound field more accurately than possible with two channel, it can be more realistic and exciting. It can reduce the effects of poor room acoustics, and the listener is not so aware that he is listening to loudspeakers. Some of the most impressive four-channel sound I have heard has been in small rooms where ordinary two-channel stereo gives indifferent results.

Media Are Tools

From the NCAE (National Center for Audio Experimentation) newsletter published by the University of Wisconsin, "The communications media are tools which convey a representation of reality. Except in a symbolic way, they do not transport reality to the presence of the viewer or listener. The media, whether they be considered art forms themselves or parallel to the arts, establish conventions which often offend when introduced but tend to be accepted by the public in a short time. . . . When new conventions are established, old conventions may be rejected or absorbed. Acceptance of the new seldom comes without a struggle."

Microsonic Grooves

Many years ago, the Dutch Philips company was experimenting with high density microgroove records. I don't remember now how tight they squeezed those grooves but I know they were 78 rpm. So were the discs (unequalized) made by my good friend Cecil Watts. Anyway, a small company up in Revere, Mass., has just come up with a stereo disc with a density of 800 grooves per inch. First release is a 7-in., 45-rpm record that plays for over 30 minutes a side. As far as I could tell (the recording was "Jesus Christ, Superstar"), quality was comparable with a conventional disc although distortion is theoretically higher than that of a 12-in. record—particularly near the center. Classical releases are promised in the near future and I hope to write a more detailed report in due course. A 12-in. disc playing for an hour each side sounds an attractive proposition—and I forgot to mention—there was no sign of mistracking or groove jumping when the record was playing with an ADC 25 cartridge at 1½ grams. Amazing!

This Is Your Life

AUDIO has just had a large-scale readership survey conducted by a market research organization, and here is what you look like. About 22% are between the ages of 25 to 29, 20% 20 to 24, and just under 14% 30 to 34. Over 30% are engineers or technicians, 25% professional or managerial, and there are nearly 12% students plus 11% engaged in research. More than 24% have family incomes in the $10,000 bracket, 22% between $15,000 and $20,000, and 30% in the $20,000 to $50,000 range. A lucky 2.7% enjoy incomes over $50,000. No less than 42% are homeowners, and 21.4% have a second or vacation home.

The Youth Market

ABC-FM recently issued a market survey of the Youth Rock Stereo Listeners in the seven areas including New York, Detroit, Los Angeles, Pittsburgh, Houston, and San Francisco. Age group is given as 18 to 34 and the report covers magazine readership, cars, clothes, books, and beer, etc., etc. More than 84% own some kind of stereo equipment, and the majority plan to buy component systems. The stereo brand preferences are listed, with Garrard at the top, closely followed by Panasonic and Sony, then Fisher, KLH, Pioneer, Sansui, Dual, Scott, and Marantz. Under the section entitled Leisure Time Activities, Swimming, Spectator Sports, and Camping rate between 11 and 13% each, but Opposite Sex gets only 0.5%. . . . Times certainly have changed!

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PSYCHOLOGY OF SOUND REPRODUCTION

Harry F. Olson*

THE PSYCHOLOGY OF SOUND REPRODUCTION involves the psychology of music, speech, and emotional responsiveness. The psychology of music provides the law and order in the structure and operation of the human hearing mechanism and the musical mind. The psychology of speech involves the factors which determine the communication of information through the human hearing mechanism to the brain. The psychology of emotional responsiveness to music and speech may be expressed as the degree and kind of perception and sensation which is produced. The sensation and perception of music involves imagery, memory, and mentality. These attributes are related to the musical mind in finding music and speech attracting or repelling, pleasing or antagonizing, and tolerable or intolerable.

The purpose of this paper is to present an exposition on the psychology of sound reproduction involving the psychology of music, speech, hearing, distortion, noise, and spatial phenomena.

PSYCHOLOGY OF MUSIC

The psychology of music is the science of musical experience and behavior. Psychology provides a working knowledge of the performance of the musical mind. Accordingly, the fundamentals for the classification of events in musical experience and behavior can be established. A scientific musical terminology can be developed from these fundamentals. Employing the definitions from the terminology, research in the psychology of music has shown that the musical listener must have four capacities for apprehending and appreciating all music, namely, the sense of pitch, the sense of loudness, the sense of time, and the sense of timbre.

The foregoing simplifies the understanding of the capacity of the musical mind in that each of these four basic functions appear in such complex musical forms as harmony, melody, dynamics, rhythm, volume, and tone quality. These musical forms are influenced by other important musical properties involved in listening to live or reproduced music such as localization, and perspective of the sound sources, acoustic ambience, reverberation, and other spatial phenomena.

The preceding brief introductory exposition shows that the psychology of music relates to the reproduction of sound in a very important and significant manner.

The purpose of this section is to describe the major psychological phenomena involved in the reproduction of music.

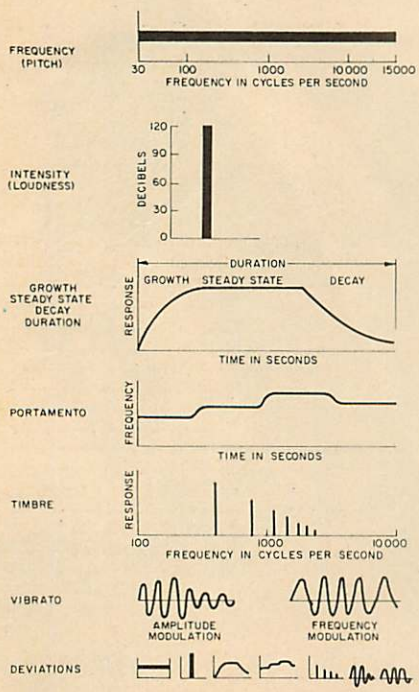


Fig. 1—The physical properties of a musical tone.

Properties of a Tone

The psychological properties of sound, namely, pitch, loudness, time, and timbre depend upon the physical characteristics of the sound wave, namely, frequency, amplitude, duration, and waveform. The four physical characteristics of a sound wave completely describe every type of sound wave whether original or reproduced. The musical mind must be capable of apprehending and appreciating, to a more or less degree, the four characteristics of a sound wave representing a musical selection.

The four physical characteristics can be broken down into seven physical characteristics which are more specific and individualistic in describing a musical tone, namely, frequency, intensity, growth, steady state and decay (duration), portamento, timbre, vibrato and deviations. These characteristics of a tone are depicted in Fig. 1.

The following definitions of tone properties are descriptive rather than absolutely rigorous presentations of the formal and somewhat abstruse language of the standards.

Frequency of a sound wave is the number of cycles occurring per unit of time, measured in Hertz. The subjective counterpart of frequency is pitch.

Intensity of a sound wave is energy transmitted per unit of time. The intensity is usually expressed in decibels above the threshold of hearing at 1000 Hz, which is 0 dB = 10^{-16} W/cm^2. The subjective counterpart of intensity is loudness.

Growth is the time required for a sound to build up to some fraction of the ultimate value.

Steady state of a sound is the length of time in which there is no change in the intensity.

Decay is the time required for sound to fall to some fraction of the original value. Note that growth, steady state, and decay lumped together become the envelope of a tone.

Duration is the length of time that a sound persists without interruption or discontinuity in the output.

Portamento is a uniform glide in frequency from a sound of

*RCA Laboratories, Princeton, N.J.

one frequency to a sound of another frequency. Portamento is also termed a frequency glide.

A complex sound wave is made up of the fundamental tone and overtones. The timbre or spectrum of a tone is expressed in the number, intensity, and phase relations of the components; that is, the fundamental and overtones or partials.

Vibrato is a low-frequency modulation of a musical tone. This may result from either frequency modulation or amplitude modulation or a combination of both. In general, the modulation frequency is of the order of 7 Hz. Tremolo, a special case of vibrato, is created by amplitude modulation only.

Deviation is a departure from the regular and is one of the beautiful and artistic characteristics of some types of music.

With reference to the preceding descriptions, many of the properties of a tone are interdependent. For example, timbre is influenced by the attack, decay, portamento, vibrato, etc. When the properties of a tone as just defined and depicted in Fig. 1 are specified, the tone can be completely described. Furthermore, the tone can be produced from these specifications by providing electronic means for generating its characteristic properties.

Loudness

Loudness of a sound is the magnitude of the auditory sensation produced by the sound. The units on the scale of loudness should agree with the common experience in the estimates made upon the sensation magnitude. A true loudness scale must be constructed so that when units are doubled the sensation will be doubled, when the scale is trebled the sensation will be trebled, etc. The sone is the unit of loudness. By definition, a pure tone of 1000 Hertz, 40 dB above the listener's threshold produces a loudness of 1 sone. The loudness of another sound as judged by the listener to be n times the loudness of 1 sone is n sones. The loudness level of a sound, in phons, is numerically equal to the sound pressure level, in dB relative to the threshold of 0.0002 microbar, of a free progressive plane sound wave of 1000 Hertz which is judged to be equally loud.

The relation between loudness and loudness level is given by

$$S = 2^{(P-40)/10} \qquad (1)$$

where S = loudness, in sones and
P = loudness level, in phons.

To establish the loudness of a complex sound, such as music, at least three specifications must be available as follows:

1. A scale of loudness termed the sone scale, the relation between sones and phons is given by equation 1.
2. The equal loudness contours for discrete frequency bands of the complex sound. The octave is a convenient frequency band.
3. The rule by which loudness adds as the discrete frequency bands of the sound are added.

Specifically, after the sound pressure level in each octave band has been determined, the next step is the proper summation in each octave band of these data. The relation between the loudness and the loudness index is given by

$$S_T = 0.75S_M + 0.3\Sigma S \qquad (2)$$

where S_T = total loudness of the complex sound, in sones,
S = loudness index in each octave band and
S_M = greatest of the loudness indices.

The loudness index in each octave band is obtained from the graph of Fig. 2. The use of equation 2 and Fig. 2 makes it possible to determine the loudness of a complex sound.

There is a very definite relationship between the preferred or tolerable top level of sound reproduction and the volume of the room. Subjective tests have been carried out on the preferred or tolerable top level of sound reproduction and the volume of the room. The results are shown in Fig. 3. The preferred or tolerable top sound level in the home is 80 dB.

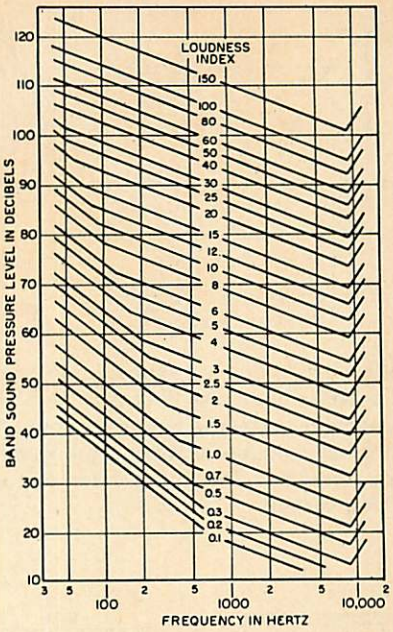


Fig. 2—The loudness index contours for octave bands.

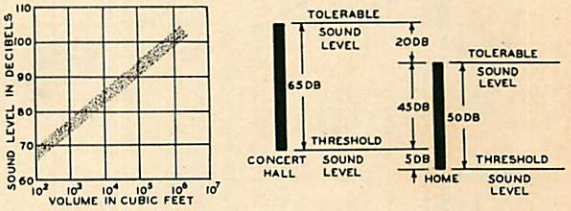


Fig. 3—The tolerable or preferred top sound level as a function of the volume of the room. The bar graphs show the tolerable top sound level and the threshold sound level due to the ambient noise for a concert hall and a room in the home.

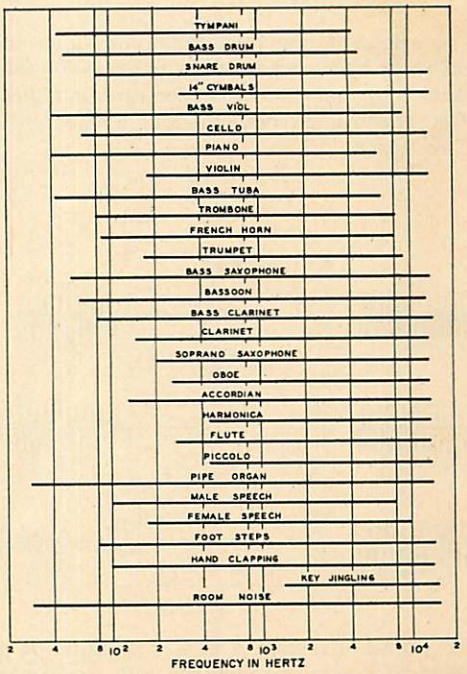


Fig. 4—The frequency ranges required for the reproduction of speech, musical instruments, and noises without any noticeable frequency distortion or discrimination. (After Snow).

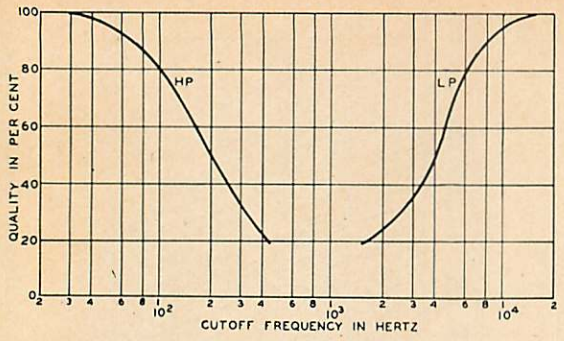


Fig. 5—The effect of frequency range upon the quality of orchestral music. **HP** is high pass filter, that is, all frequencies below the frequency given by the abscissa removed. **LP** is low pass filter, that is, all frequencies above the frequency given by the abscissa removed. The data is for a quadraphonic sound reproducing system.

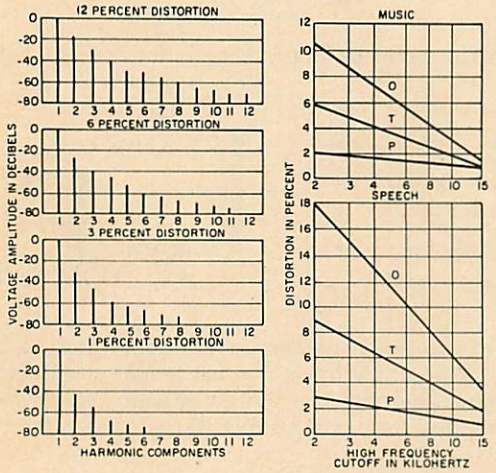


Fig. 6—The effect of nonlinear distortion upon reproduced speech and music depicting **O**—objectionable, **T**—tolerable and **P**—perceptible nonlinear distortion for various high frequency cutoffs. The spectrums showing four values of nonlinear distortion are typical.

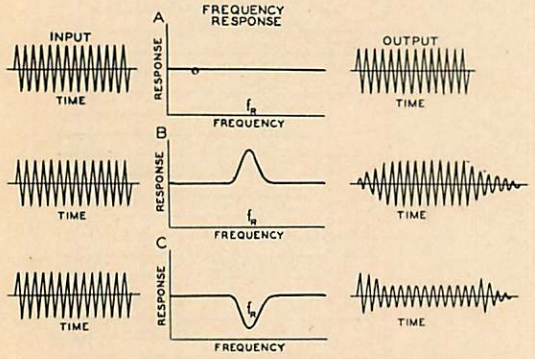


Fig. 7—The transient response to a tone burst of frequency f_R. **A**—A sound reproducing element with uniform response. **B**—A sound reproducing element with a peak in the response at frequency f_R. **C**—A sound reproducing element with a dip in the response at frequency f_R.

For the concert hall, the top level is 100 dB. The threshold due to the ambient noise is 30 dB for the average home and the threshold due to ambient noise in the concert hall is 35 dB. The bar graphs of Fig. 3 depict the threshold levels and the preferred or tolerable levels for the home and the concert hall. The bar graphs show that the amplitude range in the home and the concert hall are 50 dB and 65 dB respectively.

Quality

The quality of the reproduced music is a subjective property describing the degree of resemblance of the reproduced to the original music.

To obtain resemblance of the reproduced music with the original music requires a high order of fidelity of performance, particularly from the standpoints of frequency range, nonlinear distortion, transient response, and noise.

The individual tones of musical instruments are composed of the fundamental and the partials or overtones. The relationship between the fundamental and the partials and the various partials must be maintained in order to preserve the quality of the reproduced music.

The frequency ranges required to reproduce speech, musical instruments, and some noises without any noticeable frequency discrimination is shown in Fig. 4.

The effect of frequency discrimination upon the quality of orchestral music is depicted in Fig. 5. To reproduce orchestral music with no discernible frequency discrimination requires a frequency range of 30 to 15,000 Hertz (Many experts would extend the upper limit to 18,000 or 20,000 Hz.—Ed.)

A sound reproducing system which introduces nonlinear distortion generates new partials and modifies the relative amplitudes of the original partials. The effects of nonlinear distortion upon the reproduction of music has been determined. Typical spectrums of the nonlinear distortion for four values of nonlinear distortion are shown in Fig. 6. There are three subjective levels of nonlinear distortion, namely, perceptible, tolerable, and objectionable. Perceptible is the amount of distortion required to be just discernible. Tolerable and objectionable are not as definite terms and are a matter of opinion. By tolerable distortion is meant the amount of distortion that could be allowed in medium-grade consumer sound reproducing systems as exemplified by the phonograph, magnetic tape, radio, and television. By objectionable distortion is meant the amount of distortion that would be definitely unsatisfactory for the reproduction of sound in consumer sound reproducing systems. Referring to Fig. 6 it will be seen that the amount of perceptible, tolerable, and objectionable nonlinear distortion decreases as the high frequency cutoff increases. To reproduce music over the entire audio frequency range with imperceptible distortion requires a system with less than one percent nonlinear distortion.

All speech, voice and music are of a transient character. Therefore, the transient response of a sound reproducing system is an important performance characteristic. Poor transient response alters the envelope of the sound, that is, the growth, duration, and decay. The response of a sound reproducing system to a tone burst depicts the transient response. The transient response of sound reproducing elements with various frequency response characteristics is shown in Fig. 7. In general, if the response is uniform as shown in Fig. 7A, the transient response will be good. If there is a peak in the frequency response as shown in Fig. 7B, there will be a lag in the growth. Following the end of tone burst input, there is a hangover in the response which decays with time. If there is a dip in the response as shown in Fig. 7C, there will be an immediate full response followed by a decrease to a lower steady level. Following the end of the tone burst input, there is a sudden rise in output followed by a decay. The data of Fig. 7 shows that poor transient response changes the envelope of the

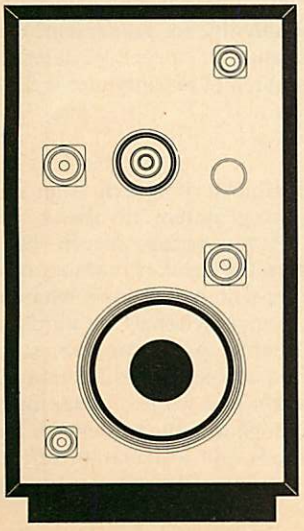
After the monthly breakthroughs and revolutions in speaker design, how come the Rectilinear III still sounds better?

Figure it out for yourself.

More than five years ago, without much fanfare, we came out with a very carefully engineered but basically quite straightforward floor-standing speaker system. It consisted of six cone speakers and a crossover network in a tuned enclosure; its dimensions were 35" by 18" by 12" deep; its oiled walnut cabinet was handsome but quite simple.

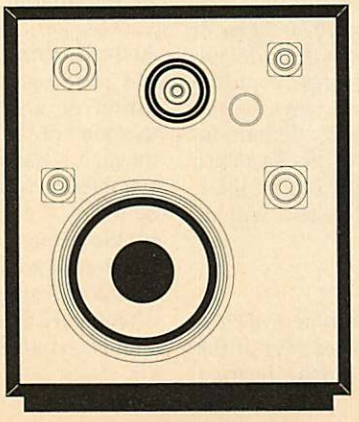
That was the original **Rectilinear III,** which we are still selling, to this day, for $279.

Within a year, virtually every hi-fi editor and equipment reviewer went on record to the effect that the **Rectilinear III** was unsurpassed by any other speaker system, regardless of type, size or price. (Reprints still available.)



Then came about forty-seven different breakthroughs and revolutions in the course of the years, while we kept the **Rectilinear III** unchanged. We thought it sounded a lot more natural than the breakthrough stuff, but of course we were prejudiced.

Finally, last year, we started to make a **lowboy** version of the **Rectilinear III.** It was purely a cosmetic change, since the two versions are electrically and acoustically identical. But the new **lowboy** is wider, lower and more sumptuous, with a very impressive fretwork grille. It measures 28" by 22" by 12¼" deep (same internal volume) and is priced $20 higher at $299.



The new version gave *Stereo Review* the opportunity to test the **Rectilinear III** again after a lapse of almost five years. And, lo and behold, the test report said that "the system did an essentially perfect job of duplicating our "live music" and that both the original and the **lowboy** version "are among the best-sounding and most 'natural' speakers we have heard." (Reprints on request.)

So, what we would like you to figure out is this:

What was the real breakthrough and who made it?

For more information, including detailed literature see your audio dealer or write to Rectilinear Research Corp., 107 Bruckner Blvd., Bronx, N. Y. 10454.

Rectilinear III

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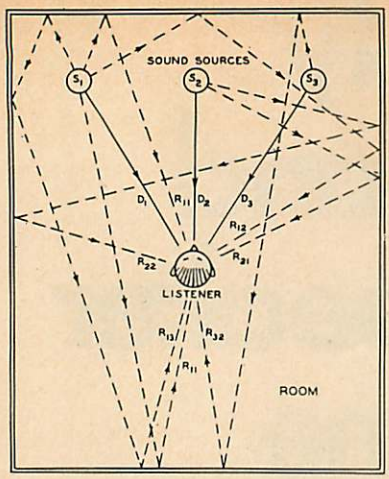


Fig. 8—An enclosure containing three sound sources, S_1, S_2 and S_3 and a listener. D_1, D_2 and D_3 represent the direct pencils of sound. R_{11}, R_{12} and R_{13} represent reflected pencils of sound with one, two, and three reflections. The direct sound supplies the auditory perspective and the reflected sound supplies the acoustic ambiance or reverberation envelope.

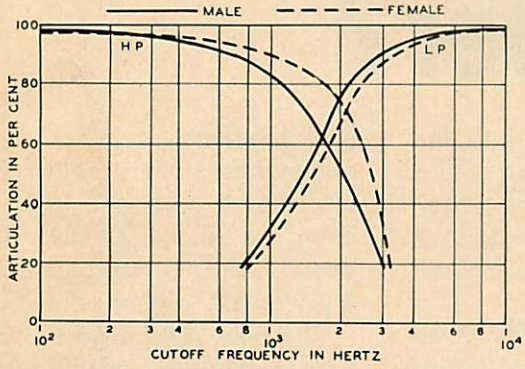


Fig. 9—The effect of frequency range upon the syllable articulation of speech. **HP**—High pass filter, that is, all frequencies below the frequency given by the abscissa removed. **LP**—Low pass filter, that is, all frequencies above the frequency given by the abscissa removed.

musical tone. Poor transient response destroys the clarity and incisiveness of a musical tone.

Noise

Noise is any undesired audio signal in a sound reproducing system. In general, noise is an erratic, intermittent or statistically random oscillation. Some disc record reproduction exhibits "ticks" of noise due to an imperfection in the record groove. Some magnetic tape reproduction exhibits ticks of noise due to "dropouts," that is, imperfections of the tape coating. Most noise is, however, of a statistically random type covering the entire audio range and is manifested as "hiss."

Noise is present to some degree in all sound reproducing systems. The objective is a noise level that is imperceptible. This is indeed difficult to achieve at the present stage of the art. Most high quality systems can be designed so that the annoyance is negligible. To achieve this order of performance requires a signal-to-noise ratio of at least 60 dB. Under these conditions the noise of the sound reproducing system will be lost in the ambient noise of the room.

Perspective and Ambience

The normal human hearing mechanism combined with a musical mind can apprehend all the tonal characteristics of the sound waves that enter the ear. In general, the human hearing mechanism operates in a field of sound, that is, the sound source and the ears are separated in space. In addition, for the most part, the sound source and the ears are located in an enclosure.

The human hearing mechanism is binaural and thereby attributes a directional sense to the sound that is received so that the source of sound can be localized. That is, the binaural hearing mechanism provides the means for placing the sound sources in perspective.

When a sound source operates in a room, the acoustic ambience or reverberation envelope is comprized of sound that has encountered one, two, three, etc. reflections from the boundaries before impinging upon the listener's ear.

The field effects of sound waves, namely, perspective and acoustic ambience or reverberation envelope, will be described as follows:

Three sound sources S_1, S_2, and S_3 are located in an enclosure as depicted in Fig. 8. The listener determines the angular location of the three sound sources from the direct pencils of sound D_1, D_2 and D_3. This angular localization is obtained by means of the human binaural hearing mechanism. The angular discrimination is the matter of only a few degrees in a part of the audio frequency range. The angular localization provides the listener with auditory perspective of the sound sources.

The sounds emanating from the sound sources are reflected by the walls, ceiling and floor. The reflections in two dimensions are depicted in Fig. 8. Only a few of the pencils of sound that have been reflected one, twice, and three times are shown in Fig. 8. The intensity decreases with each reflection due to absorption of sound by the boundaries. The decrease in the level of each reflection continues and the amplitude of the reflected sound is ultimately lost in ambient noise level. The reflected sounds provide the acoustic ambience or reverberation envelope.

Perspective and ambience are important psychological factors in apprehending and appreciating original and reproduced sound in an enclosure. The optimum acoustic ambience which is determined by the acoustical performance of the enclosure depends for the most part upon the reverberation time of the enclosure.

The auditory perspective of the original sound is reproduced in stereophonic and quadraphonic sound reproducing systems. The auditory perspective and acoustic ambience are reproduced in the quadraphonic sound reproducing system.

PSYCHOLOGY OF SPEECH

The psychology of speech is the science of the transfer of intelligence by means of the sounds of speech. Psychology provides a workable insight into the nature of perception of speech sounds by the human hearing mechanism and the mind.

There are two fundamental quantities involved in the transmission of speech, namely, intelligence and resemblance. The transmission of the intelligence of speech is determined by the articulation. The transmission of resemblance is determined by the quality.

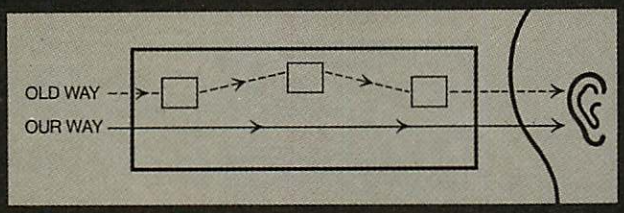
Articulation

The recognition or intelligibility of speech is an important aspect of a sound reproducing system involving the transmission of information. In measuring speech recognition through a transmission system the speaker reads aloud sounds, syllables or words to a listener who writes down what he thinks he hears. A comparison of sounds, syllables, or words recorded by the listener with those uttered by the speaker provides the fraction of what is interpreted correctly. The fraction is termed sound and syllable articulation and word intelligibility.

There are three types of recognition measurements involving sounds, syllables, and words. Sound articulation refers to the

(Continued on page 73)

We've shortened the distance between you and the music.



Now you can really snuggle up to Schumann. When you get next to our new stereo receiver, the SA-6500.

Because we cut down the distortion. By cutting out the input transformer, the output transformer and the output capacitor. So instead of putting your music through a whole electronic maze, we put it right through. Via direct coupling. With less than 0.5% distortion. And an amplifier frequency response of 10 to 100,000 Hz—1dB.

And because the signal doesn't get capacitored and transformered to death, you get something else. Full 200 watts of power (IHF) all the time.

The music is more than just close, it's sharp. Because we've got 1.8 μV sensitivity on FM from two 4-pole MOS FET's that can pull in your favorite station. So it sounds like it's being broadcast next door. Even if it's coming from the next state.

We also have selectivity. Because of two RF stages, a four-section tuning capacitor, four tuned circuits and an IF stage with a crystal filter and integrated circuit.

Having brought you closer to the music, we also bring you closer to absolute control. With linear sliding controls for bass and treble. Low Filter, High Filter, and Loudness switches to shape the sound. An FM Muting switch to eliminate annoying inter-station noise. And pushbutton audio controls.

There's even more. Like a linear FM dial scale with maximum station separation, for easier tuning. And dual tuning meters to measure FM/AM signal strength and pinpoint FM stations. Plus Lumina-Band tuning to light them up. A full range of input and output jacks. Even a rich walnut cabinet.

Now that our SA-6500 has shortened the distance between you and the music, all you have to do is shorten the distance between you and your nearest Panasonic Hi-Fi dealer.

PANASONIC®
just slightly ahead of our time.

200 Park Avenue, N.Y. 10017. For your nearest Panasonic Hi-Fi dealer, call 800 631-4299. In N.J., 800 962-2803. We pay for the call. Ask about Model SA-6500.

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The experts talk about a new

"...The tuner which may well prove to be the 'classic' of the 1970's is Heath's new AJ-1510 Digital FM Stereo Tuner."

— Leonard Feldman, AUDIO MAGAZINE

"...When it comes to using the AJ-1510, we find ourselves almost at a loss for words. It is probably as near to the ideal FM tuner as we have ever encountered."

— Julian Hirsch, STEREO REVIEW

Mr. Feldman goes on to say: "The 'ultimate' tuner? Well, if it isn't it'll do until someone comes up with something better!...There is NO tuning knob and there is NO tuning dial or pointer, since all frequency indications are read from digital read-out tubes...At the left are ten keyboard buttons, numbered '1' through '0', as well as a re-set button (punched when you wish to 'punch up' a new station frequency) and a button labeled BY-PASS (used to initiate the 'auto-sweep' action which causes the tuner to sweep downward in frequency, automatically locking in on every available signal in your area)...three more buttons, labeled A, B and C ...are used to select three predetermined favorite stations...and there are additional buttons for SQUELCH DEFEAT and STEREO ONLY reception...

"...a tiny test switch button when depressed, lights up all the elements of the digital readout tubes to insure that they are operative. There is also a rotary control which determines the speed at which the AUTO-TUNE action takes place, a noise squelch adjustment control, and an AGC squelch control. A slide switch changes the meter function from signal strength indication to multi-path indication and a second, three-position slide switch selects automatic stereo, partial stereo blend (for reduced noise in weak-signal stereo reception situations with some sacrifice in overall stereo separation), and mono-mix. The right section behind the trap door contains three horizontal slots, labeled A, B and C. These slots correspond to the three PREPROGRAM selection buttons described earlier and, upon inserting three plastic cards no larger than a standard credit card, the buttons can be used to tune in your favorite station which you easily program onto the cards yourself...

"...The rear panel of the AJ-1510...contains antenna terminals for 300 ohm or 75 ohm transmission lines, a dual pair of output jacks as well as horizontal and vertical output jacks for connection to an oscilloscope for observing the nature and extent of any local multipath problems beyond what you can read on the dual purpose self-contained signal meter...

"...we were able to appreciate the amount of thoughtful engineering that went into this unit, both in terms of its performance as well as its kit feasibility. Recent Heathkits have increasingly stressed the modular approach and the AJ-1510 has carried this concept to its ultimate. There is a 'master' or 'mother' board into which are plugged seven circuit boards. Connectors are used throughout, which means that boards can be removed without having to unsolder or unwire a single connection.

"...The heart of the non-mechanical tuning aspect of this unit lies in the voltage-tuned FM front-end, which is of the varactor-tuned type and contains no moving variable capacitor. Instead, a suitable d.c. voltage applied to the varactor diodes determines their effective capacitance. The keyboard, pre-programmed cards, or automatic sweep tuning methods all program a divider circuit. The divider circuit divides the tuner's local oscillator frequency and compares it to a crystal controlled reference frequency and the result of this comparison is the tuning voltage. Changing the divide ratio of the divider circuit changes the d.c. voltage applied to the tuner and a different station is tuned in. Simultaneously, a visual display of the station frequency is provided by the readout circuitry. Because of the crystal controlled reference frequency and the phase-lock-loop circuitry, however, the accuracy of the frequency tuned in is no longer dependent upon the drift-free characteristics of the FM front-end but will be as accurate as the reference crystal frequency and, in the case of the AJ-1510, that means at least 0.005% accuracy!...

"...Do not confuse this 'digital readout' tuner with some units which have recently appeared on the market and simply replace the tuning dial with numeric readout devices. The latter variety guarantee no more tuning accuracy than their 'dial pointer' counterparts. The Heath AJ-1510 is tuned **exactly** to 101.5 MHz when those readout tubes READ 101.5 — and not to 101.54 or 101.47!...

"...There is no doubt that the elaborate 'computer' type circuitry incorporated in the Heath AJ-1510 must represent a fair percentage of its selling price, but even if you ignored it completely (or considered it as a welcome bonus), the tuner's performance as a tuner would justify its total price and then some.

"...Almost as if to reprimand us, when we punched up 87.9 MHz on the keyboard, a light lit up on the front panel and read RE-PROGRAM. (It could have said 'please'...) Realizing that we weren't about to fool this unit, we settled for 88.3, 98.9 and 106.1. These

Heathkit 'classic'

chosen frequencies, together with our not-too-perfect 'screen room' enabled us to read a sensitivity of 1.6 uV. Impressed, we decided that we weren't going to let this one get off so easily, so we tried to measure alternate channel selectivity and, as near as we could figure, it was just about 100 dB!...[With] the total quieting curve, you can interpolate the THD (mono) down to an incredible 0.18% for 100% modulation (as opposed to 0.3% claimed). Ultimate S/N is a very respectable 66 dB....quieting reaches a very usable 56 dB with a mere 5 uV of signal input. In the stereo mode, we remeasured the THD and found that it was only 0.25% for 100% modulation (as against 0.35% claimed) and that, to us, represents a real breakthrough, since stereo THD is usually much higher than mono THD on most tuners and receivers we have measured in the past...

"...Here's a tuner that maintains at least 30 dB of separation from 50 Hz to 14 KHz and hits a mid-band separation figure of 46 dB! Both SCA and 19 and 38 kHz suppression were in excess of 60 dB, which means that SCA interference was absolutely inaudible. Capture ratio measured 1.35 dB as against 1.5 dB claimed... In short, every space was easily met or exceeded and if you compare published specs with the best of the 'ready mades' you're not likely to come up with a finer set of readings anywhere...

"...After spending several hours playing with the keyboard, the automatic sweep, and the dozen or so cards which I prepared with the aid of a small pair of scissors, I got down to the serious business of logging stations...Would you believe 63, without having to rotate my antenna?...

"...We enjoyed the crystal-clear, distortion-free reception we obtained in using the Heath AJ-1510...[it] has got to be the way all tuners of the future will be made. It's very nice to know that Heath has just brought that future into the present..."

Mr. Hirsch comments further: "...the Heath AJ-1510 digital Stereo FM tuner kit is new, with a fresh and imaginative design approach ...and we know of nothing else on the market with comparable features...

"...It is quite impossible, in the available space, to give an adequate description of this remarkable tuner. Anyone familiar with the inside of a typical FM tuner will not recognize this as belonging to the same family. It more closely resembles a small digital computer. There are no moving parts (the tuning is entirely electronic), and almost nothing resembling r.f. circuit components... The i.f. selectivity is provided by sealed multipole inductance-capacitance filters. Not only do they give outstanding alternate-channel selectivity (the kind most of us are concerned with), but it is also easy to separate adjacent-channel signals only 200 kHz apart...

"...our measured performance data on the AJ-1510 met or exceeded Heath's published specifications...The IHF sensitivity was 1.6 microvolts...The 89-dB image-rejection figure was very good, and we confirmed Heath's alternate-channel selectivity rating of 95 dB...The FM frequency response was well within ±1 dB from 30 to 15,000 Hz. Stereo channel separation was exceptionally good — 40 dB at middle frequencies...suppression of 19 and 38 kHz components of stereo FM signals was the best we have yet encountered...

"...tuning the AJ-1510, in any of its modes, is a unique experience. No matter how you go about it, the output is always a clean signal or nothing — not a hint of a thump, hiss, or squawk at any time...for anyone who wants a tuner that is most certainly representative of the present state of the art, and which is not likely to be surpassed in any important respect for the foreseeable future, his search can stop at the AJ-1510."

Kit AJ-1510, "Computer Tuner" less cabinet, 23 lbs. **539.95***
AJA-1510-1, pecan cabinet, 6 lbs. **24.95***

New versatility in 4-channel sound — the Heathkit AA-2004 Integrated Amplifier

Improves what you already own. Thanks to built-in matrix circuitry that decodes matrixed 4-channel recordings and 4-channel broadcasts, the AA-2004 lets you use your present turntable, tape equipment or tuner. Also, the decoder enhances your present record & tape library, and conventional 2-channel FM broadcasts by feeding the "hidden presence" to rear speaker for an extremely satisfying 4-channel effect.

Puts you ahead of tomorrow's developments. As discrete 4-channel media becomes more prevalent, the AA-2004 is ready. Four conservatively rated and fully protected amplifiers produce 260 watts into 4 ohms (4x65), 200 watts into 8 ohms (4x50), 120 watts into 16 ohms (4x30). Controls are provided for every source, mode and installation. Amplifier sections are controlled in pairs with one complete stereo system for left & right front speakers and another for left & right rear — so your AA-2004 can be used to power two separate stereo systems if desired. With outputs for both main and remote speaker systems, it can be used to power two 4-channel systems (up to 8 speakers). Duplicate controls are provided for front and rear bass, treble, balance and volume; phono, tuner, aux, tape & tape monitor inputs. Mode switches select mono, stereo, matrixed 4-channel or discrete 4-channel. And 20 input level adjustments — enough for five separate 4-channel sources — can be reached from the bottom of the chassis. Separate rear-panel jacks give direct access to preamp outputs & power amp inputs, permitting biamplification by simply adding a crossover network.

Performance specs you'd expect from Heath. Make your own comparison of the AA-2004's impressive specifications. Power bandwidth on all channels from less than 5 Hz to more than 45 kHz for 0.25% total harmonic distortion. IM distortion less than 0.2%. Damping factor greater than 100. Hum and noise — 65 dB for phono, –75 dB for tape and aux.

Goes together with traditional Heathkit simplicity. Plug-in circuit boards and preassembled wiring harnesses reduce point-to-point wiring — make the AA-2004 as much fun to build as it is to use. Add the preassembled, prefinished pecan cabinet — and you have the most attractive, as well as the most practical approach yet, to the fascinating new world of 4-channel sound. Get with it...today.

Kit AA-2004, 39 lbs., less cabinet **349.95***
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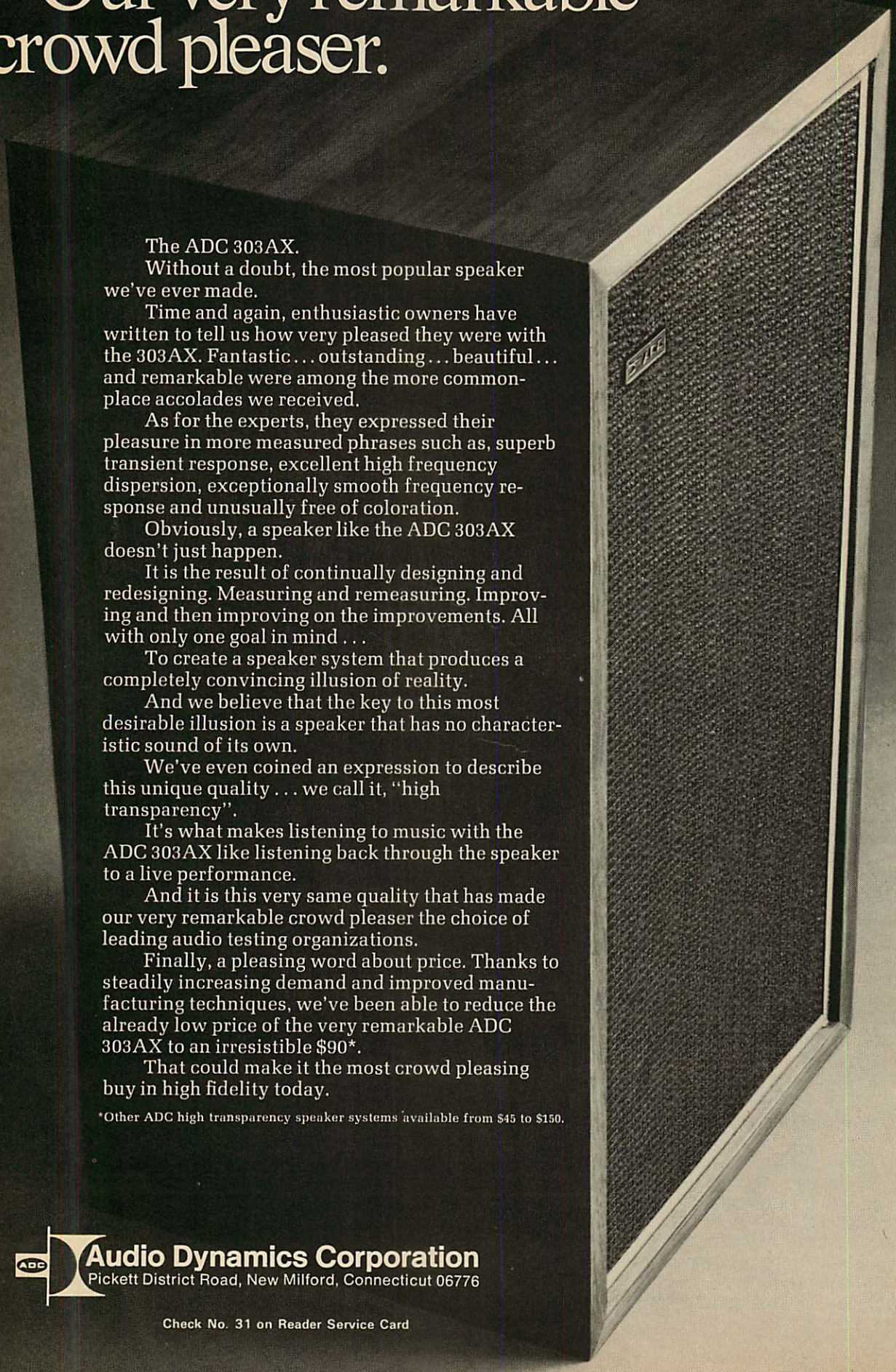

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A Dynamic Noise Filter For Mastering

Richard S. Burwen

Burwen Laboratories, 12 Holmes Road, Lexington, Massachusetts 02173

NOISE IS A PROBLEM! You can't escape it. It is in the environment, electronics used for recording, records, tapes, AM, FM, TV, microwave, and other audio communication media. Noise in studio tape recorders is too high for much of the musical program material being recorded today. Studios without noise reduction equipment usually overcome noise by such undesirable methods as (1) recording at such a high level that peaks far exceed the 1% or even the 10% distortion level of the tape, (2) limiting the signal before recording or (3) monitoring through a speaker system that attenuates the very high frequencies. The rather serious limitations of these methods have been overcome by electronic noise reduction.

Among the three principal methods of noise reduction available for studio mastering two of them, the Dolby Laboratories Noise Reduction System[3] and the Burwen Laboratories Noise Eliminator[2], involve compression of the signal before recording. As a result the signal recorded on the tape is nonstandard and a separate noise reduction channel must be used for each track in multitrack recording.

A third system, the Dynamic Noise Filter, Fig. 1, manufactured by Burwen Laboratories, is much simpler, requires far less equipment, eliminates the problems of nonstandard tapes, and is more versatile than either of the two systems mentioned above. For example, a single two-channel Dynamic Noise Filter operating on a two-track master tape output feeding a disc cutting system, as illustrated in Fig. 2, reduces the cumulative noise from *all* sources ahead of it. Thus two channels of the Dynamic Noise Filter do the job of 18 channels of the other types in the 16-track system of Fig. 2. One of the key advantages of the Dynamic Noise Filter is that it may be used to reduce the noise in any program material without the need for special processing and without audibly affecting the signals.

Principles of Operation

The operation of the Dynamic Noise Filter is based on two principles: (a) the noise output of an electronic system is dependent upon the system bandwidth and (b) the human auditory system "masks out" noise in the presence of the desired signal at frequencies in the vicinity of the signal frequency when the signal-to-noise ratio is sufficiently high. The Dynamic Noise Filter* can be described as an automatically variable bandpass filter whose bandwidth changes rapidly with each musical note and whose high and low frequency cutoffs are independently controlled by the spectral content of the input signal. Figure 3 illustrates the Filter's dynamic frequency response. Noise reduction is achieved by restricting the bandwidth at high and low frequencies when the signal level is very low (the minimum bandwidth is 800 Hz). At medium and high signal levels it passes the full 20 Hz to 20 kHz bandwidth. As in the other noise reduction systems, the Filter reduces noise only for low level signals; the noise is passed along with the high level signals. However, due to the characteristics of the ear, the noise that is present during each note is masked by the music.

The noise reduction, as shown by the minimum bandwidth curve in Fig. 3, is 25 dB @ 30 Hz and 22 dB @ 10 kHz. On 7½ or 15 ips unweighted tape noise the reduction measured typically 10 to 11 dB. Because noise reduction is attainable without any special preprocessing of the signal, the Dynamic Noise Filter is useful not only for a multitrack mix or a master tape playback but also for prerecorded tape, cartridges, cassettes, records, FM programs, or video tape sound.

This versatility comes, of course, at a sacrifice—the bandwidth is restricted for low level signals. However, as will be shown later full bandwidth is attained at such low signal levels and in such a short time that the effect of the Dynamic Noise Filter on most good quality program material is completely inaudible except for the reduction of noise. When musical instruments are played at such a low level that the bandwidth is restricted, they usually produce much less overtone output and little is lost by the attenuation of the high frequencies.

Design Simplification

The system described here is a simplification of an extremely flexible and highly complex Dynamic Noise Filter[1] system described in an earlier paper. The previous system, built in

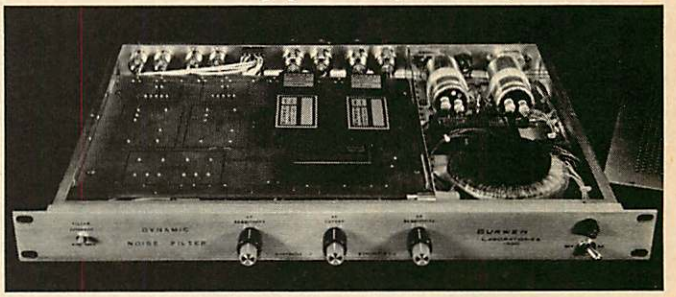

Fig. 1—The Dynamic Noise Filter chassis accommodates modules for 1, 2, 3, or 4 channels.

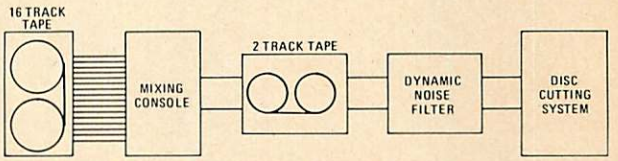

Fig. 2—Two-channel Dynamic Noise Filter reduces noise in a 16 track system.

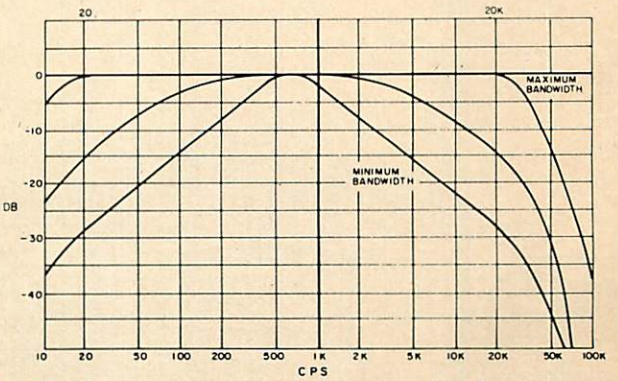

Fig. 3—The frequency response varies with the input signal level.

*Patent pending

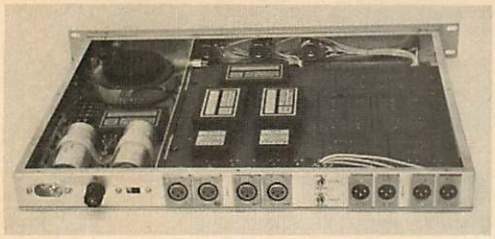

Fig. 4—Rear view.

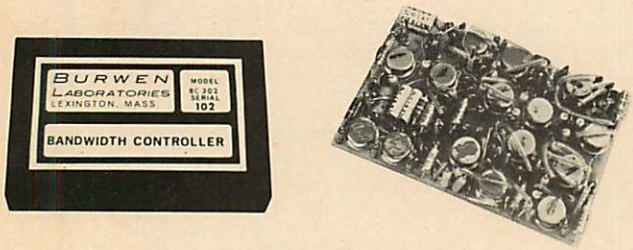

Fig. 5—A high performance module incorporating 15 operational amplifiers.

three channels, incorporated precision multipliers and integrators for bandwidth control and used a total of 320 integrated circuit operational amplifiers mounted on 57 plug-in circuit cards. It provided a choice of cutoff frequencies of 6, 12 or 18 dB/octave at high and low frequencies, a variety of bandwidth limiting functions, four-frequency notch filtering for hum and rumble, and a unique click limiter to eliminate noise impulses from phonograph records. Experiments made with this unit on a wide variety of program material indicated that the steeper slopes were preferred mainly for old material having high frequency distortion or completely lacking in the very high frequencies. For wide frequency range program material it was found that the same noise reduction could be achieved using a 6 dB/octave filter having a high cutoff frequency considerably below the minimum tolerable for 12 or 18 dB/octave filters. Furthermore, the 6 dB/octave filter seems to produce smoother operation on low level classical music.

In an instrument optimized for studio mastering, the notch filters for hum and rumble along with the click limiter and a number of the controls were deemed expendable luxuries. The use of common control circuits for two channels saved a considerable number of components while preserving the stereo balance. Thus a simplified Dynamic Noise Filter, Figs. 1 and 4, evolved having a minimum of controls and accommodating 1, 2, 3, or 4 channels on a single 1¾" high rack panel. Operational amplifiers are still used extensively to achieve a 100 dB dynamic range with 0.01% midband harmonic distortion. The system is built using high quality, reliable plug-in modules, such as is shown in Fig. 5, involving a total of 80 operational amplifiers for four channels with as many as 15 in a single module.

Block Diagram

The modules can be arranged into as many as four signal channels and the configuration for one channel is illustrated in Fig. 6. The input signal is first fed to the active transformer which is a unique differential input d.c. amplifier. It serves the same function as a conventional audio transformer and provides the same common mode rejection while overcoming the transformer's limitations in frequency response, distortion, and hum pickup. The signal from the active transformer is fed to two other modules, the voltage variable bandpass filter and the bandwidth controller, which form the heart of the

noise reduction system. At the input to the bandwidth controller signals from two channels are added. Inside the module the high and low frequency components are selected out and individually rectified, filtered, and compressed to form two separate d.c. control voltages that adjust the cutoff frequencies of the voltage variable bandpass filter. The control voltages vary the bandwidth of the system in relationship to both the frequency content and level of the input program material.

The Voltage Variable Bandpass Filter

The key module in the noise reduction system, the voltage variable bandpass filter, is shown in block form in Fig. 7. The signal from the active transformer is brought to the input of the module where a feedback type pre-emphasis network increases the high frequency gain at 6 dB/octave above 3 kHz for the purpose of increasing the signal-to-noise ratio. At the output of the module the response is flattened by a complementary de-emphasis network and output buffer amplifier.

Following the pre-emphasis network the signal passes through a multiplier, X1, which attenuates the signal in accordance with the value of the high frequency d.c. control voltage produced by the bandwidth controller. The multiplier then feeds the main signal operational amplifier, A1, which in turn delivers its output to the de-emphasis network. Three separate feedback paths around A1 determine the high, middle, and low frequency gains of the module.

The first feedback path via capacitor C1 converts A1 into an integrator and reduces the high frequency gain. The gain from the input to the output at very high frequencies is the product of the gain of the multiplier X1 and the integrator A1. At middle and low frequencies, where the gain allowed by capacitor C1 is high, the closed loop gain is determined by the ratio of the values of resistors R6/R1. At low frequencies the feedback is further increased by the multiplier X2, the integrator A3, and the inverter A2. Combining the three feedback paths produces virtually infinite d.c. feedback and reduces the system gain to 0 at d.c.

Changing the high frequency cutoff point is achieved by varying the high frequency control voltage supplied by the bandwidth controller. Increasing the control voltage on multi-

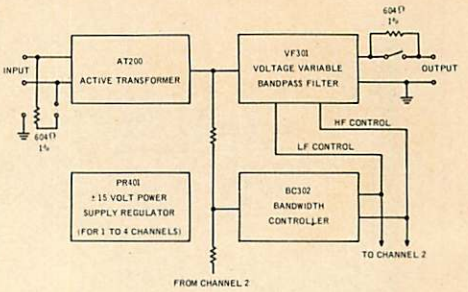

Fig. 6—Single channel system diagram.

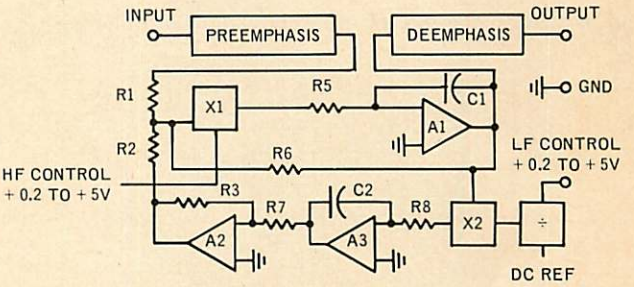

Fig. 7—Block diagram of Voltage Variable Bandpass Filter module.

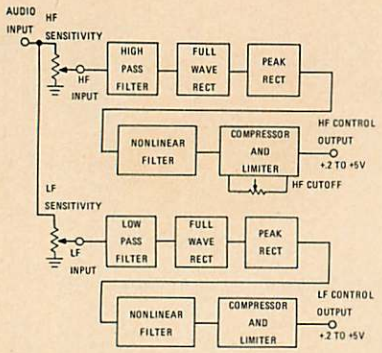

Fig. 8—Block diagram of the Bandwidth Controller.

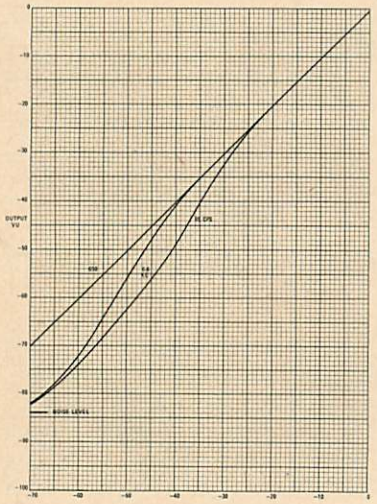

Fig. 9—Output vs input at 85 Hz, 650 Hz, and 6.6 kHz.

plier X1 effectively reduces the time constant of integrator A1 and raises the high frequency cutoff in direct proportion to the voltage.

The low frequency cutoff is changed by causing the feedback path made up of integrator A3 and multiplier X2 to predominate over R6 at low frequencies. Changes in the gain of the multiplier and the effective time constant of the integrator are caused by the low frequency control voltage generated by the bandwidth controller. Increasing the d.c. control voltage delivered to the multiplier X2 effectively reduces the time constant of the integrator A3 and raises the low cutoff frequency. What is desired is a reduction in low cutoff frequency for an increase in low frequency control voltage. To accomplish this, the value of the low frequency control voltage is inverted by dividing it into a d.c. reference in the divider block causing a value to +0.2 V to produce a 350 Hz frequency cutoff and +5 V to produce a 13 Hz low frequency cutoff.

The frequency response curves produced for d.c. control voltages of 0.2 V, 1 V, and 5 V at both control inputs are the same as in Fig. 3. Note that the midband gain is constant and determined by R6/R1 and the wideband response is flat within 0.2 dB from 20 Hz to 20 kHz. These curves are very similar to the curves that would be produced by feedback around A1 via R6 at middle frequencies, through a variable capacitor at high frequencies, and through a variable inductor at low frequencies if the remaining components were removed.

The Bandwidth Controller

The bandwidth controller which produces the high and low frequency d.c. control voltages is shown in more detail in Fig. 8. External to the module are high frequency sensitivity and low frequency sensitivity potentiometers which divide down the summed output of the active transformers in channels 1 and 2. The arm of the high frequency sensitivity potentiometer feeds a high pass filter which selects out frequencies primarily in the vicinity of 6.6 kHz and provides considerable amplification. The high frequencies are then full wave rectified and peak rectified using a precision feedback circuit that produces accuracy down to millivolt levels. A multiple section nonlinear filter is used to smooth the output of the peak rectifier sufficiently to eliminate modulation of the bandwidth at any audio frequency. The filter is a nonlinear feedback system which can charge rapidly and takes only 1 mS to reach full output. Its decay time is approximately 50 mS to within 10% of final value. The output of the nonlinear filter passes through a compressor and limiter circuit which increases the effect a small audio input has on the bandwidth. An external high frequency cutoff potentiometer places an upper limit on the +0.2 to +5 V control voltage anywhere within this range, and may be used to limit the bandwidth for poor quality or distorted program material.

The low frequency d.c. control voltage is generated in the same manner as the high frequency control voltage following the low frequency sensitivity potentiometer. In this part of the bandwidth controller the low frequencies primarily in the vicinity of 85 Hz are used to produce the d.c. control output and the time constants are longer. The low frequency attack time to produce +5 V output from an overdrive input is 10 mS and the decay time is approximately 500 mS to within 10% of the final value. The low frequency part of the controller is about 14 dB less sensitive than the high frequency section because music tends to have more low frequency energy than high frequency energy.

In choosing the attack and decay time constants for the high and low frequency sections of the bandwidth controller, an attack time of 1 mS to attain the full 32 kHz bandwidth was found to be short enough for no audible effect on musical transients. On the other hand, it was found undesirable to shorten the attack time further because this allowed the ticks on a record to actuate the filter. The decay time seemed to be optimum at about 50 mS to within 10% of final value. A shorter time reduced the effective reverberation in the program material and a longer time allowed more noise to be heard between the notes.

The low frequency attack and decay times appeared to be somewhat less critical but had to be longer to support the low frequency response and prevent more than 0.05% harmonic distortion on a low level 20 Hz signal.

Other Features

Each channel has a differential input with a 100k impedance which may be changed to 600 ohms by means of a rear panel switch. The overall voltage gain of each channel is 0 dB ±0.1 dB and the maximum output is ±11V instantaneous peak into an open circuit, +18 dBm into 600 ohms, or +16 dBm into 150 ohms. The output is single ended, grounded to the chassis and has an internal impedance of 0.4 ohms to which 600 ohms can be added by means of a rear panel switch.

A 0.01% regulated ±15 V power supply powers all four channels. The transformer is toroidal for low external magnetic field, and the positive and negative voltages are interlocked and overvoltage protected so that a supply failure will not damage the other modules.

Performance

A measurement of the output vs input, Fig. 9, shows that the Dynamic Noise Filter behaves as a linear amplifier at

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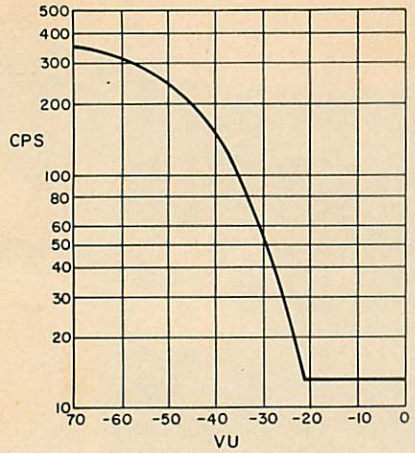

Fig. 10.—Low frequency cutoff vs input at 85 Hz.

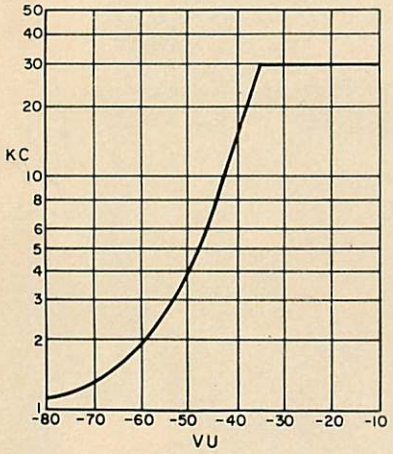

Fig. 11—High frequency cutoff vs input at 6.6 kHz.

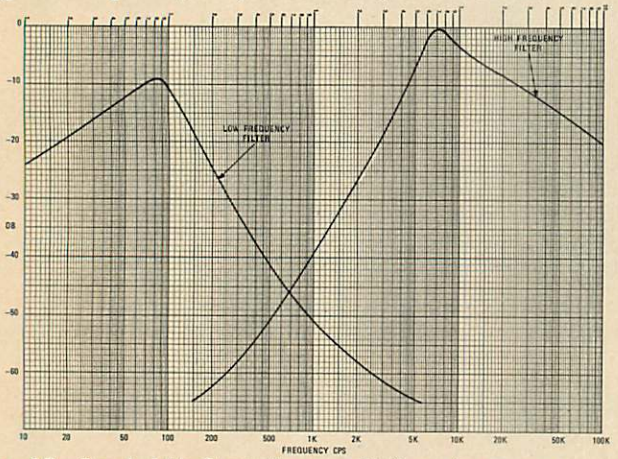

Fig. 12—Bandwidth Controller sensitivity vs frequency.

650 Hz but appears to be a low level expander at 85 Hz and 6.6 kHz. These measurements were made at the typical control setting used when playing a multitrack mix or a master tape. It can be seen that the expansion takes place at a very low level in the range of –75 to –35 VU at 6.6 kHz. What is really happening, of course, is that the bandwidth is being extended as the signal increases.

Another way of looking at this same effect is to plot the –3 dB bandwidth vs input as shown in Fig. 10 at 85 Hz and in Fig. 11 at 6.6 kHz. These frequencies are the points at which the bandwidth controller is most sensitive as shown by the response curves of the bandwidth controller filters in Fig. 12. At other test frequencies the bandwidth variation will occur at higher levels as determined by these curves.

The sensitivity can be varied over a wide range to shift the curves in Figs. 9, 10, and 11 up and down in level to suit the particular program material. Generally, the low frequency sensitivity is set so that rumble just begins to operate the low frequency filter and the high frequency sensitivity is set so that hiss just begins to operate the high frequency filter.

As in other types of noise reduction systems, the Dynamic Noise Filter discriminates best between the music and the noise when the signal-to-noise ratio is high initially. When used with extremely noisy program material such as a 78 rpm record, the controls have to be set for a compromise between noise reduction and degradation of the program material. Many 78 rpm records contain only noise and distortion in the region of 6.6 kHz and there is some advantage in cutting off the high frequencies at 12 dB/octave at a somewhat lower frequency ahead of the Dynamic Noise Filter. Since the filter attenuates the high frequencies at small signals as low as 1100 Hz, it produces worthwhile noise reduction in excess of that attainable with a fixed filter. The tone can be balanced for pleasing response following the Dynamic Noise Filter.

In listening tests an interesting psychological effect was observed. A reduction in tape hiss seems to be accompanied by an attenuation of the high frequency content in the program material even when it does not actually occur. This effect can be confirmed by adding hiss to a noise-free signal in which case the high frequency output seems to be somewhat increased.

Applications

The Dynamic Noise Filter achieves 10-11 dB of noise reduction on tape program material by performing as a constant gain filter whose instantaneous bandwidth is a function of the program content. It has the advantage over other noise reduction methods in its ability to reduce noise arising anywhere in a system ahead of the filter. In contrast, the Dolby Laboratories Noise Reduction System and the Burwen Laboratories Noise Eliminator are both designed to prevent the recording system from introducing noise into the program material but they are not designed to improve existing noisy program material.

For live recording on 16 tracks followed by a two-track tape master and then a two-channel disc, 18 channels of the Dolby Laboratories Noise Reduction System or the Burwen Laboratories Noise Eliminator are normally used. By recording non-standard signals on the tape the former achieves 10 dB noise reduction and the latter as much as 50 dB. Alternatively, the signal can be recorded on the 16-track machine and then on the two-track machine in normal manner without noise reduction and played through a two-channel Dynamic Noise Filter inserted before the tape duplicating equipment or a disc cutter.

The range of applications for the Dynamic Noise Filter is just now being explored. Potential exists in the AM, FM, and television broadcast fields as well as in theatre sound systems, and rerecording of historic material. For the audio engineer the Dynamic Noise Filter is a new, versatile, and economic tool by which he can control the noise present in his environment, his equipment, his recordings, and his program material.

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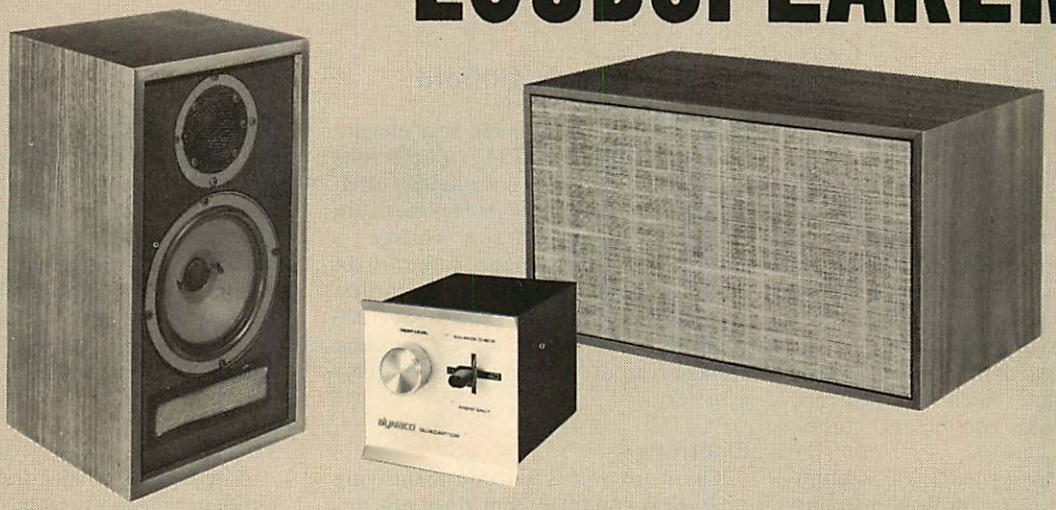
2 NEW DYNACO A-10 LOUDSPEAKERS



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Martin Clifford

LANGUAGE, basically intended to improve communications, sometimes behaves perversely and, seemingly deliberately, compounds confusion. The word *components* is an example. In high fidelity it refers to the parts of a system—the tuner, amplifier, record player, tape deck, and speaker system. But it also means the individual parts that comprise these components—parts such as resistors, capacitors, coils, conductors, tubes, and solid-state devices.

These electronic parts or components, although different in appearance and behavior, all have a common function—to take a signal voltage, guide it, strengthen it, and to let it emerge unscathed to the final transducer—the speaker system. Unfortunately, the word *voltage* is a simplification and gives us no inkling of the large variety that exists.

Voltages are easy to produce; so easy in fact, it's almost impossible to avoid doing so. Walk across a rug, rub your lapel, drive your car—in each instance you produce a voltage, sometimes more elegantly known as an electromotive force and promptly made less elegant by abbreviating it as EMF. These voltages are not always controllable—often just a nuisance, but sometimes are dangerous. Controlling a voltage is easy if it is man-made rather than naturally produced. One of the earliest man-made techniques (now about 200 years old) for producing a controlled voltage is to use a chemical technique—a battery.

Electrons

The word *volt* is a name identifying a physical condition, but does not describe it. Voltage is predicated on the behavior of extremely tiny particles called electrons. Electrons are associated with atoms and form part of their structure, and because of this may be termed bound electrons. Electrons, though, may also be independent or free. Their unique feature, whether atom associated or not, is that they all carry a negative electric charge. Get enough of them together on some surface and you will have developed an electrical pressure, or force, between the electron-crowded plate and a nearby plate relatively free of electrons. This electrical pressure, created by the fact that each electron demands its *lebensraum* and repels other electrons, is voltage. Voltage, or electrical pressure, or electron pressure, or EMF, is due to a difference in electron quantity on two surfaces, often adjacent. However, when electrons do move, they are referred to as a current. And so voltage and current are inextricably bound. It is possible to have voltage without current flow just as it is possible to have physical pressure without movement, hence the use of separate labels, voltage and current, makes electronic sense.

The Battery

A battery is a chemical method for removing electrons from one substance and then transferring and storing them on another. Two identical metal plates adjacent to each other in a glass of water do not supply a voltage since the number of electrons on each plate may be about the same. Change the plates so they are of different metallic substances, immerse them in an alkaline or acidic liquid and you have a voltage-producing device. The liquid (Fig. 1) called an electrolyte, robs one of the plates of electrons and transfers them to the other plate. Since electrons have a negative charge, the electron-enriched plate or electrode becomes negative (or minus). The other plate, deprived of many of its electrons is less negative than formerly, or, saying the same thing, is positive (or plus). An electrical pressure or EMF now exists be-

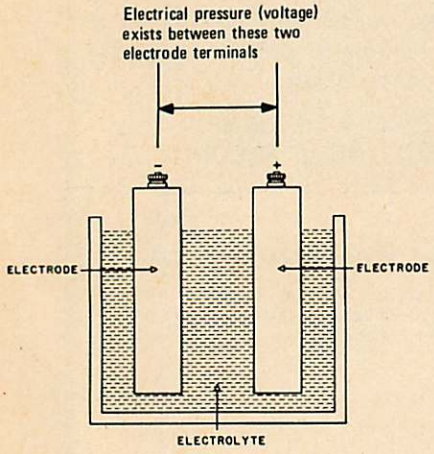


Fig. 1—Electrons taken from the electrode at the right make it positive. The electrons move through the electrolyte to the electrode at the left, making it negative. An EMF now exists between the two electrodes.

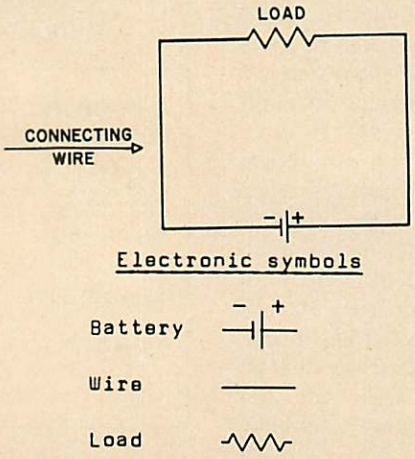


Fig. 2—A load is any device drawing current from a voltage source, such as a battery.

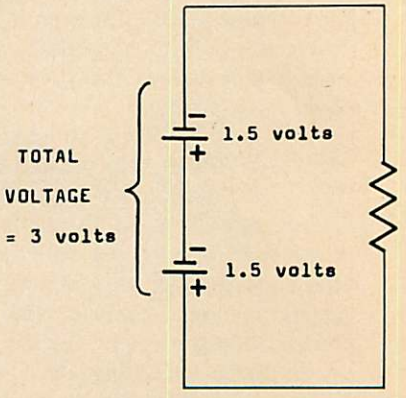


Fig. 3—When cells are connected in series the total voltage is the sum of the individual cell voltages.

tween the two plates. There is an electron migration inside the battery from one plate to the other and because there is no longer an electron balance there is a voltage between the exposed terminals connected to the electrodes. Connect a wire (Fig. 2) from one terminal to the other and there will be a flow of current through it, external to the battery. It is this external current we want to use and control.

Cells And Batteries

Technically, this voltage producing chemical factory isn't a battery, but a cell with two or more connected units does form a battery. The current obtainable from a cell is a function of its physical construction. The larger the electrode plate area, the greater the current capability. A 12-volt car battery is much larger and heavier than eight 1½-volt transistor batteries. The big difference is one of current capability, not voltage.

More Voltage, More Current, Or Both

To get more voltage we connect cells in series (Fig. 3), an arrangement in which the plus terminal of one cell is wired to the negative terminal of the next, analagous perhaps to circus elephants proceeding in single file, trunk to tail. To get more current (Fig.4), we wire cells in parallel (or shunt) with all plus terminals connected, and all minus terminals connected. To get more voltage *and* current (Fig. 5), we combine series and parallel wiring methods.

Current Flow Opposition

The movement of current, whether through a liquid or solid, isn't smooth or free, but encounters a certain amount of opposition generally known as resistance. Any substance that permits the relatively easy passage of electrons through it is called a conductor, but the amount of opposition or resistance to electron passage varies, depending on the material of which the substance is made, its volume, and the temperature. Copper is a commonly used conductor. So is aluminum. Silver is a much better conductor (it has less resistance) but is much more expensive.

However, we are not only interested in forcing a current to flow through a wire but to get it to do some useful work in the process. Thus, the external current flow of a battery can be made to do this by inserting some component, such as a light bulb, in the wire connecting the battery terminals. (Fig. 6)

Current Control

To permit current to move with minimum opposition from one point to another, we connect them with copper wire. This permits maximum flow, but it is often in our interest to regulate the amount of current, to permit only precise amounts to flow between parts. Resistors are simple devices for letting us do so. Made of carbon compressed with a special binder or a special kind of wire alloy (such as the wires used inside your toaster), they can govern current quantity quite effectively. The larger the amount of resistance, the smaller the flow of current. A substance that allows very little or no current flow at all is called an insulator. Resistors are used to govern amount of current flow; insulators for keeping currents in their proper paths.

The basic unit of resistance is the ohm, often represented by the Greek letter omega Ω. Multiples of the ohm are the kilohm, abbreviated as KΩ, or thousand ohms, and the megohm, often abbreviated to meg.

Some resistors, particularly those designed for use in test instruments, are manufactured with considerable precision. Inexpensive, mass-made receivers may use resistors having wide tolerances. Precision costs money but precision is often needed for very fine current control.

Resistor Combinations

Although the resistor is a current-controlling component, further refinement in current control is obtainable by connecting resistors in various combinations. One technique is to wire resistors so that the total opposition to current flow is increased. Known as a series circuit, just as in the case of series-wired cells, the resistors are connected so that the same current flows through each. Thus, a 100-ohm resistor in series with another 100-ohm resistor, behaves like a single 200-ohm unit. Resistors can be wired in series to obtain values not normally obtainable. The total resistance is then equal to the sum of the value of the individual resistors.

Another current controlling technique using resistors is to wire them in parallel or shunt (Fig. 8), a method that reduces the overall resistance. When two resistors are in parallel, the current has two paths, hence the opposition to flow is lowered. To find the equivalent resistance of two resistors in parallel involves arithmetic, but nothing more than ordinary multiplication and division. Multiply the values of the two resistors and then divide by their sum. If you have a 6-ohm resistor in parallel with a 3-ohm unit, $6 \times 3 = 18$. The sum of 6 and $3 = 9$. 18 divided by $9 = 2$. Thus, a 6-ohm resistor in

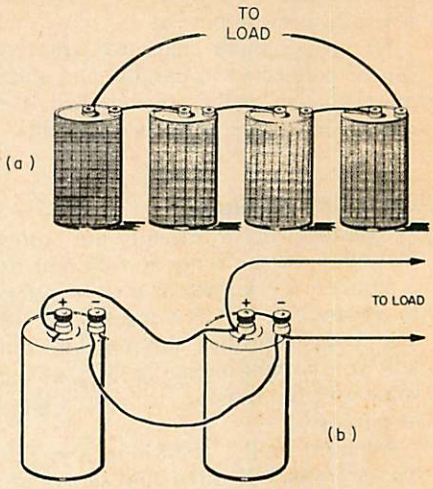


Fig. 4—Cells can be wired in series (a) to supply more voltage, or in parallel (b) to supply more current.

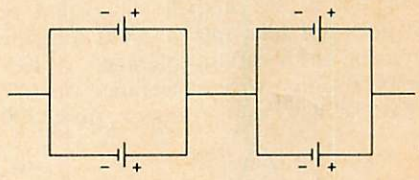


Fig. 5—Circuit diagram of a series-parallel arrangement of cells.

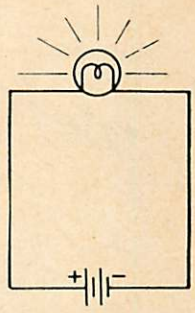


Fig. 6—In this diagram the current is utilized to light a lamp.

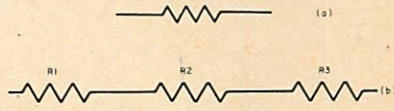


Fig. 7—Symbol for a resistor (a) and resistors in series (b). When resistors are series connected, the total resistance is equal to the sum of the values of the individual resistors.

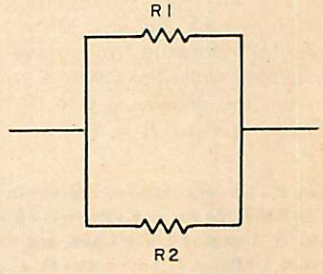


Fig. 8—Resistors in parallel.

parallel with a 3-ohm resistor behaves like a 2-ohm component.

Of course more than two resistors can be connected in parallel and since more current paths are supplied, the overall resistance is reduced further*.

Codes And Values

Resistors in a circuit are often identified by the letter R followed by a number. R1, known as a code, refers to resistor No. 1. R18 is resistor No. 18. The code identifies the resistor, but tells you nothing more—nothing of the value of the resistor, its size, shape, or purpose.

Adjacent to the resistor in a circuit diagram you will often find the value. This may be given as a simple number, such as 1,000, or the number may be followed by the omega symbol for resistance. The value supplied in the diagram is the median value—that is, it does not take into account that the resistor has a certain tolerance. A 100-ohm resistor with a tolerance of 10% may have a value ranging from 100 ohms + 10% to 100 ohms - 10%. On the diagram, though, the resistor will be identified as 100 ohms, but its true value may be anywhere from 90 ohms (100 ohms - 10%) to 110 ohms (100 ohms + 10%).

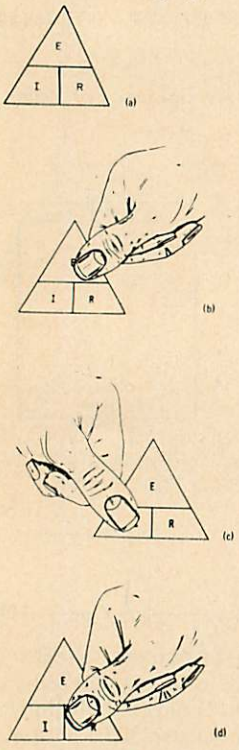


Fig. 9—Ohm's law. The triangles are a memory aid for remembering the various forms of the law. Ohm's law triangle (a). Drawing (b) shows how to determine voltage. Cover E with a finger and the answer is I × R. In (c) I = E/R and in (d) R = E/I.

***The formula for more than two resistors in parallel is: 1÷Re = 1÷R1 + 1÷R2 + 1÷R3 . . .**

Let R1 = 3 ohms, R2 = 6 Ohms, and R3 = 2 ohms, then 1÷Re = (1÷3) + (1÷6) + (1÷2) = 2/6 + 1/6 + 3/6 = 1 ohm.

Voltage, Current And Resistance

Voltage is often represented by the letter E, current by the letter I, and resistance by R. These three are inextricably involved, for we start with an electrical pressure, E, produce a current I, which flows through a conductor or resistor having a certain amount of resistance, R. The relationships of E, I, and R are simple and direct and are best represented by a simple formula known as Ohm's law: E = I × R. This formula (Fig. 9), probably the most widely used in electronics, is less formidable than it looks. It simply states that if you know the amount of current (in amperes) and multiply it by the amount of resistance (in ohms) your answer will be the voltage (in volts). The formula can be rearranged to read: I = E/R. Divide the amount of voltage by the amount of resistance, and the answer will be the amount of current. And in its third form, Ohm's law looks like this: R = E/I. Divide the voltage by the current value to obtain the amount of resistance.

Fixed vs Variable Resistors

The technique for current control by wiring resistors in series, in parallel, or possibly series-parallel combinations, is useful but it has limitations. Sometimes the amount of current flow needs to be varied smoothly and continuously over fairly wide ranges. This can be done by means of a variable resistor (Fig. 10), known formally as a potentiometer and less formally as a pot. Every hi-fi system has a number of these components controlled by knobs from the front panel or as a screwdriver-adjust type on the rear apron of a component such as an amplifier or speaker system. The pot consists of a resistive element on which a sliding element makes contact.

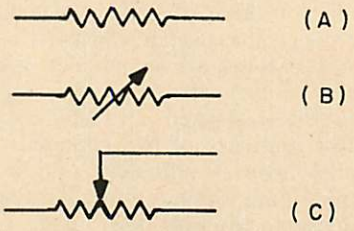


Fig. 10—Resistors can be fixed or variable. Symbol for a fixed resistor (a). Two symbols can be used for variable resistors, as in (b) or (c).

Power

There are a number of types of energy: chemical, heat, light, electrical. Power is the rate at which energy is produced or used. The basic unit of electrical power is the watt, with submultiples such as the milliwatt (thousandth of a watt) and the microwatt (millionth of a watt). Going in the other direction, a kilowatt is a thousand watts, and a megawatt is a million.

There are various ways of calculating power, one of the more commonly used being the product of voltage and current. Multiply the current (in amperes) by the voltage (in volts) to obtain the amount of power (in watts).

Some electronic parts, notably resistors, both fixed and variable, are rated in terms of watts, a measure of their power handling ability. Resistors range from as little as 1/8th watt to units having values of 100 watts or more. The wattage of a resistor is an indication of its ability to dissipate heat, a consequence of the friction of electron movement through the resistor. The wattage rating of a resistor is an economic factor: the higher the wattage rating, the greater the cost. Wattage ratings are also applied to components, such as audio power amplifiers, but in this instance the rating indicates the sound power output capability of the amplifier.

Meaning of D.C.

The movement of current external to a battery is uncomplicated. Current always flows from the negative terminal of the battery, through a device (Fig. 11) such as a lamp or a resistor, and then back to the positive terminal. Inside the battery the current moves from the positive to the negative terminal, but normally our concern is with the external movement only.

Current movement is unidirectional no matter what arrangement of resistors or other components are wired to the battery. Because of this steadfastness

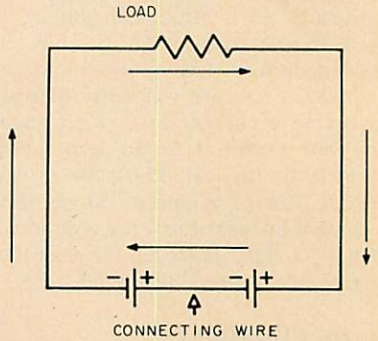


Fig. 11—Arrows are often used to indicate direction of current flow.

The Dual 1219.

Still the favorite of the purist who insists upon a full-size professional turntable.

Ever since its introduction two years ago, the 1219 has been widely acclaimed and accepted as the "no-compromise" automatic turntable.

Today, it is still the favorite of the more serious music lovers, those purists who are never quite satisfied unless every component in their system is "state-of-the-art."

From years of listening, these record lovers know that on a Dual, any Dual, records are preserved indefinitely and continue to sound as good as new no matter how often played. Yet over the years, they have purchased more "high-end" Duals than any other model. Readers of the largest music magazine, for example, have purchased more 1219's than any other turntable at any price. That is quite a tribute for a turntable that sells for $185.00.

The reasons for the 1219's continued popularity vary from purist to purist. To many, it's the tonearm, centered and balanced within the two concentric rings of a gyroscopic gimbal. With horizontal bearing friction less than fifteen thousandths of a gram. When a cartridge actually arrives that can track at a quarter of a gram, this tonearm will do it full justice.

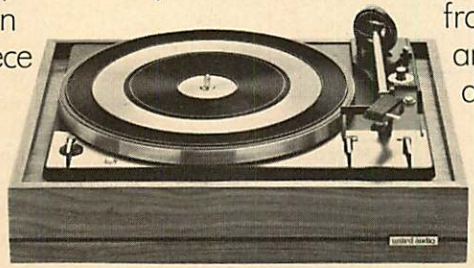
To others, the 1219's platter is important. It's a full-size 12 inches in diameter, cast in one piece non-magnetic zinc alloy, and individually dynamically balanced. To drive this massive seven pound platter, there is a powerful continuous-pole motor that brings it up to full speed in less than half a revolution. Then the motor's synchronous element takes over to hold speed at absolute constancy.

We find that most people interested in a turntable of the 1219's caliber use it primarily in its single-play mode. So the tonearm was specifically engineered to perform precisely as a manual tonearm: parallel to the record instead of tilting down. This is accomplished by the Mode Selector which lowers the entire tonearm base for the single-play mode. And raises it for the multiple-play mode.

To the purist, all of the 1219's many precision features are important. But in the end he buys this Dual for the same reason a non-purist buys it. For its uncompromised performance and absolute reliability.

If you'd like to know what the independent test labs say about the 1219, we'll send you complete reprints of their reports. Plus a reprint of an article from this magazine that tells you what to look for in record playing equipment.

Better yet, just pay a visit to your franchised United Audio dealer and ask him for a demonstration. Dual®



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of direction, the current is called direct, promptly abbreviated as d.c., and leading to such anomalous phrasing as d.c. current which could be translated as direct current current. The voltage that produces a direct current is a direct voltage, also abbreviated as d.c. and translatable as direct current voltage. Because of this moderate confusion in terminology, d.c. is often specified as d.c. current or d.c. voltage. Some of the currents that flow through high-fidelity components (tuners, receivers, etc.) are direct. Others, however, more or less periodically, reverse their direction of movement.

Alternating Voltages And Currents

It is possible to reverse the direction of current flow from a battery by transposing its connecting leads. The external battery current still flows from negative to positive or minus to plus, but now the current direction through the resistor is reversed.

An easier method of producing current reversal is through the use of a generator, a large sized version of which delivers voltage and current to the outlets in your home. The basic idea of the generation of a voltage by mechanical rather than chemical means (as in a battery) is an extremely simple one. A magnet (Fig. 12) is plunged into a coil and then removed, with the process being repeated regularly.

The moving magnetic field of the magnet as it goes into the open form around which the coil is wound causes some of the electrons inside the coil wire to collect at one end of the wire, leaving the other end with a deficit. However, an electron displacement, just as in the case of a battery, means the production or generation of a voltage. In the case of the coil, the end with the electron surplus is negative; the other end is positive.

However, when the freely moving magnet is pulled out of the coil, the situation is reversed. The electrons rush from the crowded end to the opposite end of the coil. This crowded end is now negative, because of its electron surplus, while the opposite, electron-poor end, is positive. Note that the voltage hasn't disappeared, but the polarity has been transposed. Because of this action, the voltage is referred to as alternating; the polarity of the voltage at the ends of the coil changes alternately. The back and forth surge of current in the coil, reminiscent of the current inside a battery, can be taken out by connecting some device to the ends of the coil—a device such as a resistor or a lamp. The current, of course, will move back and forth through the external device, hence the current is also referred to as alternating. Alternating voltage and alternating current are both identified by the abbreviation a.c. A.c. current means alternating current current bringing us right back to our earlier terminology fracas. Just say a.c. voltage or a.c. current and be done with it.

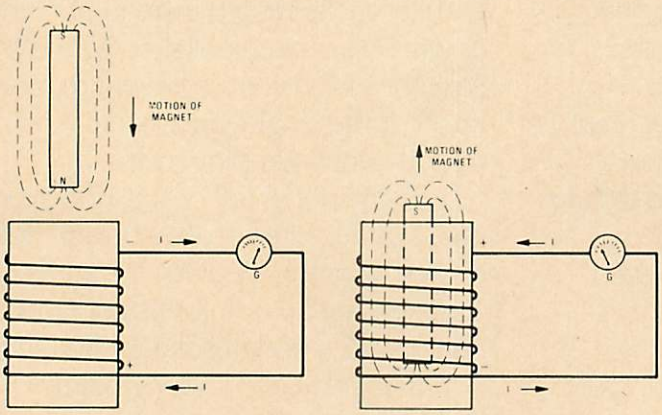

Fig. 12—Electromechanical method of generating a voltage. The voltage produced is a.c. The small circle with the letter G indicates a galvanometer, a sensitive current measuring instrument.

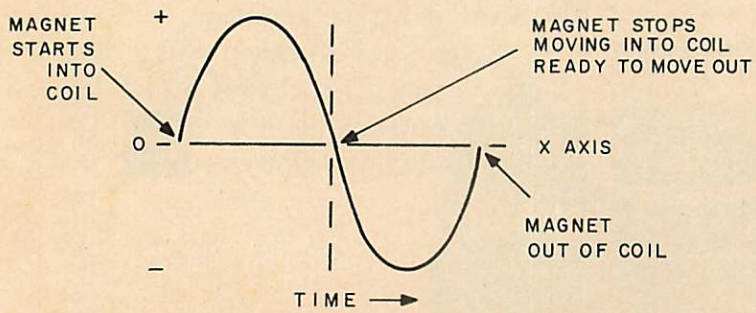

Fig. 13—Sine wave of voltage or current produced by the generator.

Back To The Sine Wave

The movement of the magnet into and out of the coil results in a sine wave (described in the previous installment) of voltage and current (Fig. 13). As the magnet moves into the coil, current starts to flow until it reaches a peak. Ultimately, of course, the magnet will need to stop to begin its reverse travel. At the moment it stops there is no voltage or current. This is indicated at the point where the graph crosses the X-axis or zero line. When the magnet is pulled out of the coil, the current increases to maximum again and then decreases as more and more of the magnet comes out of the coil form. When the magnet is completely out and stops moving, the graph once again crosses the X-axis.

There is nothing mysterious about the sine wave. The portion above the X-axis indicates that the current is flowing in one direction. The portion below the X-axis shows that the voltage has reversed its polarity and that the current is now moving opposite to its original direction.

Back To Frequency

The faster the magnet is pushed in and out of the coil form, the more often the polarity of the voltage reverses, simply another way of saying that the frequency is higher. The amplitude or strength of the sine wave depends on the strength of the magnet, and on the number of turns of wire of the coil. The voltage produced across the ends of the coil is sometimes referred to as an induced EMF. Any wire carrying an alternating current is surrounded by a varying magnetic field, capable of inducing a voltage in any nearby conductor, not necessarily a coil. That is why it is inadvisable to place power line cords (such as lamp cords) adjacent to FM antenna lead-ins, or to put a record player directly on top of a tape unit.

The combination of coil and magnet is known as a generator, an electromechanical device for producing a.c. It is eminently suitable for power-line frequencies, such as 60 Hz, but purely electronic generators are used for the much higher frequencies required in broadcasting.

(To Be Continued)

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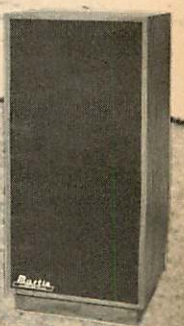

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How A Turntable Is Profiled

TESTING AND EVALUATING audio equipment is one of the most interesting facets of preparing the editorial content of a magazine, and since the early 1950's has been an important function of practically every magazine in the field, both in this country and in hi-fi magazines throughout the civilized world. How it is done is usually unexplained and in any case is likely to invite criticism from readers and manufacturers alike—the latter particularly if the finished profile does not paint the product in as glowing terms as the advertising might have done. But in this writer's opinion, no test report is of value to the reader unless it tells the bad features of the product as well as the good ones. The advertising always tells the good points, but if there are any deficiencies in operation, they should be pointed out to the reader. In most instances, a product which does not come up to its specifications is not reviewed in print—the manufacturer is advised of the results of the tests, and if satisfactorily explained the profile is rechecked to determine the actual performance. If the recheck is still unsatisfactory, the profile does not appear in print. Fortunately, that happens only rarely, for most manufacturers offer equipment that has stood the tests of time or of continual upgrading by the factory to ensure that the product will be as good as possible in order to be a success on the market.

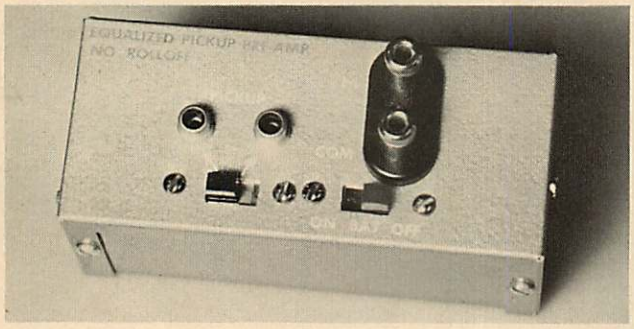


Fig. 1—Exterior view of battery-operated preamp used to provide sufficient gain for use in turntable measurements. Since this photo was taken, another switch has been added to place a 10-μF capacitor in the feedback circuit to give flat response.

Fig. 2—Inside view of the preamp. Entire circuit is on etched board which plugs into circuit-board socket shown at right.

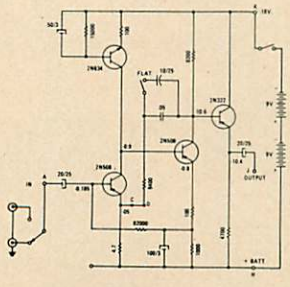


Fig. 3—Circuit of the battery-powered preamp used to boost output from magnetic cartridge to level adequate for measurements.

The Test Procedure

The first step in testing is the unpacking. This seems simple, but when it must be considered that the product is to be returned to the manufacturer is the same condition it was received, the unpacking operation becomes important. Placement of packing material, wrapping in the usual plastic bag, protection of the external leads, placement of accessory equipment—all are important when the equipment is to be repacked. Our custom is to replace all the corrugated cardboard material, plastic wrappers, rubber bands, and any other surplus items back in the original shipping box. Some manufacturers provide diagrams on the outside box or on an enclosure which show just exactly how the unit should be repacked, and to these manufacturers go our unqualified thanks. It is often a month after unpacking before the unit is to be returned to its box and thence to the manufacturer, so the routine of unpacking is likely to have been forgotten. That is why we applaud the diagrams which make the job easier.

The equipment is then given a visual inspection to determine its various features, as well as to aid in restoring it to its normal condition before the actual testing begins. Then it is photographed as a whole, and in as many separate shots as seem to be desirable to point out the specific characteristics of the product. For a turntable, this implies shots of the controls, the platter—often from top and bottom—the arm and its features, the top of the unit with the platter removed, and the underside of the chassis. This usually results in from six to ten separate "poses," with four to six usually ending up in the profile as it appears in the magazine.

The unit is then reassembled, and if a cartridge is not supplied with and mounted in the head or on the cartridge slide, we pick out a reliable make of cartridge and install it. Since we are not measuring cartridge characteristics in a turntable test (in most instances) it makes little difference what cartridge we use, assuming it is not especially susceptible to hum pickup. The

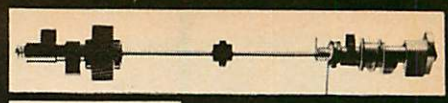
The ultimate turntable for sophisticated systems.

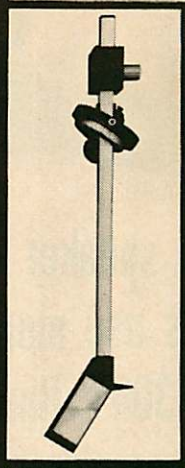
The BSR McDonald 810 Transcription Series.

BSR makes more automatic turntables than any other manufacturer. More than all the other manufacturers in the world put together. But of all the turntables we make, the BSR McDonald 810 Transcription Series is the finest. It is a triumph of years of painstaking efforts and research in our Engineering Laboratories in Warley, Worcestershire, England.

The 810 offers an impressive group of design innovations for serious music lovers . . . for professional users of transcription turntables . . . and for the audiophile who revels in sophisticated high fidelity equipment. It has the tightest specifications for rumble, wow and flutter of any automatic turntable made. We would be pleased to send you detailed technical specs upon request. As a matter of fact, few—if any—automatic turntable manufacturers publish complete specifications as we do. Only your personal inspection can reveal the overall excellence of this fine instrument. We suggest a visit to your BSR McDonald dealer.

BSR
McDONALD



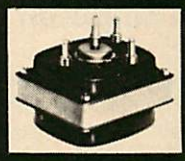


Sequential Cam System
New smoothness and quietness of operation and overall reliability. Eight independent pre-programmed cams eliminate the light stampings and noisy moving parts of conventional cam gear and swing plate used in every other turntable mechanism.

Transcription Tone Arm System
The 8.562" pivot-to-stylus length reduces tracking error to less than 0.5° per inch. Low-mass aluminum arm assures extremely low resonance. Counterbalanced horizontally and vertically.

Automatic Tone Arm Lock
Automatically locks arm to rest post when unit is off. Prevents damage to stylus or record. Automatically unlocks in any mode. (See large photo.)

Stylus Setdown Adjustment
Adjusts stylus setdown to initial record groove. Once adjusted setdown correct for all record sizes on automatic or semi-automatic. (See large photo.)



Synchronous Power Unit
New high-torque, ultra-quiet synchronous induction power unit achieves unwavering constancy of speed independent of voltage input or record load.

Concentric Gimbal Arm Mount
Gyroscopically pivoted on 4 pre-loaded ball-bearing races to assure virtually no friction in horizontal or vertical planes. Provides ¼ gram tracking capability.

Rotating Manual Stub Spindle
Rotates with platter, eliminating record drag and center-hole wear. Interchanges with automatic spindle. (See large photo.)

Viscous-Damped Cue and Pause Control
Gentle silicone oil-damped tone arm descent. Other anti-skate systems tend to move arm outwards in descent. Our positive friction Cue-Clutch prevents this. Arm returns to identical groove every time. Cueing operates in automatic and manual.

Viscous-Damped Tone Arm Descent
Same gentle cueing descent functions during automatic and semi-automatic play.

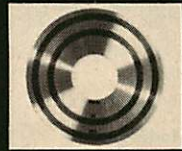
Stylus Overhang Adjustment
Cartridge slide has ±⅛" stylus overhang—quickly and accurately set by removable locating gauge. Once set, gauge replaced by stylus whisking brush provided.

Stylus Pressure Adjustment
Resiliently mounted gliding counterweight adjusts to zero-balance over full range of cartridge and stylus masses. Precision micrometer wheel allows continuous infinite stylus pressure settings 0 to 5.0 grams.

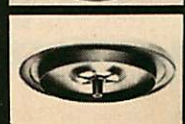
Dual-Range Anti-Skate Control
Dynamic anti-skate control system adjusts for all elliptical or conical stylii. Applies continuously corrected compensation regardless of stylus location.

Variable Pitch Control
Infinitely variable 6% range of speed adjustment (33⅓ and 45 RPM) to match pitch of record to live instrument or other playback device.

Integral Strobe Disc
Enables precise adjustment of turntable speed with pitch control for 33⅓ and 45 RPM.



Push-Button Operation
Unexcelled flexibility. Settings for manual, semi-automatic, infinite repeat of one record, or fully automatic play. (See large photo.)



12" Dynamically Balanced Turntable Platter
Full 12" die-cast, non-ferrous platter, approx. 7 lb., machined and precision-balanced to run true for optimum performance and maximum record support.

BSR (USA) Ltd. Blauvelt, N.Y. 10913
Check No. 44 on Reader Service Card

unit is then turned on and left running with no record on the platter for an hour.

Before making any measurements, the next step is to study the instruction book to find out if there are any unusual features that should be described in the write-up, and—contrary to the time-honored custom of audiophiles everywhere—to find out how the unit should be operated. Surprising how often this prevents our damaging the machine by doing something wrong, and often it simplifies the actual operation.

The first measurement that we normally perform is that of wow and flutter. To get sufficient level for such a measurement, the output of the cartridge must be amplified, so it is plugged into a small battery-operated preamp which has been in use for a long time and not yet brought up to date with a modern IC form of construction. The device derives from an early GE transistor manual and uses four PNP transistors—two 2N508's and one each of 2N634 and 2N322. Since the photos were taken, an additional switch has been added to connect a 10-μF capacitor across the 0.05-μF unit in the feedback network to give a gain of 46 dB and a flat response, whereas the original supplied bass boost and no high-frequency rolloff. A SPDT switch selects either left or right cartridge coil, and the output is fed to further measuring equipment. The gain is 46 dB, and the output noise is 0.5 mV with the input terminated, 1.0 mV with the input open circuited.

Using a CBS BTR-150 test record, we next play the 3000-Hz band, feeding the output of the battery-operated preamp to the input of a wow-and-flutter meter—the one described in these pages in the spring of 1966. The writer has used this unit consistently for the intervening years, and while it does not provide "weighted peak flutter" in accordance with the new IEEE Standard 193-1971, it does indicate the difference between wow, or low-frequency speed variation, and flutter, which is high-frequency variation. The wow and flutter are measured separately with this instrument, and the figures recorded. Plans are under way for the addition of a 4-Hz filter to permit weighted peak flutter as specified. In the meantime, a Ferrograph RTS-1 is also used. See page 61 for a review of this unit.

The next step is to determine the range of vernier speed variation provided by the control. The output of the preamp is fed to a Heathkit IB-101 frequency counter, and the 1000-Hz band of the record is played, with the control at the normal position. The indicated frequency is noted, as are the frequencies at both extremes of the vernier control. This is easier and quicker than counting revolutions, and percentages of speed variation can be calculated from the frequencies read.

Still using the frequency counter, the line voltage is varied from 120 to 135 and down to 85, with variations in indicated frequency being noted and recorded. Then with the voltage held at 120, a varying frequency ranging from 40 to 90 Hz is applied to the turntable and speed changes again noted and recorded. With synchronous motors, the speed varies with frequency, and only slightly (if at all) with variations in voltage. Induction motors maintain the same speed regardless of frequency (within the range noted above), and their speed increases with higher voltages just a little, and drops off quite rapidly down to the lowest voltage applied. All of these figures are recorded.

The next to last measurement we make is the important one of signal-to-noise ratio. There are many different ways in which this measurement can be made, particularly as to the reference.

The NAB Standard further specifies level of 1 cm/sec peak velocity at 100 Hz, with the further notation that this level corresponds to a peak velocity of 5 cm/sec at 500 Hz. A peak velocity of 5 cm/sec results from an rms velocity of 3.54 cm/sec, and since most standard records rely on a frequency of 1000 Hz for their reference, a correction factor of 3.0 dB must be added to the numerical value of measured S/N to obtain a valid figure. Thus our actual reference is 3.54 cm/sec rms velocity at 1000 Hz, and the correction factor is added.

The NAB Standard further specifies that the response of the measuring system shall fall off at the rate of 12 dB/octave above 500 Hz, and with this proviso, the acceptable turntable shall have a S/N of 50 dB if the response of the measuring circuit is flat from 1000 Hz to 15,000 Hz, and rolls off at the rate of not less than 12 dB/octave below 500 Hz. This therefore eliminates the effect of hum and/or rumble, and constitutes the high-frequency S/N. We customarily measure with an RIAA low end (500-Hz turnover) and a flat high end. The presumed ARLL (audible rumble loudness level) figure derives from the "flat" measurement which corresponds roughly to the rolloff of human hearing at low frequencies at low levels.

Thus we again use the battery-operated preamp and feed its output to an a.f. voltmeter, making sure that grounding results in the lowest possible hum. We then play the 3.54-cm/sec, 1000-Hz groove of the STR-150 record and note the level. Next we play the "silent"

groove and again note the levels in both positions of the preamp—bass boosted and flat. The difference between the 1000-Hz level and the level of the silent groove in the boosted position represents the measured value of the S/N, to which must be added the correction factor of 3 dB. The figure obtained with the preamp "flat" closely approximates the ARLL value. The average measured S/N is in the vicinity of 38 to 40 dB, resulting in a figure of 41 to 44 dB when the correction factor is added. The ARLL figure is usually about 19 dB better than the value obtained with the preamp in the bass boost position.

These constitute the major measurements made on turntables. In the case of automatic models, the change time is noted, both for start and for the time from the tripping of the mechanism at the end of one record to the setdown of the arm on the next record.

There are several other measurements that could be made, but none is considered necessary with modern turntables. Among these additional measurements are the horizontal and vertical forces to move the arm. The requirements for these measurements are quite precise and are complicated to perform, but on any hi-fi turntable they are hardly considered important. The measurement of "stiction" which is the term given to the force required to start the arm moving is even more complicated, and still not considered important.

Arm resonance is measured by playing the 200-to-10-Hz band of the CBS STR-100 record and recording the output on a graphic recorder. If the arm resonance falls within this range, a small flick will be seen on the recorded curve, and by interpolation this frequency of resonance can be determined. If it does not fall within this range, it is simply reported as being "below 10 Hz."

Finally, the unit is connected to an amplifier and a number of records played—automatically if it is a changer, and manually if not. Overall handling is noted, as well as any eccentricities the unit may have. Stylus force is decreased until faulty reproduction is heard as well as noted on a scope. Visual observation of the general performance of the turntable completes the test procedure.

Then, and only then, can a valid Profile be prepared, and since this procedure does not constitute part of the testing, it will not be described other than to say that the Profile results from a compilation of the information gained from the testing, and written in as readable a form as this observer can produce. *C. G. McProud*

TURNTABLES: Capsules

Manual

NOTE: Rumble figures are NAB unweighted. The weighted figures (DIN or ARLL—Audible Rumble Loudness Level) would be about 10 to 20 dB higher. A directory of turntables begins immediately following these capsule reviews.

Empire 598
Speeds: 33⅓, 45, & 78 rpm. **Features:** Integral arm with special "star" mounting, belt drive from hysteresis-synchronous, outer-rotor motor, illuminated record surface, anti-skating, stylus pressure 0 to 6 grams calibrated.
Reviewed: December, 1970. **Price:** $234.98
Wow: 0.03%; **Flutter,** 0.06%; **Rumble:** -54 dB unweighted.

"A finely crafted and well-designed record playing device. . . . A handsome unit, very low rumble and wow and flutter."

Check No. 86 on Reader Service Card

Panasonic SP10
Speeds: 33⅓ and 45 rpm. **Features:** Direct-drive with low-voltage electronically controlled 20-pole motor. Speed change, ±2%.
Reviewed: August, 1971. **Price:** $329.95
Wow: 0.04%; **Flutter:** 0.06%; **Rumble,** -57 dB unweighted.

"The Panasonic SP-10 must therefore be classed very close to the top in turntables—one any of us would be glad to put in our systems. One thing is sure—few of us could possibly have a better one."

Check No. 87 on Reader Service Card

Rabco ST-4
Speeds: 33⅓ or 45 rpm. **Features:** Straight-line servo tracking, pushbutton cueing, PE light sensitive cell used for actuating lift cycle, belt drive from synchronous motor. Tracking pressure adjustment, ¼ gram per full turn of counterweight.
Reviewed: November, 1971. **Price:** $159.00
Wow: 0.05; **Flutter:** 0.03%; **Rumble:** -43 dB unweighted.

". . . we found the Rabco ST-4 to be well-made and capable of excellent performance in every particular. It takes a little longer to set up and get into action than the usual turntable, but when it is in your system, you are sure to like it."

Check No. 88 on Reader Service Card

Thorens TD-125
Speeds: 45, 33⅓, 16⅔ rpm. **Features:** Belt drive; interchangeable tonearm mounting; motor driven by Wien bridge oscillator and 20 watt amplifier. Speed change: ±2½%.
Reviewed: June, 1969. **Price:** $215.00, Model TD-125AB with integrated arm, $310.00.
Wow and Flutter: 0.07%; **Rumble:** -49 dB unweighted.

"If you have room for its 18-in. width, you will most certainly find the TD-125 the answer to your continuing search for the ultimate in every department—beauty of functional design, virtual absence of rumble, low wow and flutter, a shock mounted drive system, and simple tonearm change facility."

Check No. 76 on Reader Service Card

From Audio's Equipment Profiles

Automatic

BSR-McDonald 810

A complete review of this turntable will be found in the Equipment Review section of this magazine. The review begins on page 56.

Wow: 0.06; **Flutter:** 0.06; **Rumble:** –44 dB.

Price: $149.50

Check No. 58 on Reader Service Card

Dual 1218

Speeds: 33⅓, 45, 78 rpm. **Features:** Two-ring gimbel mounted tonearm, elastically damped counterbalance, anti-skating & vertical tracking adjustment 0 to 5 grams. Speed control: ±3%.

Reviewed: January, 1972. **Price:** $155.00.

Wow: 0.1%; **Flutter,** 0.05%; **Rumble:** –44 dB unweighted.

"For those who long for a fine turntable but who cannot get up the scratch for a 1219, the 1218 is a logical choice and it will certainly give long and satisfactory service for the average user."

Check No. 90 on Reader Service Card

Garrard Zero 100

Speeds: 45 and 33⅓ rpm. **Features:** Anti-skating, "parallelogram" tracking, plug-in heads, vernier speed control (±3%), vertical tracking adjustment, anti-skating, adjustable tracking pressure calibrated in 1/10th gram steps.

Reviewed: July, 1971. **Price:** $199.95.

Wow: 0.085%; **Flutter:** 0.03%; **Rumble:** –41 dB unweighted.

"This is certainly the finest in a line of automatic turntables which have been around for over 50 years. As usual, each model contains improvements over its predecessors, with constant research which strives to both performance and reliability."

Check No. 89 on Reader Service Card

Miracord 50H II

Speeds: 33⅓, 45, 78 rpm. **Features:** Lateral tracking with gauge, anti-skating, facility for "repeat" operation, stylus pressure range ½ to 6 grams, speed adjustment ±3%.

Reviewed: May, 1972. **Price:** $199.50.

Wow: 0.08%; **Flutter:** 0.03%; **Rumble:** –41 dB unweighted.

"Tracking error calculated close to the classic 0.5 degree attained by the best off-set arm turntables. . . . On the whole the 50H II is certainly the best of a long line of excellent automatic turntables, and should satisfy both the critical audio buff as completely as its appearance and ease of operation should please the distaff side of the household."

Check No. 91 on Reader Service Card

PE 2040

Speeds: 33⅓, 45, and 78 rpm. **Features:** Speed control (6%), adjustable vertical tracking angle, cueing facility, stylus pressure 0 to 6 grams.

Reviewed: December, 1970. **Price:** $155.00.

Wow: 0.05%; **Flutter:** 0.11%; **Rumble:** –42 dB unweighted.

"Among the features we found most interesting are: The lead carrying the two shielded cables and the third grounding wire, the jig for setting the stylus for the vertical angle, the dynamically balanced motor and platter and the overall ease of operation."

Check No. 92 on Reader Service Card

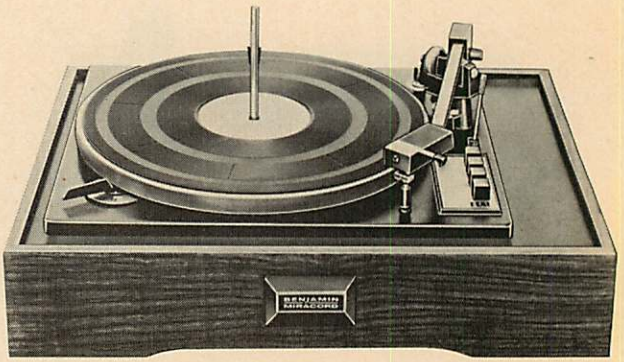
Automatic

SPEEDS

A – 33, 45, 78
B – 33, 45
C – 33 only
D – 16, 33, 45, 78
E – 16, 33, 45
F – Cont. variable

BSR 610/X

Fisher 502



Benjamin/Miracord 750

MODEL	Speeds (see letter code)	Platter diameter, in.	Wow and flutter at 33⅓, %	Rumble (NAB) dB	Max. tracking error, deg.	Pivot-stylus dist., in.	Arm type	Cart. weight range, gms.	Arm resonance, Hz	Max. stack records	Change cycle at 33⅓, secs	Clearance below board, in.	Clearance above board, in.	Overall W x D, in.	Overall height, in.	Weight, lbs.	Price	SPECIAL FEATURES
BSR MCDONALD																		
810	B	12	0.1	-55	0.5	8.56	Conc. Gimbal	0-6	7	6	5	3	4½	17 x15	9¼	22	149.50	Also available with wood base, dust cover, M91E MD Shure Cartridge 239.45
610	D	11	.08	-42	1.2	6.474	Counter Bal.	5-20	13	6	5	2-7/16	3⅜	13⅛ x11¼	6-15/16	13	79.50	Available as "total turntable" w/base Shure M 93E ctg. and dust cover, 141.95
510	D	11	.08	-42	1.2	6.474	Counter Bal.	5-20	13	6	5	2-7/16	3⅜	13⅛ x11¼	6-15/16	10	64.50	Available as "total turntable" w/base, Shure M75ECS ctg. and dust cover, 100.00
310	D	11	0.12	-40	1.25	6.474	Bal. & Spg.	5-14	14	6	5	2-7/16	3⅜	13⅛ x11¼	6-15/16	10	44.50	Available as "total turntable" w/base, Shure M75CS ctg. and dust cover, 80.00
MIRCORD (BENJAMIN)																		
Miracord 50H II	A	12	0.06/0.02	-40			Bal.& Spg.		8	10		3¾	5⅝	18½ x14½	10	18	199.50	
Miracord 50H	D	12	0.06 0.025	-40	0.5 Deg In.	7¼	Bal.& Spg.	0-15	8	10	10	3¾	5⅝	14½ x12½	10	18	179.50	Hysteresis-synchronous motor.
Miracord 750	D	12	0.06 0.025	-40	0.5 Deg. In.	7¼	Bal.& Spg.	0-15	8	10	10	3¾	5⅝	14½ x12½	10	18	149.50	
Miracord 650	D	10⅜	0.07 0.03	-39	0.5 Deg. In.	7⅛	Bal.& Spg.	0-11	10	10	12	2⅝	5⅝	13⅜ x11⅝	9	17	119.95	
Miracord 660H	D	10⅜	0.06 0.025	-39	0.5 Deg. In.	7⅛	Bal.& Spg.	0-11	10	10	12	2⅝	5⅝	13⅜ x11⅝	9	17	149.50	Hysteresis-synchronous motor, overhang adj., calibration marker.
FISHER																		
310X	D	10½	0.15	-38	1.0	7.5	Spg.	0-9	20	7	7	3	4	13x11	6⅜	14	80.00	Includes base, dust cover & Shure M-75 cart. Cueing, stylus pressure & anti-skating adjustments.
302	A	10⅜	0.15	-37	1.8	8	Bal.& Spg.	3-15	10	8	3¼	3⅛	5⅛	13 x10¾	8⅞	11¼	99.95	Anti-skating & stylus pressure adjustments; var. pitch cont.; viscous cueing.
402	A	10⅜	0.15	-40	1.8	8	Bal.& Spg.	3-15	10	8	3¼	3⅛	5⅛	13 x10¾	8⅞	12	129.95	As above.
502	A	11½	0.1	-43	1.8	8	Bal.& Spg.	3-15	10	8	3¼	3⅛	4½	14⅛ x12	8⅞	15¼	159.95	As above plus vert. tracking angle adjust.

Dual 1219

V-M 1555

Garrard Lab 95B

MODEL		Speeds (see letter code)	Platter diameter, in.	Wow and flutter at 33⅓, %	Rumble (NAB) dB	Max. tracking error, deg.	Pivot-stylus dist., in.	Arm type	Cart. weight range, gms.	Arm resonance, Hz	Max. stack records	Change cycle at 33⅓, secs	Clearance below board, in.	Clearance above board, in.	Overall W x D, in.	Overall height, in.	Weight, lbs.	Price	SPECIAL FEATURES
GARRARD	Zero 100	B	11½	0.06/ 0.025			7½	Bal.	0-15	8	6	10	3	4⅜	15¼ x14⅛	6½	12	199.95	Tangent zero tracking tone arm; built-in ill. strobe & var. speed; mag. anti-skate; viscous damped arm.
	SL-95B	A	11½	0.07/ 0.025		0.75	8¼	Bal.	0-15	8	6	10	3	4⅜	16 14½	7⅜	11	149.95	Viscous damped arm; 2-pt. disc support; oversize platter; anti skating; slide-in cart. clip.
	SL-72B	A	10½	0.08/ 0.025		0.75	7½	Bal.	0-15	8	6	10	3	4⅜	15¾ x14½	7⅜	10½	109.95	Viscous damped arm; anti skating; cartridge clip.
	SL-65B	D	10½	0.09/ 0.025		0.85	7½	Bal.	0-18	10	8	12	2⅞	4	15¼ x13⅛	6⅞	9	84.95	As above.
	SL-55B	D	10½	0.12/ 0.025		0.85	7½	Bal.& Spg.	0-12	12	8	12	2⅞	4	15⅜ x13⅛	6⅞	9	64.95	As above.
	40B	D	10½	0.14/ 0.03		0.85	7½	Bal.& Spg.	0-12	12	8	12	2⅞	4	15⅜ x13⅛	6⅞	9	49.95	Viscous damped cue lever; cart. clip; tubular tone arm; super-sensi. trip.
JVC	VC-5203	D	11	0.1	-45		8	Bal.& Spg.			6	10			16⅜ x14¼	7¼	9	89.95	Includes mag. cart., wal. base & dust cover.
RADIO SHACK	Realistic/ Miracord 45	D	11⅞	0.1	-50	0.6	7¼	Bal.& Spg.	3-4	12	6	12			16¾ x14¼	4¼	20	159.95	Includes base & cartridge.
	Realistic/ Miracord 40A	D	11⅞	0.1	-50	0.6	7¼	Bal.& Spg.	5-7	12	6	12			16¾ x14¼	4¼	20	119.95	Includes base & cartridge.
	Realistic Lab-36	D	11					Bal.& Spg.			6				15¼ x13¼	6½	10½	79.50	Includes base & cartridge.
	Realistic Lab-24A	D	11					Bal.& Spg.			6				15¼ x13¼	6½	8	64.50	With base & cartridge.
	Realistic Lab-12A	D	11					Bal.& Spg.			6				15¼ x13¼	6½	8	49.95	With base & cartridge.
UNITED AUDIO (Dual)	1219	A	12	0.05	-45	0.3	8¾	Bal.& Spg.	1-12	8-14	6	13	3	5	14¾ x12	8	15½	185.00	Gimball susp.; adjust. vert. track. angle; 6% pitch con.; sync. mtr.; cueing.
	1218	A	10⅜	0.08	-45	0.5	8¼	Bal.& Spg.	1-12	8-14	6	11	2⅝	5	13 x10¾	7⅜	10	155.00	As above.
	1215	A	10⅜	0.08	-45	0.5	8¼	Bal.& Spg.	1-8	8-14	6	11	2⅝	5	13 x10¾	7⅜	9¼	105.00	Sync. tracking & anti-skating; pitch cont.; damped cueing. C16, similar, with base, cover, cartridge, $125.00.
V-M CORP.	1555	B	11¾	0.3		1½	9½	Bal.& Spg.	3-9	11	6	15		5½	17x13	5½	18	200.00	Belt-drive sync. mtr.; cart., wal. base & dust cover included.
	1542	D	11	0.3		5	7⅛	Spg.			6	9		6	14½ x13½	6	10½	100.00	4-pole sync. mtr.; cart., wal. base & dust cover included.

Manual

Benjamin Lenco L-75

JVC VL-8

AR-XA

SPEEDS

A – 33, 45, 78
B – 33, 45
C – 33 only
D – 16, 33, 45, 78
E – 16, 33, 45
F – Cont. variable

	MODEL	Speeds (see letter code)	Wow and flutter at 33⅓, %	Rumble (NAB) dB	Motor type	Platter diameter, in.	Platter weight, lbs.	Drive	Arm mounting provision	Dimensions, W x D x H, in.	Weight, lbs.	MODEL	Overall length, in.	Pivot-stylus dist., in.	Vertical bearing	Lateral bearing	Stylus force method	Max. tracking error, deg.	Cart. weight range, gms.	Arm resonance, Hz	Stylus force range, gms.	Weight, if sep., oz.	Price	SPECIAL FEATURES
ACOUSTIC RESEARCH	XA	B	0.1	-35	24-p Sync.	11¾	4	Belt	Integ.	16¾x12¾ x5¼	13.5	–	12	9	Cone point	Ball	Counter-balance	0.35/ in	–	10-15	0-8	–	87.00	Includes dust cover, base, stylus force gauge, oil, overhang gauge.
	TA	C	0.1	-35	24-p Sync.	11¾	4	Belt	Integ.	16¾x12¾ x5¼	13.5	–	12	9	Cone point	Ball	Counter-balance	0.35/ in	–	10-15	0-8	–	84.00	
	XA Univ.	B	Same as XA, except usable on 100-120 or 220-240 V., 50-60 Hz.																				87.00	
EMPIRE	598	A	0.01	-55	Hys. Sync.	12	7	Belt	Integ.	17½x15⅛ x8	30	990*	12	9	Ball	Ball	Bal.& Spg.	0.7	5-15	6	0-6	20	234.98	*990 arm alone is $74.95.
HITACHI	PS-77	B	0.05		Hys. Sync.	12	5.6	Belt/ Idler	Integ.	22⅛x17¾ x8¾	33		14½	11	Jewel	Ball		1.5					About 450.00	
JVC	VL-8	B	0.05	-60	Servo	12	3	Belt	Integ.	19⅜x16¼ x7⅛	22	–	12	9	Ball	Ball	Bal.		5-20	7	0-4	–	249.95	
LENCO (BENJAMIN)	LENCO B-55	F, D	0.12	-37	4-pole Ind.	11.8	3.6	Idler	Integ.	17½x 13¾ x5⅝	24												85.00	
	LENCO L-75	F, D	0.06	-38	4-pole Ind.	12	8.8	Idler	Integ.	17½x 13¾x6⅛	32												99.50	
NORELCO	GA 202	A	0.06	-38	Servo	12		Belt	Integ.	15½x13½x x5½	10½	–					Bal.			7	½-4		139.50	
	GA 308	B	0.2	-38	Sync.	10		Belt	Integ.	14½x12 x5½	11½	–					Bal.			7	2-4		94.50	
PANASONIC	SP-10	B	0.03	-65*	†	12	7	‡	Sep.	14x14 x4	20												329.95**	*DIN A standard; † brushless d.c. servo motor ‡direct drive. **less base and dust cover.
PIONEER	PL-41DC	B	0.07	-50	8-pole Sync. Hys.	12¼	4	Belt	Integ.	19⅝x16⅞ x7⅞	28	–	12	9½	Ball	Ball	Static				0-10		229.95	
	PL-A35C	B	0.10	-47	Sync.	12	2.9	Belt	Integ.	18⅞x16⅜ x7¼	16	–	12	8⅞	Ball	Ball	Static				1½-5		139.95	
	PL-12AC	B	0.12	-46	Sync.	12	2.9	Belt	Integ.	17x13½ x6	13.5	–	12	8⅛	Ball	Ball	Static				1½-5		99.95	
ORTOFON												RMG-212	12	9	Ball	Ball	Bal.& Spg.	1.19	7-19	8	0-4½		90.00	
												RMG-309	16	12	Ball	Ball	Bal.& Spg.	0.83	7-19	8	0-7		75.00	

Pioneer PL-41DC

Sansui SR-2050E

Sony 5520

	MODEL	Speeds (see letter code)	Wow and flutter at 33⅓, %	Rumble (NAB) dB	Motor type	Platter diameter, in.	Platter weight, lbs.	Drive	Arm mounting provision	Dimensions, W x D x H, in.	Weight, lbs.	MODEL	Overall length, in.	Pivot-stylus dist., in.	Vertical bearing	Lateral bearing	Stylus force method	Max. tracking error, deg.	Cart. weight range, gms.	Arm resonance, Hz	Stylus force range, gms.	Weight, if sep., oz.	Price	SPECIAL FEATURES
RABCO	ST-4	B	0.08	-32	Syn.	11⅜	5	Belt	Integ.	15x18x5	15												159.00	
												SL-8E	14	7	Cone	Cone	Wght.	0.16	4-18	10	0-4	48	169.50	
REK-O-KUT	B-1271	A	0.09	-39	Hys.	12	16	Idler	Sep.	15¼x15¾x6													194.50	
	CVS-12	F	0.09	-35					Sep.	15x16x5	15												169.50	
												S-320	12		Ball	Ball	Bal.		12				54.95	
												102	13	9½	Ball	Ball	Bal.	1.25	10	½-2½			69.50	
SANSUI	SR2050E	B	0.07	-40	Sync.	12	2.9	Belt	Integ.	17½x13⅞ x7½	26	–	8¾		Angular Contact		Bal.	1.5					149.95	Auto shut-off; damped cueing; includes base, dust cover.
	SR1050E	B	0.07	-40	Sync.	12	2.9	Belt	Integ.	17¼x13¼ x7½	21⅜	–	8¾		Angular Contact		Bal.	1.5					119.95	As above without auto shut-off.
SHURE SME												3009		9	Knife Edge	Ball	Rear wgt.		3-20		¼-5		117.50	Adj. anti-skating; viscous damping; cueing.
												3009HE		9	Knife edge	Ball	Rear wgt.		3-20		¼-5		123.75	As above; horizontal cable entry.
												3012		12	Knife Edge	Ball	Rear wgt.		3-20		¼-5		128.08	Same as 3009.
SONY	PS5520	B	0.1	-43	Sync. Hys.	12	2¼	Belt	Integ.	17⅜x15½ x6⅞	18½	–	11½	8½		Ball	Bal.	3	4-14		0-3		139.50	
SOUND SYSTEMS INTERNATIONAL, INC.	MM-3000	B	0.06	-37	Sync.	12	3	Belt	Integ.	19⅜x15 x6	24	–	–				Bal.	0	4.5-11		0-2.5		Under 300.00	
THORENS	TD-150 MK II	B	0.09	-37	Sync.	12	7	Belt	Integ.	15⅜x12⅞ x5	20												140.00	
	TD-125	E	0.08	-48	Sync.	12	8½	Belt	Indep.	18x14x5	32												215.00	
	TD-125 AB	E	0.08	-48	Sync.	12	8½	Belt	Integ.	18x14x5	32												310.00	
YAMAHA	YP500	B	0.08		4-pole sync.	12	3	Belt	Integ.	17¼x15½ x6½	19	–	12	9			Bal.		5-12		0-5		189.00	
	YP700	B	0.08		4-pole sync.	12		Belt	Integ.	17⅜x15¼ x6½	19	–	12	9			Bal.		5-12		0-5			
V-M CORP.	1579	B	0.3		Sync.	11¾	2	Belt	Integ.	17x13x5	12	–	12	9½	Flex member	Cone	Bal.& Spg.	1.5	3-9	11	0-4			

Equipment Profiles

Harman-Kardon Model 930

AM/FM Stereo Receiver

MANUFACTURER'S SPECIFICATIONS

AMPLIFIER SECTION Power Output: 45 Watts per channel, RMS, at any frequency from 20 Hz to 20 kHz. **THD:** Less than 0.5%. **Power Bandwidth:** Below 10 Hz to above 40 kHz. **IM Distortion:** Less than 0.15% at rated output. All above referenced to 8 ohm loads, both channels driven. **Damping Factor:** 30 or better to below 20 Hz. **Input Sensitivity:** 1.5V. **Hum and Noise:** Better than 85 dB below rated output (unweighted). **Frequency Response:** From below 4 Hz to above 70 kHz ±0.5 dB.

PREAMPLIFIER SECTION Frequency Response: From below 3 Hz to above 100 kHz ±0.5 dB. **THD:** Less than 0.05% at 2 V. output, 20 Hz to 20 kHz. **Hum and Noise:** Low level, 65 dB below 2 V out at 10 mV input reference; high level, 80 dB below 2 V, volume control fully clockwise; residual, 90 dB below 2 V. **Phono Overload:** 90 mV. **Tone Control Range:** ±12 dB boost and cut (frequencies not stated).

FM TUNER SECTION IHF Sensitivity: 1.8 μV. **Ultimate S/N:** 70 dB. **THD:** Mono, 0.5%; Stereo, 0.6%. **Selectivity:** Better than 50 dB. **Image Rejection:** 90 dB. **I.F. Rejection:** 90 dB. **Spurious Response Rejection:** 90 dB. **AM Rejection:** Better than 60 dB. **Stereo FM Separation:** 38 dB @ 1 kHz; 33 dB @ 100 Hz; 30 dB @ 10 kHz. **38 kHz supression:** Greater than 45 dB.

AM TUNER SECTION AM Loop Sensitivity: Better than 200 μV/meter. **Selectivity:** 35 dB. **Image Rejection:** Better than 60 dB. **I.F. Rejection:** Better than 60 dB.

GENERAL SPECIFICATIONS Dimensions: 17in. W by 13¾in. D by 4¾in. H. **Weight:** 29 lbs. **Price:** $399.95

It's been a couple of years since the engineering department of Harman-Kardon reintroduced its magnificent Citation line of separates in their solid-state versions, but the Citation 11 preamplifier and the Citation 12 power amplifier are today regarded by many experts as among the finest separate components available at any price. It's been a long while, too, since we had an opportunity to evaluate a receiver from this "old-line" high fidelity manufacturer (they've been in the business almost since it began). When the Citation components were in their final design phases we had the rare opportunity to see some of the first engineering prototypes and we have never quite gotten over the dedication and enthusiasm exhibited by the highly qualified engineering team that "gave birth" to those winners. Small wonder, then, that we were elated to find that the Model 930 receiver is the brain-child of that very team. It abounds in Citation features, many of which one would have thought impossible to incorporate in a receiver at this attractive price. Of course, the Citation 12 boasts more power (60 watts rms per channel), but then again, the 11 and 12 combination retails for a cool $600.00 or so, as opposed to just under $400.00 for this receiver. The rest of the circuit refinements are there, though, including the twin power supplies (not negative and positive voltages supplied by one power transformer, but actually two complete power supplies including two separate power transformers), super-wide frequency response and power bandwidth, fantastic square wave response and rise time, and conservative and meaningful power ratings that can serve as a model to the rest of the industry. All this plus a superior tuner section make the 930 a receiver that even the died-in-the-wool "separatists" should take a good look at.

Taking a look at the front panel layout, as shown in the accompanying photo, we recognize the traditional Harman-Kardon "blacked-out" plus rich gold-anodized front panel. With power applied, the black-out portion becomes fully illuminated when power is applied and FM or AM operation is selected. For other program sources, the dial is still invisible and only a function indicator light below the dial scale tells you what program source you have selected. Two illuminated meters (signal strength and zero-center tuning) are mounted to the left of the dial scale while the tuning knob

(with its flywheel action) is positioned at the right of the dial scale. At the extreme right of the upper section of the panel are three push-push buttons for FM MUTING, MPX FILTER and STEREO AUTOMATIC. Since the STEREO-AUTOMATIC switch must be in the *depressed* position to receive stereo FM while all other push-push buttons are normally operated in their undepressed position, some other notation for the function of this switch might be preferred, such as stereo-mono—either that or *reverse* the action of the switch so that in its normal, or undepressed, position, automatic stereo switching takes place when a stereo signal is received. Of course, a few moments with the receiver clears this up, and it seems to be the only human engineering flaw in this entire receiver, and a very minor one at that.

Along the bottom half of the panel we find an illuminated power switch, headphone jack, speaker selector buttons (two pairs of speakers may be selected singly, together or—not at all if headphone use is desired), a pair of tape monitor switches, high and low cut filter switches, loudness contour and tone-defeat switches. All of the above-named switches are in the form of tiny gold push-buttons which, though very positive in their action, require just the barest push of a forefinger to actuate. Dual concentric BASS and TREBLE controls (each channel can be separately regulated), BALANCE control, master VOLUME, MODE and FUNCTION selector switches complete the panel layout. The MODE switch offers positions for STEREO, REVERSE, L+R (mono mix), LEFT signal to both speakers and RIGHT signal to both speakers. That's a lot of front panel controls when you list them but somehow their placement on the panel *does not* tend to confuse or clutter—everything is placed just about where you'd want it to be.

The rear panel layout is pictured in Fig. 1 and in addition to the usual input and output jacks, speaker terminals and antenna terminals (for both 300 and 75 ohm lines as well as an external AM antenna), there are speaker and line fuses, a switched and unswitched convenience a.c. receptacles, the usual AM loopstick antenna (which, by the way is fully pivotable for best AM reception) and a pair of jumper bars which interconnect the preamp stages from the main power amplifier section. This last feature has become extremely worthwhile in the light of the increasing popularity of electronic-crossover amplifying systems as well as four-channel decoders which are easily "inserted" into the circuit at this convenient "break" point.

In the top-of-chassis view of Fig. 2 you can clearly see the two power transformers mentioned earlier, as well as the dual pairs of electrolytic filter capacitors (would you believe 6800 μF *each?).* Separate p.c. modules are used for the AM section, the FM-i.f. strip, the phono-preamplifier, the multiplex circuits, meter and muting circuits, audio control section, and the main amplifier circuits. All voltages supplied to the AM and FM modules are regulated by means of a transistorized, zener-diode regulation circuit. Each power amplifier section is direct coupled from input to loudspeaker connections and internal, factory-adjusted bias controls insure that no d.c. components will reach the speaker voice coils. Ceramic filters are used in the FM i.f. strip, while the four-gang FM front-end employs an FET for the first of its two r.f. amplifiers. The heart of the multiplex circuit is a single, multi-purpose IC with discrete transistors used only for impedance isolation and stereo-light current amplification. In all, the receiver employs 53 NPN transistors, 3 integrated circuits, 1 FET, 22 diodes (including zener regulators), and 8 power rectifier elements.

Performance Measurements

As shown in Fig. 3, IHF FM sensitivity measured exactly 1.8 μV as claimed. Ultimate S/N was 70 dB, and at 5 microvolts of input signal, quieting reached 57 dB. Impressed with the steepness of this quieting curve we checked to see where the muting threshold was set and found it to be at 10 microvolts. That's all right for a lesser performing set but we prefer to be able to have interstation silence *and* all the stations we

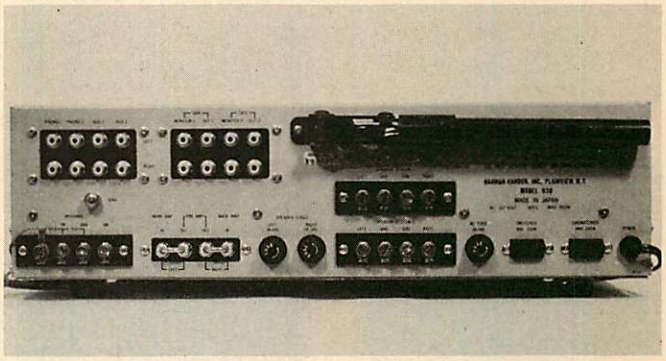


Fig. 1—Rear panel.

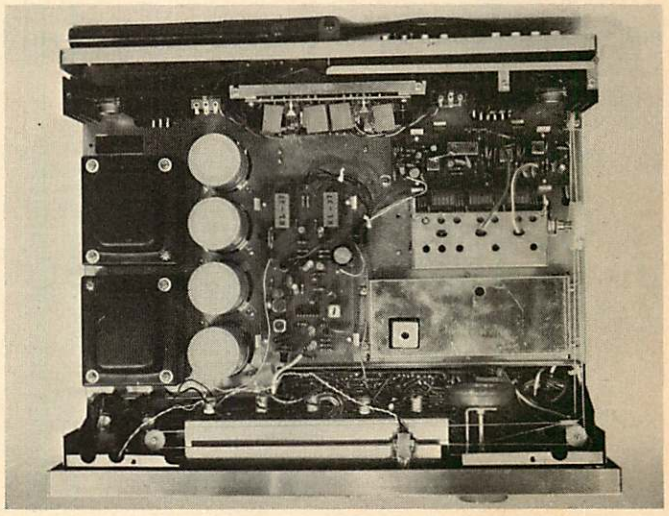


Fig. 2—View of the Chassis from above.

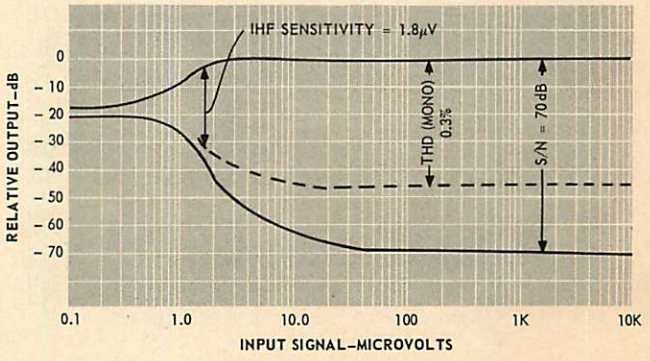


Fig. 3—Mono FM characteristics.

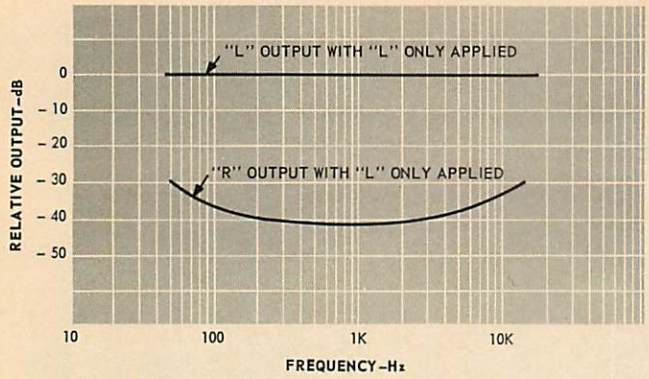


Fig. 4—Stereo FM separation.

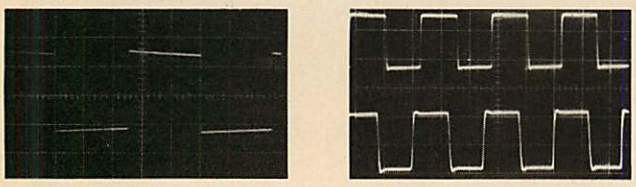


Fig. 5—Square wave response at **A**, 20 Hz and **B**, 20 kHz.

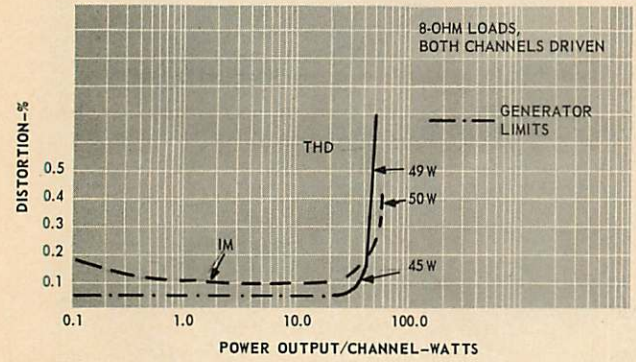


Fig. 6—THD and IM characteristics.

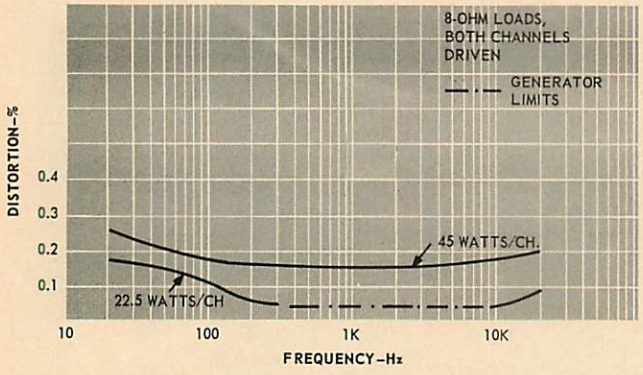


Fig. 7—THD vs. frequency at various power levels.

can get with reasonable listenability. Happily, a small hole in the bottom cover is labeled "muting adjustment" and this enabled us to reset the muting at about 5 microvolts, where we felt it ought to be. Any customer can do the same, except that no mention is made of this feature in the otherwise complete instruction manual. THD in mono was a bit better than stated, measuring 0.3% while stereo THD for 100% modulation turned out to be 0.45%, considerably better than claimed. Figure 4 details the separation characteristics of the stereo FM circuits and in the case of our sample, it turned out to be one of those rare units that actually meets or exceeds transmitter separation requirements of the FCC—that is, we were able to obtain better than 30 dB of separation from 50 Hz right up to 15 kHz. At mid-band, separation was just over 40 dB, somewhat better than claimed. It takes a really superior piece of test equipment to verify this kind of separation performance and, fortunately, we now have just such a stereo generator.

To summarize, then, the tuner is as good as we expected it to be and should have no difficulty providing the kind of FM reception we all want to get, but it's the amplifier and preamplifier section that leaves this reviewer wide-eyed and somewhat awed. This is the kind of amplifier performance we tend to find (and then only rarely) in the very best separate preamplifiers and power amplifiers. For starters, consider the photos of Fig. 5 (however out of context it might be). Yes, they are reproduced square waves at—you'll never guess the frequencies 20Hz and—20,000Hz! Need we say more about the rise time and transient response of this amplifier? Incidentally, the photos were taken while feeding the signal through the entire system—preamp and amp sections—not the power amplifier section alone. The THD and IM characteristics of the 930 are plotted in Fig. 6. Note that at mid-band, rated THD was reached at a power output of 49 watts—more than the 45 watts claimed—and that, of course, was with both channels driven into 8 ohms loads.

Checking into the power claims made for the entire audio spectrum, we plotted THD versus frequency for rated and half power levels. *At the very worst* (20 Hz), THD measured twice as good as claimed at full power output—a mere 0.25%. At half power, THD readings were limited by our generator (which specs out at 0.05%) over most of the audio spectrum, reaching 0.1% at 20 Hz. Lower power levels are not plotted, since, in such cases, all readings would have been limited by our equipment. Power bandwidth extended from below 5 Hz (the limit, once again, of our audio generator) to 55 kHz, using the half power point and a 45 watt reference as our criteria as shown in Fig. 8. All hum and noise readings just about corresponded (within a dB or so) with published claims, both in low level and high level input settings. Tone control, filter, and loudness characteristics are plotted in Fig. 9 and are more or less typical of these types of circuits. Within the audio spectrum there was less than 0.5 dB of variation in frequency response with or without the tone control circuits defeated, but high frequency roll-off began a bit earlier (somewhere around 60 kHz) when the tone controls were actively in the circuit and set at their mechanical "flat" position. Without the tone controls in the circuit, we "ran out of generator frequencies" at about 100 kHz and still were within 1 dB of our zero reference.

Listening Tests

We're the first to admit that it's very easy to become "brainwashed" by highly promoted engineering design features in this business and while "two independent power supplies" sounds like a sensible idea, intuitively, we wondered whether or not we would be able to *hear* any audible advantage in this arrangement. Frankly, at moderate listening levels we

could not, but when we really began to pump power and used truly dynamic source material (such as the exciting two-disc Columbia album of the score from the film "Shaft") we knew, instantly, that there was something better about the sound we heard. In our listening experience, stereo separation often tends to become a bit "blurry" when we listen to stereo material at really ear-pounding levels. In the case of the 930 that just did not happen. Now, of course, this apparent improvement might be due to the excellent rise-time and square wave response, it might be due to the wide-band frequency response (which Harman-Kardon has espoused for years and years), or it might even be due to other design features which still elude us, but whatever the reason(s), this was our kind of sound—and our kind of sound, dear reader, is the kind that makes us feel like we are there—at the performance!

P.S. Quite apart from any performance considerations, we came across a little pamphlet which H-K places conspicuously on top of their receivers, so that you can't miss seeing it and, hopefully, reading it, even before you unpack the set. The pamphlet is entitled, "The Outdoor Antenna, The Key To Better FM Reception," and it contains information about FM reception that is so valuable and so concisely and succinctly put that Harman-Kardon ought to make it available at a nominal cost to *every* FM listener or potential FM listener in the world! *Leonard Feldman*

Check No. 54 on Reader Service Card

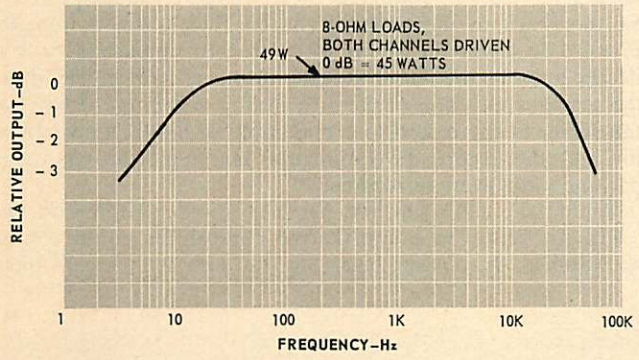


Fig. 8—Power bandwidth

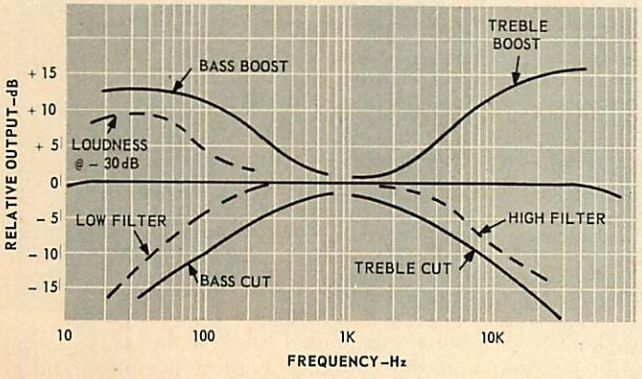


Fig. 9—Tone control, filter, and loudness characteristics.

BSR McDonald Model 810 Automatic Turntable

MANUFACTURER'S SPECIFICATIONS

Speeds: 33⅓ and 45 rpm. **Wow and Flutter:** Wow, 0.1% rms; flutter, 0.05% rms. **Motor:** Synchronous/Induction. **Platter:** Die-cast, non-ferrous, 12" diameter; weight, 7½ lbs. Push button operation. Adjustable anti-skating control. **Stylus Force:** Adjustable from 1 to 4 grams. Cueing control, automatic arm lock. Square aluminum tone arm, gimbal mounted. Knob-adjusted counterbalance. Rotating single-record spindle. **Pitch Control:** ±3%. **Dimensions:** 17⅛ in. W. by 15⅛ in. D. by 9½ in. H. (over furnished dust cover). **Weight:** 19 lbs. **Price:** $149.50, with base, dust cover, and Shure M 91E cartridge, $239.95.

This is the top-of-the-line model from BSR, the newest of a group of "total turntables" which are almost ready to go as soon as you take them out of the box. The 810 is complete with base (which is enclosed on the bottom), dust cover, and a Shure M91E cartridge already installed in the removable cartridge slide. This eliminates the need for shopping for a separate cartridge, base, and dust cover.

As the top-of-the-line model, its performance ranks along with every other top-line turntable we have profiled to date. The 810 is similar in appearance to other top turntables—the platter off center in the chassis, speed control, and arm in all the usual places. But the speed control is different—a rocker-type lever is centered in the vernier speed control, and the user simply pushes one end or the other of the rocker to change speeds. Integral with the turntable mat is a stroboscope disc, with two being furnished to be used with either 60 or 50 Hz viewing light, and an additional motor pulley is supplied so the user can change from 60 to 50 without having to wait for a new motor pulley from the manufacturer in case he moves from the U.S.A. to any other country where 50-Hz line frequency is common. Similarly, the user can change from 120-volt operation to 240 if his new supply is at the higher voltage. Power connections and ground are made with the usual 4-pin connector on the chassis, with the leads connected to a female receptacle—interchangeable with most turntables sold for high-fidelity use.

Mechanically, this turntable differs considerably from practically all others. There is no large cam rotated during the cycle by gear teeth on the turntable engaging those on the rim of the cam, with all the mechanical motions thereby actuated by the convolutions of the cam surfaces. Instead, the 810 employs what is called a "sequential cam system" which consists of eight pre-programmed cams located on a shaft which runs parallel with the chassis. The action is quieter and apparently completely reliable.

To actuate the turntable, there is a panel at the right front of the chassis which accomodates five pushbuttons and a knob. The latter switches the action from single to automatic operation, while the buttons activate START for manual operation, STOP, and START at diameters of 12, 10, and 7 in. respectively. Further back in the panel is the cue lever, which is pulled forward to lower the stylus to the record or pushed back to lift the arm. To the left of the cue lever is a knob which adjusts the set-down position of the arm from a minimum of 5½ from the center of the record to a maximum of 6⅛ inches when set for a 12-inch record. Two triangular marks indicate the nominal limits for average records.

Behind the satin finished panel is another knob with two scales for setting the anti-skating control for either conical or elliptical styli. After balancing the arm with the flexibly-

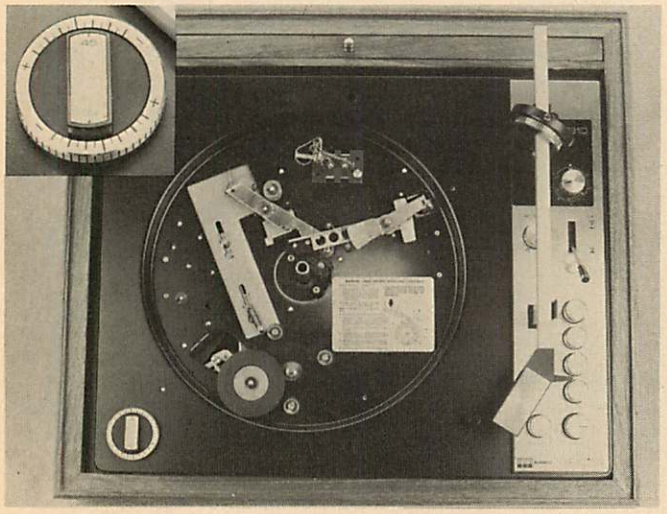


Fig. 1—Top view of the turntable with the platter removed and without the arm counterbalance. Note the compartment cover at the rear which protects the 45 adapter and whichever spindle is not in use. The inset shows the speed change control—a rocking lever—and the vernier speed adjustment ring.

Fig. 2—The arm-mounting gimbal has the anti-skating control at its right and the set-down control directly in front. Stylus force is set by the large ring on the gimbal. The cue lever is shown at the right front.

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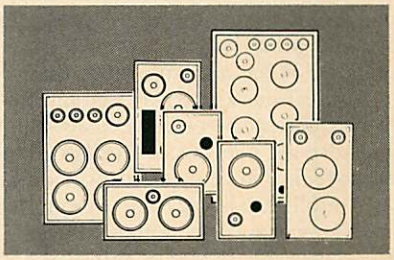

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mounted counterweight, using the knob for fine adjustment, stylus force is then set with the large ring which is part of the gimbal in which the arm is supported. Stylus overhang can be adjusted by moving the cartridge adapter on the slide, with the exact position being indicated by a plastic fitting which slips over a split pin on the chassis. After achieving correct adjustment, the indicator is removed and replaced with a stylus-cleaning brush which slips over the same pin. Every time the arm passes over the brush, the stylus is wiped clean.

The single record spindle slips over the center bearing of the platter and rotates with it, while the automatic spindle drops into a hole in the center bearing. Leads from the arm are carried in a shield, consisting of a long spring coil, and connect under the turntable platter to a pair of phono jacks into which the paired cable plugs from the underside. On the whole, the 810 appears to be well designed and well built in every particular.

Performance

Measured performance of the 810 indicated a very low wow figure of 0.06 per cent, and an equally low flutter of 0.06—both unusual, since most turntables show slightly more wow than flutter. This is somewhat better than the specified 0.15 total. Similarly, hum, noise, and rumble measured 44 dB below the 1000-Hz level of 3.54 cm/sec, unweighted. This corresponds closely to the specified level of 1 cm/sec at 100 Hz, and when compensated for ARLL (audible rumble loudness level, commonly reported by others) corresponds to about -63 dB, which is excellent. With the synchronous/induction motor, there was no speed variation with change in frequency, and none over a voltage range from 85 to 135 volts.

Cycling time measured 16 seconds from a standing start, and 12 seconds from trip to setdown in the automatic mode. The vernier speed control varied the speed from the normal 33⅓ by 1 per cent downward and by 4 per cent upward, resulting in an overall range of 5 per cent, which is only slightly less than usual. One interesting feature is the ability to repeat a single record as long as desired. The single-play spindle is inserted and the AUTO/SINGLE knob turned to the AUTO position, and upon starting by depressing either the 12, 10, or 7 button, the record will be played continuously until the stop button is depressed.

BSR is to be complimented on the clarity and completeness of the owner's manual which comes with the 810. Full instructions are given for changing the motor spindle and for changing the unit for the required line voltage. This information should save the owner from having to locate a qualified service man if such changes are required—the owner can join the do-it-yourself cult quite proudly. *C. G. McProud*

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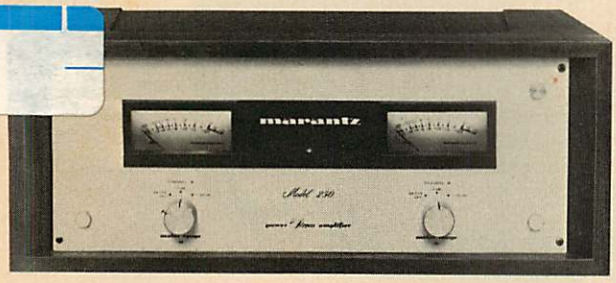


Marantz Model 250 Stereo Power Amplifier

MANUFACTURER'S SPECIFICATIONS

Power Output (each channel, both channels driven, at rated distortion, 20 to 20,000 Hz: 4 ohms, 150 W; 8 ohms, 125 W; 16 ohms, 64W. **Total Harmonic Distortion** (at or below rated power): less than 0.1%. **Intermodulation Distortion** (at or below rated power) SMPTE, any combination of two frequencies, 20 to 20,000 Hz: less than 0.1%. **Frequency Response:** +0, -1.5 dB, 2 Hz to 100 kHz; ±0.1 dB 20 to 20,000 Hz. **Input Sensitivity:** 1.5 V. for rated power. **Input Impedance:** 100k ohms. **Damping Factor:** Greater than 100 at 8 ohms. **Total Noise:** Better than 106 dB below rated power into 8 ohms. **Power Requirements:** 120 V. a.c., 50/60 Hz, 500 W maximum. **Dimensions:** 15⅜ in. W by 6⅛ in. H by 9½ in D. **Weight:** 28 lbs. **Price:** $495.00.

The first thing we can say about this husky amplifier is that it is a superb unit—as would be expected from this manufacturer and at this price. Not so powerful as to be a hazard with your pet loudspeakers, yet with more than enough power for any home application, and easily enough for commercial uses where the two channels can have their inputs paralleled and their outputs driving two sets of speakers, hopefully alternated around the listening area so as to provide adequate coverage even if one amplifier should fail, although there seems to be little chance. However, in commercial applications, this possibility must always be borne in mind, for equipment failure cannot be tolerated.

The amplifier is mounted behind a heavy gold-finished panel on which are two softly illuminated meters of the 4½ in. variety. Below each is a solid metal knob which actuates the meter switch for its respective channel. No power switch and no volume controls, since this is a basic power amplifier intended to be plugged into the control amplifier and actuated by the switch on it. The rear panel is equipped with two phono jacks for inputs, a four-terminal barrier strip for outputs, a fuse, a convenience receptacle, and the line cord. The ends of the enclosure are completely taken up by enormous heat sinks, at the center of which are the four output transistors of each channel—two complementary pairs, each with V_{ceo} ratings of more than 130 volts. This indicates a wide safety range, since the maximum static d.c. voltage applied is 58.

The amplifier circuit is a fairly complex arrangement, employing a total of 45 transistors, 19 diodes, and 8 Zener diodes in the complete unit. It is divided into several sections—the amplifier proper (including the eight output transistors), the rectifier/relay board, and the meter board. Referring to Fig. 1, the input is fed to Q519, an emitter follower with current source Q518. The output of the emitter follower is fed to one base of a differential amplifier, Q501 and Q502, and its output to the base of inverter Q503 which has Q504 as its current source. The inverter is coupled to Q507 and Q506, complementary pre-drivers, and their output is fed to Q510 and Q511 which serve as drivers to feed the complementary output transistors Q802/Q804, and Q803/Q805. The amplifier is supplied with both negative and positive voltages, each 58 volts, with the common point between the two output pairs at d.c. ground potential, thus eliminating the need for coupling capacitors to feed the speakers.

A protection circuit, consisting of transistors Q516, Q517, Q505, and Q506, precludes the possibility of damage to the output transistors if excessive inputs are applied. Transistors Q516 and Q517 sense the voltage across resistors R531 and R532 (each only 0.1 ohm) and when current reaches the design maximum, corrective signals are fed to the bases of Q505 and Q506 which disable the predrivers on excessive output current peaks, and thus limit the current through the output transistors to a safe value. Feedback voltage is fed from the output point—the junction between R531 and R532—back to the base of the second transistor of the differential pair (Q501, Q502), and to the input to the predrivers to place the entire amplifier under feedback control.

The rectifier-relay board consists of the main power supply rectifiers, together with a three-transistor circuit which provides

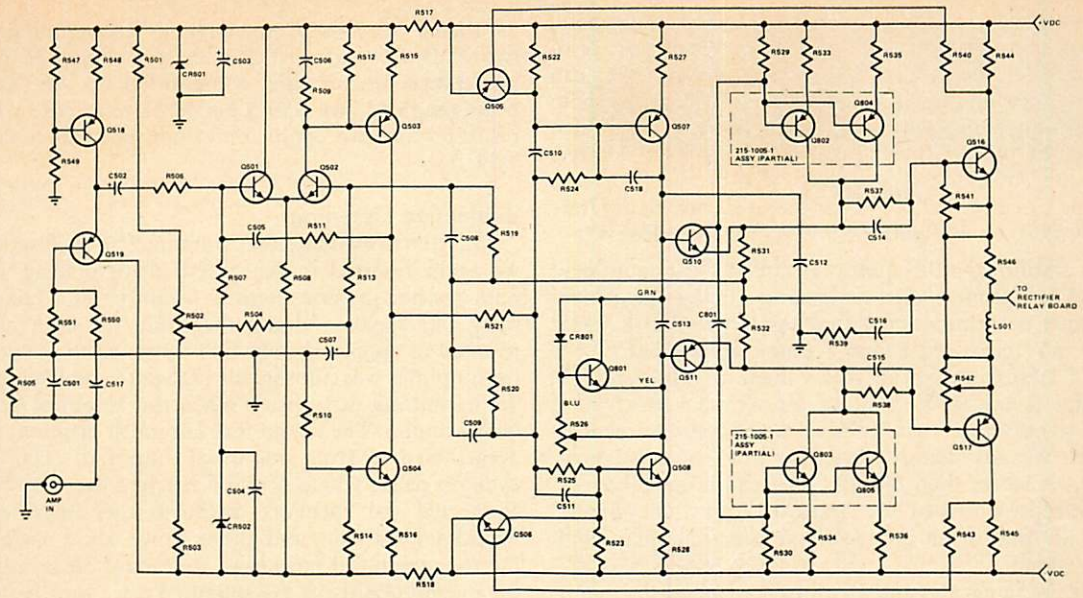


Fig. 1—Simplified schematic of the Marantz 250 amplifier.

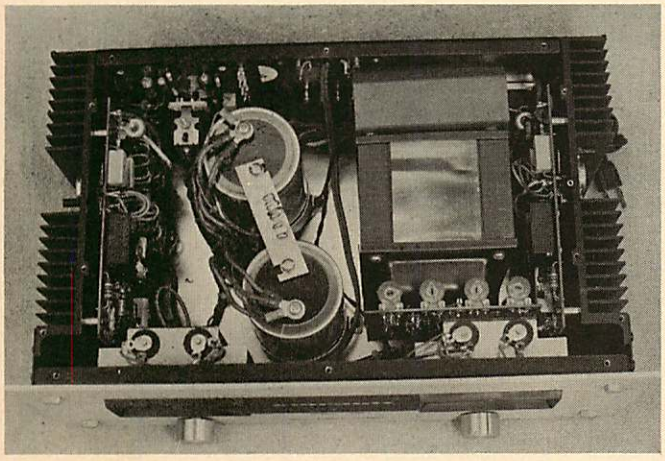


Fig. 2—Top view with the cover removed. Note ground strap between the two 20,000-μF filter capacitors. Ground connection to exact center of this strip is important in reducing hum.

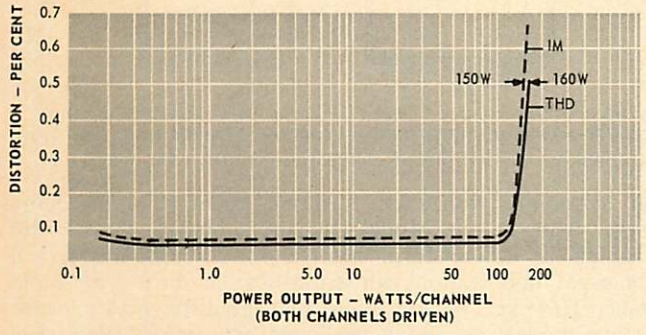


Fig. 3—THD and IM distortion vs. power output.

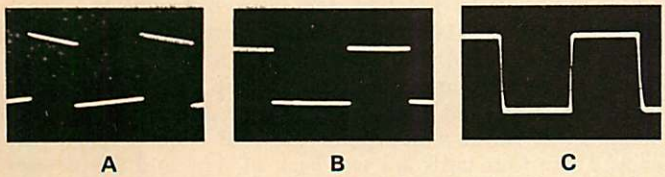


Fig. 4—Square waves at **A**, 20 Hz; **B**, 1000 Hz, and **C**, 12,000 Hz.

the delay of some two seconds before actuating the relay which connects the amplifiers to the output terminals. In addition, this current samples the d.c. voltages on the two output lines, and when there is a difference between them of 4.5 volts, it acts to de-energize the relay, thus disconnecting the speakers from the amplifier. Similarly, if there is a high-level signal below 10 Hz present, the circuit also de-energizes the relay. Eighty-six volts a.c. is fed to the power rectifier bridge, resulting in positive and negative supplies of 58 volts being provided for the amplifier. Filtering is effected by two 20,000-μF capacitors—yes, 20 *thousand* microfarads. That accounts partially for the very low noise level of the amplifier.

As practically everyone knows, the rectifiers of a VU meter connected across any audio circuit introduce a measureable amount of distortion, so the metering circuit board serves to isolate the meter rectifiers from the output circuits. Each channel employs two transistors, three Zener diodes, and six diodes. The transistors serve to provide a push-pull signal from the single-ended circuit of the speaker line, and this push-pull signal drives the bridge rectifier which furnishes the d.c. for the meter movement. Two of the Zeners are connected back to back to protect the meter against overloads, and two regulate the positive and negative voltages from the 58-volt supply to a more-usable 13 volts. Two of the diodes serve to prevent any excessive voltage spikes from reaching the meter amplifier circuit. Each meter is illuminated by two lamps, and a pleasing blue glow results from the filtering of the glass on the meter front. The switches have three positions —off, "0", and "+20," with the "0" representing an output of 0.75 watts, and the "+20" representing an output of 75 watts.

Performance

This is an amplifier which needs very little in the way of performance curves. The frequency response is flatter than water on a plate from the claimed 2 Hz to 70,000 Hz, drooping slightly—1 dB—at 100 kHz. Power bandwidth, not specified by the manufacturer, was measured at 4 to 65,000 Hz. Distortion —both harmonic and intermodulation—was well under 0.1 per cent up to the rated output, and, in fact, IM began to rise at an output of 150 watts. At the 1-watt level, harmonic distortion was below the residual of our measuring equipment—0.04 per cent. Frequency response could be drawn with a ruler on the usual 20-20,000 Hz curve paper. Distortion curves are shown in Fig. 3, and square-wave photos are shown in Fig. 4.

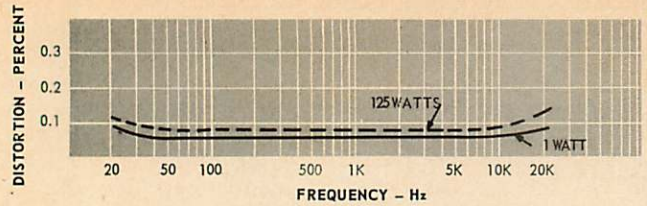


Fig. 5—Distortion vs. frequency at two power output levels.

Testing an amplifier of this quality strains the test equipment to its limits. For instance, with a signal-to-noise ratio of over 100 dB, it must be remembered that this represents a signal of about 0.3 mV measured across 8 ohms. An output of 125 watts across 8 ohms implies an rms voltage of 31.6, and 100 dB below that is the 0.316 mV. It doesn't take much of a ground loop to introduce that much of a signal in the measuring apparatus. We did measure less than 1 mV of noise, however, and that is better than -90 dB. This amplifier, therefore, could well be represented by the classical "equivalent circuit," which is usually that of an input voltage times the gain, with nothing else added.

Power measurements at 4 and 16 ohms confirmed the manufacturer's claims for those load impedances. Then testing with the standard load which consists of a resistor, an inductance of 20 μH series with a noninductive load resistor of—in this case—9.26 ohms which is paralleled with a 2 μF capacitor, and again we found the square waves at 10 kHz at 10-watt and 100-watt outputs to be identical with those at 1000 Hz, indicating complete stability in the amplifier.

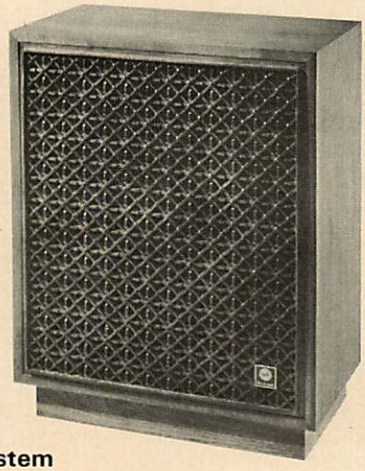
(The 9.26 ohms was arrived at by a simple way of making a noninductive resistor. We paralleled two center-tapped 75-ohm wire-wound resistors, then connected one lead to the paralleled center taps, and the other lead to both ends of the paralleled resistors. Connecting to the center tap and to the two ends of a wire-wound resistor results in practically no inductance—in our case, a measured 0.1 μH. It would have been simpler if we had a single 35-ohm wire-wound 50-watt resistor which we could center-tap, but that is not a standard value.)

Subjective Listening

In order to evaluate the Marantz 250 at close to full output, we again resorted to the expedient of placing a 300-watt, 8-ohm resistor in series with a 1-ohm resistor, across which we hung our speaker, doing the same for both channels. This resulted in approximately 1.25 watts fed to our speakers while the amplifier was putting out 125 watts—protecting the speakers yet permitting us to listen when the amplifier was working at its maximum. The sound was not much different than we were accustomed to from our usual amplifier, clean and smooth, even on peaks which actually reached the 125 watts. Then we connected the speakers direct to the amplifier as anyone would normally do, and although we could not have stayed in the room with full power, we were most pleasantly surprised at the overall quality of the sound. We are fortunate in not living in an apartment, so we were able to get up to levels in the vicinity of 110 dB SPL and the resulting sound was still excellent. If we were looking for a fine high-power unit, with top drawer performance, we would not have to look further than this one.

With the kind of performance the Marantz 250 offers and added to it the ease of converting to 220 volts if we ever moved out of the U.S.A., there is no doubt that this unit is sure to be acclaimed as one of the finest amplifiers ever to reach the market. (The conversion to 220 volts is a simple operation which shouldn't take more than ten minutes.)

C. G. McProud



Rectilinear III Lowboy Speaker System

MANUFACTURER'S SPECIFICATIONS

System Type: Three way, bass reflex. **Components:** One 12-in. woofer, one 5-in. midrange, and four cone tweeters (two each 2 and 2½ in.). **Frequency Response:** 30 to 20,000 Hz. ±4 dB. **Nominal Impedance:** 8 ohms. **Dimensions:** 28 in. H. by 22 in. W. by 12¼ in. D. **Weight:** 75 lbs. **Price:** $299.00

The Rectilinear III Lowboy is a recently introduced version of the Model III which was released some four years ago. It uses a similar speaker arrangement in a different style cabinet, so the change only involves styling. The original model is still available but there is no doubt that many people will find that the Lowboy with its attractive wooden grille and low profile will harmonize with their furniture better than the more severe styling of the Model III. Just a matter of taste. But changing the cabinet form factor is not a simple matter and even slight modifications can seriously affect the overall sound quality. However, we can report that the differences between the two models are quite small and are probably less than those caused by room acoustics. Figure 1a shows the speaker arrangement of the Lowboy; the 12-in. bass unit has a corrugated plasticized surround and the enclosure is a reflex type with the ducted port opening at the lower right. The 5-in. midrange driver is mounted near the top and the cross-over frequency is 500 Hz. It uses a twin-cone and functions up to about 3,000 Hz at which point the four cone tweeters take over. These four units are two each of 2-in. and 2½-in. sizes and are spaced around the top half of the cabinet to give a large source effect. Figure 1b shows how the speakers are

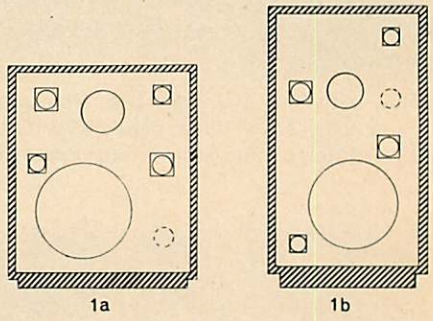


Fig. 1A—Arrangement of the Lowboy speaker units; **B**, How the speakers are mounted in the older-design Model III.

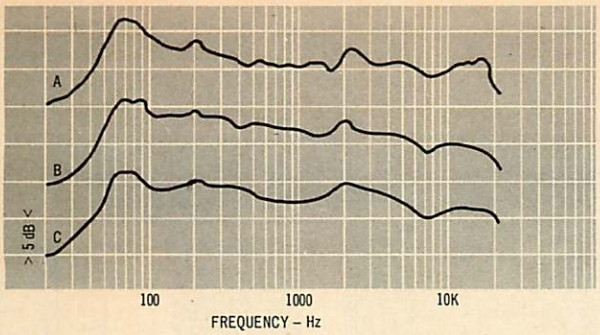


Fig. 2—Frequency response taken with one-third octave band pink noise; **A**, on-axis; **B**, 45 degrees, and **C**, average of five positions.

within specifications, and excepting the small "bump" centered on 70 Hz, is within ±5 dB from 40 up to 20,000 Hz. The top curve, A, shows the response on-axis, B is taken at 45 degrees off-axis, and C shows an average of five positions. The speaker level controls were set to the best listening position which was about central for the midrange and a slight reduction in the treble. Figures 3 and 4 show the ranges of the level controls, and the harmonic distortion at low frequency is shown in Fig. 5. Frequency doubling commenced at 75 Hz but a useful output was obtained down to 30 Hz. The tube port is filled with fiberglass and we removed it and checked the low frequency response again. As might be expected, power below 75 Hz fell by half—in other words, the fiberglass reduced the "Q." White noise tests showed up some coloration

Fig. 3—Showing range of mid-band control.

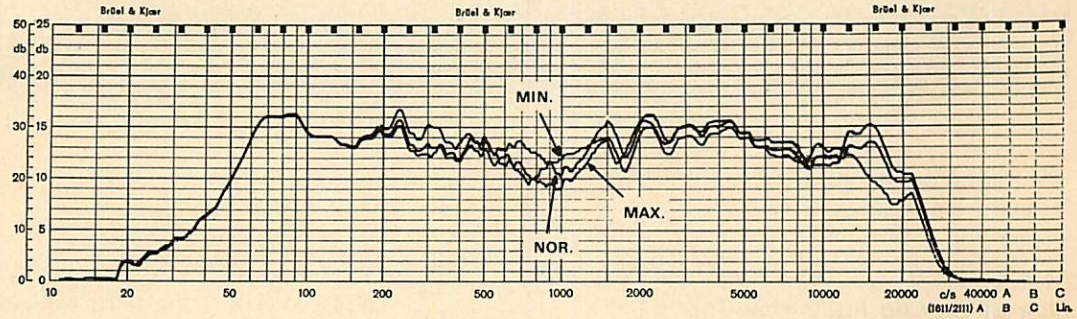
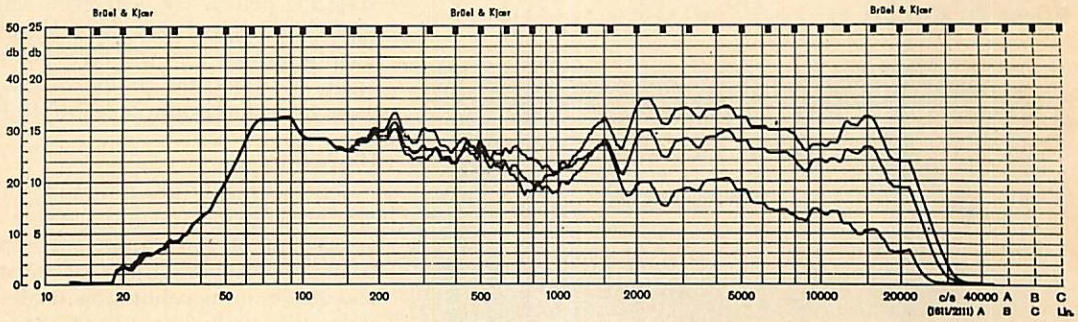


Fig. 4—Range of treble control.



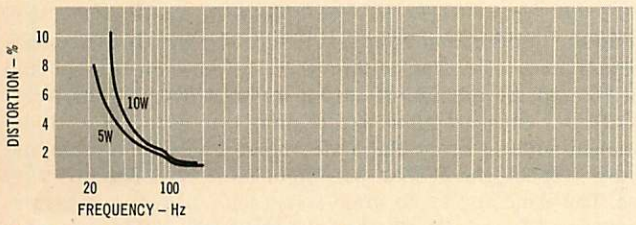


Fig. 5—THD at low frequencies.

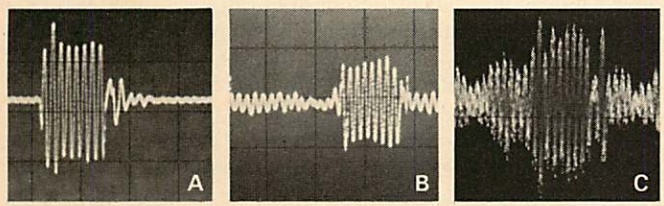


Fig. 6—Tone burst characteristics at **A**, 100 Hz; **B**, 500 Hz, and **C**, 10,000 Hz. Note that the 10,000 Hz response shows interference effects because of the multiple units.

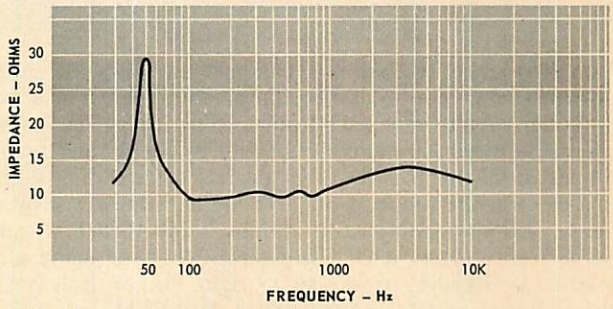


Fig. 7—Impedance characteristics.

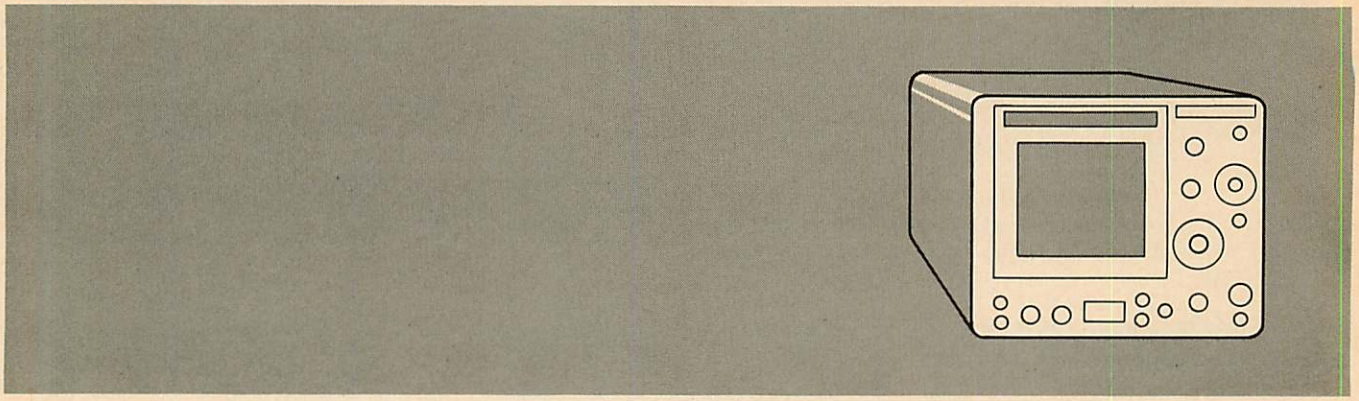
mounted in the older Model III. At the rear are level controls for midrange and treble, and I was pleased to see that the input terminals were spaced well apart.

Measurements

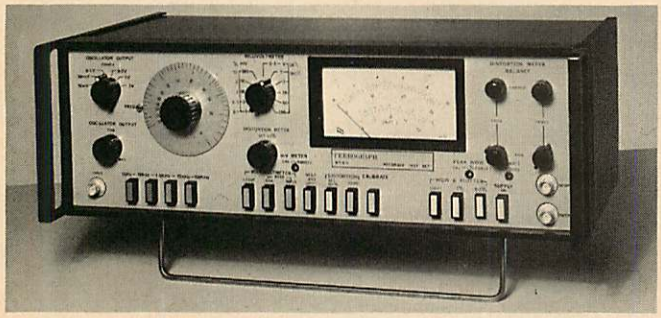
The frequency response, taken with one-third octave band pink noise, is shown in Fig. 2. Note that the response is easily

(some frequencies were increased) when the midrange control was set to minimum, but in the normal or center position, coloration was very low. Tone burst response can be seen from the photographs in Fig. 6. The 10,000 Hz response shows interference effects from the multiple units. Figure 7 shows the impedance characteristics and it will be noted that the lowest point is over 9 ohms, thus extension speakers can be used as well as the main speakers without reducing the load to an undesirable figure. System resonance is at 50 Hz and above this point impedance is remarkably smooth. Sensitivity is quite high—a one-watt signal produces an average output of 95 dB at one meter, so a moderate power amplifier would be quite adequate for small to medium size rooms. All-in-all, this is a fine sounding system with good frequency response and above-average dispersion. *T.W.A.*

Workbench



Ferrograph RTS-1 Tape Recorder Test Set
Elpa Marketing Industries, Inc.
Price: $1200.00

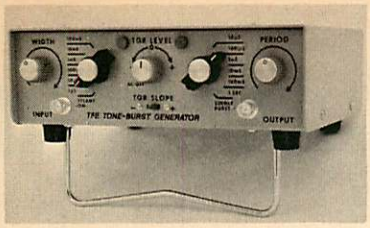


The Ferrograph RTS-1 is a compact and versatile instrument consisting of an audio oscillator, millivoltmeter, a wow and flutter meter, and a THD distortion bridge, all housed in one case measuring only 17⅜ by 10 by 5⅝ in. and tipping the scale at 13 lbs. It is ideal for dealers or recording studios but it can also be recommended to the enthusiast who wants to check his own equipment. Although the RTS-1 is called "a tape recorder test set," it will obviously have many other applications. Reading from left to right, the controls are as follows: Range switch for OSCILLATOR OUTPUT (10 mV to 3 V) frequency dial and fine output control, MILLIVOLTMETER range switch, DISTORTION METER level control, and then the four BALANCE controls on the right. At the bottom are push-buttons for FREQUENCY RANGE, DISTORTION, CALIBRATION, LF CUT and WOW AND FLUTTER ranges. The ON-OFF switch is on the right, and next to it are output sockets for a scope, etc. The meter itself has a 4½-in. dial calibrated in rms, dB, and drift percentages. Used as a millivoltmeter, the ranges are 1 mV FSD to 100 V in 11 switched positions, and the input impedance is 1 megohm on the lower 5 ranges increasing to 2 megohms from 300 mV up. The THD section is calibrated down to 0.1% FSD and the internal generator can supply a 1000 Hz test signal. The DIN standard is used for wow and flutter measurements and the input frequency is *weighted* with maximum response at 4.5 Hz and -3 dB points at 1.5 Hz and 15 Hz. There are two meter ranges—0 to 0.3% and 1% FSD. A zero-center scale also allows measurement of drift or speed changes. Here's how it works: The internal 3.15 kHz test signal is recorded and then the tape is played back so the meter will now indicate on the "drift %" scale the percentage difference between the frequency of the reproduced signal and the 3.15 kHz test signal. Yet another facility provided by the RTS-1 is measurement of frequency response using the built-in generator which provides an accurate signal in the range of 15 Hz to 150 Hz.

Performance

The instrument has now been in use for some months and has certainly proved a lot easier to use than my standard assortment of test equipment with its bird's nest of interconnecting cables! All the specifications were met or exceeded and the built-in calibration facilities were positive and free from drift. Millivoltmeter frequency response checked out at ±0.3 dB from 10 Hz to 200 kHz with an accuracy well within the limits claimed for that range. The variable frequency internal generator was within 0.2 dB between 15 Hz and 150 Hz and the maximum output was just over 3 volts. Wow and flutter measurements were almost as accurate as those obtained with far more elaborate and complex equipment and in this respect, the RTS-1 will meet most requirements with ease. The same applies to some extent with distortion measurements and I found myself using the instrument for many quick checks. The filters only cover the range from 500 to 1500 Hz, which means that lab or design applications would be somewhat restricted—but for many other purposes this range would be perfectly adequate. A high-pass filter attenuating below about 400 Hz allows hum and low-frequency components to be assessed separately, if so desired. I found the four small balance controls quite tricky to use—especially when measuring distortion below 1%, and I thought it a pity some kind of slow-motion or vernier was not employed here. But all it takes is a little patience and unless the instrument is used almost continuously, it should cause no problems. Lowest repeatable THD measurement was about 0.08%. Inherent noise—partly due to oscillator leakage—made it difficult to get below that figure with any accuracy.

Incidentally, the instrument is fitted with folding metal legs which permit it to be raised at a convenient angle without propping it up with a meter or something. All-in-all, the Ferrograph RTS-1 is a most useful instrument which will find a place in many dealers' workshops, service centers, recording studios, and so on. *T.A.*



Tone-Burst Generator Model TBG-4

Burst width adjusts from 1 μS to 100 mS and period varies from 10 μS to 1 sec. 5V P-P output, and input and output Z of 10 kilohm and 2 ohms respectively. Accepts inputs from any lab signal source, including noise generators. Price: $179.95 ($105.95 Kit).

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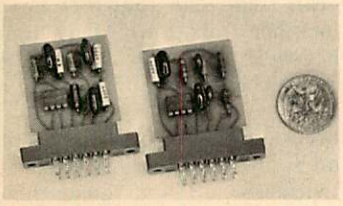
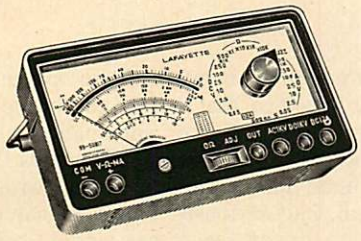


Lafayette Multitester

This is an inexpensive meter which features a.c. volts range from 0-2.5 up to 1000 in 7 ranges, d.c. from 0-0.25 up 1000, current 0.25 mA up to 12 amps, and 3 ohms ranges up to 60 megohms. D.c. sensitivity is 30,000 ohms per volt. Size is 7 by 4 by 2 in. and the price is $22.95.



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Active Filters

These units are intended for electronic crossovers and they are available in any crossover frequency. Configuration is 3-pole Butterworth, and the input impedance is 150 K. Attentuation is 3 dB at the crossover point and increasing at 18 dB per octave. Price: $29.95 per pair, including sockets. Power supply units, giving $\pm$15 volts at 50 mA, are available at $19.50 each.

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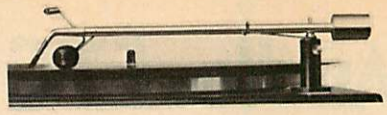

Bib Groov-Kleen

This is described as a sophisticated Automatic Record Cleaner, and it uses a sable brush with velvet collar plus an adjustable counterweight. Base is self-adhesive and price is $7.50. No liquid cleaner is necessary.

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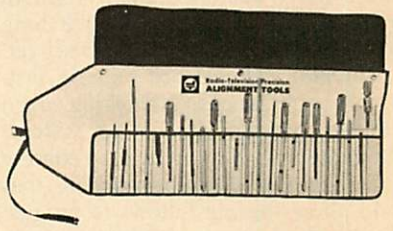

25-Piece Alignment Tool Set

Designated 23C750, this useful set includes a long reach core aligner, tuning wand, i.f. transformer aligner. Working ends feature slotted, recessed, and hex styles. Price: $17.00, including pouch.

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Audio ETC

Edward Tatnall Canby

YES, WE STILL HAVE, or are about to have, two opposing systems for the quadraphonic disc, promoted by you-know-whom, the same old familiar adversaries. It would seem to be a nasty deadlock and a fight to the finish. But it isn't, not by a long shot. We may get an Ultra Disc yet, the *Ultimate*. Things are moving fast, the corporate blocks unblocking, even with two systems, and other systems still threatening. New ideas keep coming up for the sort of compromising that would allow the big fellows to wriggle out of their present positions, faces more or less saved, images intact. A big order, I know, and you'd hardly think it possible right now. But where there is smoke there is fire, and where reasoned ways out of impasses are made visible and well publicized (we in the press try to help), then sooner or later the results will show.

First, if things continue as is and the RCA discrete disc, some of its thorny incidental problems well solved, appears as scheduled by RCA early this spring, then many of us will go along with the two incompatible disc systems—maybe even 2½. Provided, of course, that we get the joint decoding componentry to play both kinds with ease on our home systems. (The dual decoder, as I suggested in April, preferably with automatic switching: just put on either type of disc and let 'er go.) If a supersonic signal is present (as in stereo FM) the thing switches itself to discrete RCA. If no supersonics, then it plays matrix. I'll buy it. So will you. That is, once again and with emphasis, assuming there *is* a discrete disc to buy and to play, that the perplexing and very real problems the discrete system brings along with it are in fact worked out, as RCA hopes to work them out. The discrete disc is good, if we take it at its best—as we've already heard it in impressive demonstrations. I'll admit that I do not see how some of its disadvantages can be met. But give the boys time. Let's assume, until we have a fair trial, that the system will go ahead. We will eagerly accept it on a working basis to compare for ourselves with the matrix disc.

But things may go further than you now might suppose in the direction of compatibility between these systems. They *could* go, that is, if the corporations were willing. So, in anticipation and hope, I am projecting here towards the ultimate quadraphonic disc, half with a laugh, half seriously. I've even named it, as you can see. It has already been described in detail and in technical language (though not with my name) before representatives of the relevant companies; it is now public property among engineers, though for the benefit of others of our readers I'll act as if it were a brand-new idea. My fingers are itching to get hold of one of these Ultradiscs! But they haven't been manufactured yet, nor perhaps even put into active experiment. Too bad. Let me lead you, in all logic, straight to the concept of this disc, so you'll see how nicely it might work.

The discrete system adds a new band of supersonic information above the standard audible bands, and FM-modulates a signal into each, cut into each side of the record groove in microscopically tiny undulations. You can hear the high twittering noise if you slow down a discrete disc by hand. The four channels aren't actually discrete—like the FM multiplex broadcast channels, they are matrixed together, share and share, each one partly in the supersonic, partly in the audible signal. Decode the two supersonic signals, dematrix all four, and as in radio you come out with what you put in. Hence, discrete. When it works it is very accurate.

The matrix systems are variably less accurate, less faithful to the ingoing four signals. And thereby they are subject to all sorts of mainly aesthetic "interpretation," variations in the chosen parameters of playback, according to taste. A complex kettle of fish. It sounds bad, and plenty of people have jumped in to make it sound even worse on this basis. But the matrix system has an absolutely enormous advantage in that it uses only the present standard stereo signal and is indistinguishably playable—or broadcastable—on *all* present equipment without reservation. Moreover, with certain additions in the way of logic circuitry—more of this in a moment—the latest matrix product is beginning to show real accuracy in playback, approaching that of the ideal discrete arrangement to a practical degree.

Meanwhile, as the news reports say, we should look further at the sources of all these quadraphonic signals. The fact is that they are almost never themselves discrete—that is, wholly different. As in standard stereo, they already share between them a large proportion of similar or identical information. Precise decoding, totally discrete, is aesthetically less important than it might seem for valid playback effect. You can trade one four-way mixture for another mix-down that sounds maybe just as good in the listening. And who hears the "original?" Not you and me.

More indicative of practical thinking behind four-channel sound is the fact that virtually all the quadraphonic material so far published, in any format, is derived from originals not intended for quadraphonic use since much of it is on three tracks or even two! This applies, impartially, to most or all of the present RCA Q8 catalogue and most or all of the Columbia SQ list. But—oh no—that does *not* invalidate present quadraphonic offerings. If anything, the usefulness of four-channel sound is strengthened by this demonstration of what it can do for all sorts of recordings *on any plural number of tracks.* (Mono is a different story.) Most quadraphonic recordings are going to be of this type for awhile. It is good to know that they are so effective and to understand that the basic recordings are enhanced right down the line by the new type of home reproduction, whatever the playback system. More of the available information is put to use via four channels than is possible via two channels. That's the story and it's a good one.

This is why the various matrix decoders, though far from identical, are able to turn out such good four-channel sound from standard stereo discs—variably but interestingly. It's why both discrete and matrix discs, sending out more specifically separate four-way information, further improve the quadraphonic effect, as a picture might be given heightened contrast and color, sharper definition. It's all on the plus

side, you see. Variable enhancement.

But it *is* important to keep your chosen four signals as discrete as possible from master tape through to home playback. Too much "play," like a worn steering gear or a loose drive shaft, blurs the accuracy of a control system and hence its *predictability*. On this point, obviously, any system that gives tight control is desirable, whereas the variable, unpredictable effects of assorted matrixing can give our recording engineers hideous headaches.

So without a doubt the discrete disc from RCA would win hands down right now, if it weren't for the aforementioned problems that RCA is now out to solve, as far as possible, before its major launch of the new discs. But these unresolved qualifications, the need for a new-type pickup and stylus, the problem of wear, a presently shortened playing time and lower volume level, the very great difficulty of cutting (and playing) grooves from 30 to 60 KHz, the incompatibility with FM broadcast, are the sort that give the matrix disc a relative boost—for it has none of these problems.

A much more serious competition from the matrix camp, however, is provided by that crucial tightener-up of matrix accuracy, the logic circuit. The key to the matrix disc, without the slightest doubt, is in the perfection of these ingenious circuits, which immensely increase the accuracy, the faithfulness of the decoding. The logic, you might say, picks up hints from its matrix and converts them into certainties. Fantastic.

Without logic circuits, matrix-decoded sound is, shall I say, pleasantly diffuse. It can be lovely, but it is imprecise and unstable. Move a foot or two or change the volume levels, and everything moves. Somehow I keep thinking of a mild inebriation—that's how unassisted matrix circuits work. "Composer" circuits, indeed! An excellent name for them. By themselves, even when matched to their own discs, they tend to treat the original four channels with a sort of drunken fervor. The effects are delightfully there, but they're awfully imaginative. Speaking more soberly—a left rear signal, say, is indeed preponderantly in the left rear speaker but it is also spuriously much too evident in other speakers, if at a lower volume. (What if you are near one of them, or move a bit?) No matrix is in itself a precision decoder, so far as I know. Just a good general indicator.

But keep in mind that few quadraphonic signals are ever one-channel, intended for *one* speaker only. Like the stereo signal, most are intended to be heard in all the speakers to some degree. Discrete reproduction merely duplicates the original balance and phasing as intended. If things are off a bit, no great aesthetic harm is done. The matrix without logic is very good to hear and do not doubt it. It just isn't precise. With logic added, we have something else again.

Logic circuitry is new and tricky, at least in this field, and we do not yet have final answers in commercial form. Manufacture of matrix units in present circuit-board constructions is obviously well ahead and practical at no great expense. Lafayette, for example, splurges with not only an SQ decoder in its new moderate-cost componentry but also a different "com-

poser" matrix and is still able to add switching for a four-input position and a two-sided hookup that joins both speakers on each side for still another kind of listening. But to add a logic circuit to these first-generation models would have been too costly and/or not yet satisfactory. (Sony's SQ has a very good partial logic.) Not, at least, in conventional circuit board form. So mostly we do not yet have logic in our decoders—and we need it, in all equipment, if the matrix disc is finally to get off the ground.

Too expensive and complex? Just wait. Wait awhile, until the *logic chip* makes its appearance. That'll be almost any day. I've held a small box of the first production models of such a unit in the palm of my hand. Tiny things the size of the end of my finger, the chip itself almost invisible among the surrounding contacts. When units like these, incorporating the usual dozens of semi-conductor elements, get into production to go with the basic matrix, the matrix-type disc is going to blossom into its own. Soon. About the same time, in fact, that the discrete disc is slated to hit the market in force. So they tell us. Next autumn, they all keep saying.

The battle will quicken then, and there'll be motion at last! Fair fight coming up, out in the open where we can all join in with our own economic clout; and may both systems win hands down. Perfected discrete disc vs. matrix-with-logic. That's how they tell it.

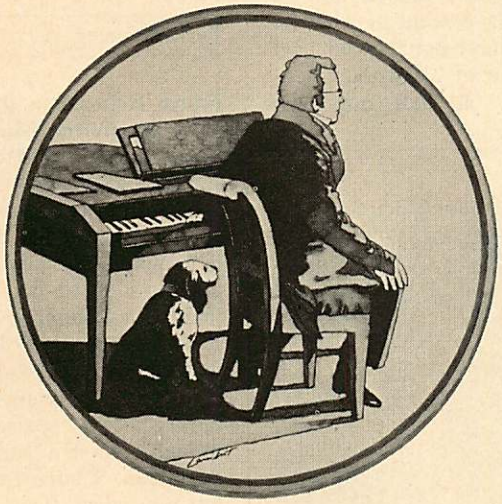
What about the Ultra Disc? Well, since the secret (if it ever was one) is already out, I'll let you in on it. Came as a foxy suggestion from the Columbia camp, intended for propaganda leverage. But, by gum, it might work! So simple.

The idea is, why doesn't RCA modulate its discrete discs with an SQ signal, so they'll play both ways? (Or it could be any other matrix.) That'd be two discs in one, two systems in a single groove. Superb! You see—it *is* quite possible. You'd play the thing with an SQ decoder and the matrix would decode the lower band into four channels, ignoring the supersonics. Play it on an RCA discrete system and the SQ would be ignored, but the RCA decoder would properly combine the super-tweet-tweets with the lower audio signals for a different set of four channels. Wow! A built-in AB! I dig.

Alternatively, Columbia might produce the complementary opposite, an SQ disc with an RCA supersonic overlay. A + B = B + A. 'Course there are a few technical problems, but no matter. The idea is so sharp that it just might persuade these two giant corporations to ease off their present high horses a bit—if we make enough hilarious noise. Actually, since RCA has four signal areas in its two bandwidths its disc is open to *any* four-way solution of the basic quadraphonic concept. And so, if it wants to, RCA can technically swallow up all the other systems ever devised, including matrix. (Well, maybe.) But if this company were merely to follow this one suggestion and, quietly, unobtrusively, add SQ signals to its discrete discs, you can guess where we'd be in no time flat. One universal quadraphonic disc—no less than my Ultradisc itself. What else? All we'd need would be a better name. Maybe we'll get it yet, if you'll all keep laughing.

Classical Record Reviews

Edward Tatnall Canby



Piano Schubert

Schubert: The Complete Piano Sonatas, Vols. 1-4 (20 Sonatas). Paul Badura-Skoda. **RCA Victrola VICS 6128, 29, 30, 31,** (3 discs ea.), $8.94 ea.

There are times when a reviewer-musician just wishes all the other records would go away. One performance, one set of performances, is so moving, so immense, the composer himself so awesomely present in the recreation that to play any other records at all means sacrilege. That's the reaction I had on several evenings, as these volumes came in from RCA. So this topmost kind of music comes to us half price! So much the better. Oddly enough, a minority of listeners here gets a real break over the majority who want show tunes, popular concerti, opera specials and piano celebrities—and must pay high. We get Schubert cheap thanks to the inexorable law of supply and demand in reverse. Sometimes it's nice to be a minority.

The world of Schubert is both very special and curiously universal, because the most difficult thing about his music is its total modesty and simplicity in outward appearance. The most haunting, incredible Schubert moments come in the easiest, most elementary tunes and harmonies, even from a single note –like the marvelous off-scale note in the A Major Sonata's little final tune, that converts a gentle melody into a soul-piercing bit of wistfulness. (Schubert knew it was good; he brings it back time after time.) Anybody with a reasonably able Western ear for our conventional scale, chords, tunes, can fall for the Schubert effects. Once fallen, you will not recover, and your life will be the deeper in perspective. Can a man really do these things? Then man as a whole can't be quite as bad as he often seems these days. That's the message.

Paul Badura-Skoda will be remembered by older record buyers as one of Westminster's original Viennese finds, back in the first months of LP. He and Georg Demus (also now on Victrola) played fabulous Schubert on two pianos or one piano four hands. Badura-Skoda, as I remember, didn't impress our toughened local music critics when he toured over here. He is one of those new pianists who are temperamentally better suited to recording than to the high voltage international concert-tour circuit. Anathema to the resident music critic (to some of them, anyhow), but Glenn Gould, another one, has survived handily with no concerts at all. So will B-S, and RCA has been wise to pick up this option on such a large scale—*all* the piano sonatas of Schubert.

It's not only the listeners who react, or don't react, to the Schubert language. Many top rank pianists, perfectly able to play the Schubert notes, nevertheless seem not really to understand what they are playing. Their ears simply do not tune to the Schubert harmonic language. Big names. Rudolf Serkin, Artur Rubinstein, for instance—as I hear them, anyhow. They miss what

thousands of non-musicians can hear with ease, when somebody like Badura-Skoda spells it out in notes.

He hears it all and, moreover, comes from Vienna where Schubert is indigenous. Enough said. If indirect proof were needed, there are the pathetically numerous unfinished Sonata movements—Schubert had a bad habit of leaving works incomplete at the point where (a) either he got stuck or (b), much more often, the rest seemed obvious enough and he'd come back later to do the copying-out. He never did. Badura-Skoda has completed a number of these movements, and if *you* can tell where he begins and Schubert ends, you are a genius yourself. It is possible, you see. If you know the idiom, know Schubert and his working methods, his circumstances at the time, other works of similar import, you can deduce 95 percent of what he inevitably would have done, given a bit better organization of his work schedule! Haven't we all left our own unfinished projects in the same fashion? Half-done circuit sketches (you audio engineers), bread-board mock-ups that never quite made it to the nearest wall plug, and so on. Will somebody finish up your projects for you as beautifully (assuming you are a genius) as Badura-Skoda has done up Schubert's?

Performances: A Sound: B+

Franz Schubert. (Impromptus Nos. 1-4; Moments Musicau Nos. 1-6.) Andor Foldes. **EMI Electrola C 063 29037,** stereo (*Eur. edition*).

These little Schubert works are not on the scale of the Sonatas, and a less dynamic approach to them in the playing is to be taken for granted. Yet there is a difference in substance, even so, between the Foldes Schubert and that of Badura-Skoda in the Sonatas.

Foldes is a pianistic genius of top rank, not a specialist in Schubert though, a Hungarian and central European, Schubert is a normal part of his repertoire. This disc, sent to me from Europe, says just that in wonderfully clear musical terms. There is no possible fault to be found in the performance—the finger work, the tempi, the phrasing and dynamics, are all perfection. Even the piano sound is steadier and better in the audio than the very convincing sound of the Badura-Skoda piano. And yet, there is an objectivity, a kind of involvement which says, quite in all truth—I can play *this* music, too, this utterly simple music, along with the fiendish complexities of my fellow-Hungarian Bartók, the biggest Beethovens . . . and so on.

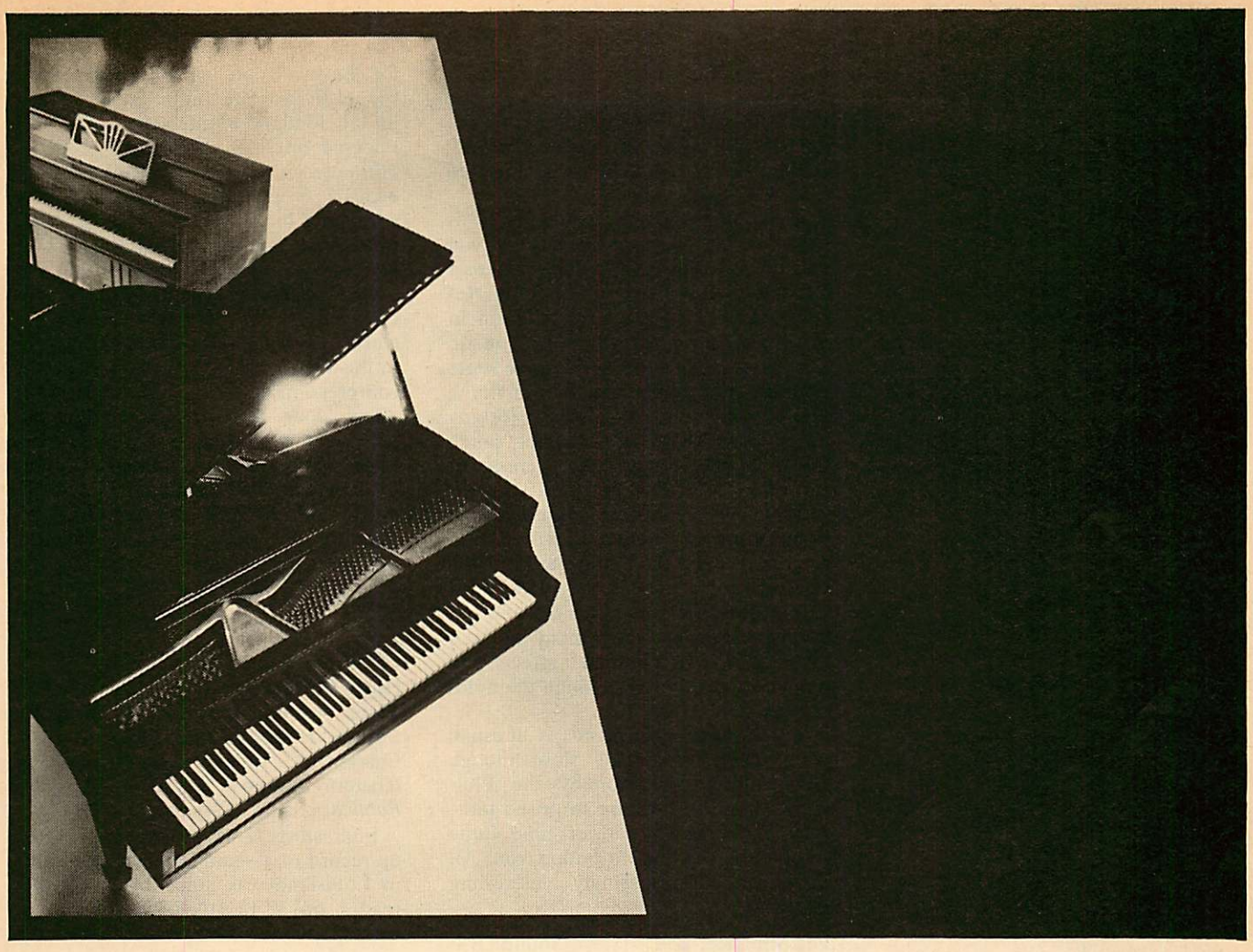
It is but the truth! Nor is there any lack of force. Where these works should be loud and muscular, they are that and more. *Everything* is right. Everything is there, except the sense of involvement in Schubert himself. Rather, I feel, this is involvement in Schubert *piano music* and the will to create a perfect performance in piano terms. I enjoyed every piano note of it, you may be sure. But Badura-Skoda carried me away. For Schubert is his life, and the piano the transmission medium.

Performance: A– Sound: A

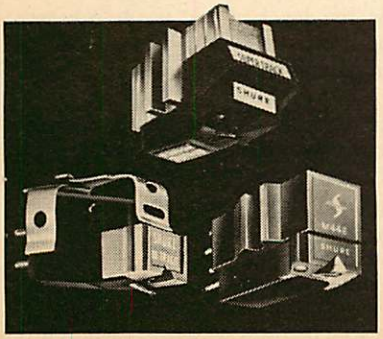
Boulez conducts Stravinsky Petrouchka. New York Philharmonic. **Columbia MQ 31076,** (SQ4), $6.98.

You have a tentative four-channel set-up and an SQ decoder? Not sure really whether it makes enough difference? Well, here's your test.

First, play a whole batch of standard stereo discs through the SQ decoder. Do it for days on end. You'll get



To each his own.



Not *everybody* needs a concert grand piano, nor does everybody *need* the best cartridge Shure makes to enjoy his kind of music on his kind of hi-fi system. Eventually, you'll want the renowned *V-15 Type II Improved,* the peerless cartridge for advanced systems and ample budgets. But, if your exchequer is a little tight, consider the *M91E,* widely acclaimed as the *second best* cartridge in the world. With a sharply circumscribed budget, all is *far* from lost. Choose any of the four models in the *M44 Series,* built for optimum performance in the easy-to-take $18-25 price range. Write for a complete catalog:

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some superb effects, in all sorts of variations. So different, from one disc to the next, that you'll think, surely, an SQ disc isn't going to be *that* different, among all these regular stereo discs via SQ decoder.

Then play this one. You'll see. It is *different.* Not necessarily because you can hear the piccolo in the right rear and the double bassoon left front. Not even because of greater separation in any specific way at all. What you do hear is simply a more vivid, alive sense of space and immediacy than anything you have heard via SQ decoder (or any other) and those two-channel stereo discs. That's the story. An increase of information for the ears.

Musically, this version is interesting because it is the opulently scored 1911 original; most recordings are of the revised version done in the 1940s. Hard to pin down details minus a score, but you will, somehow, hear many odd and vaguely new instrumental effects you hadn't noticed before, though the notes are the same.

The Boulez performance is unusual, parts of it surprisingly slow, though always alive. Occasionally the Philharmonic musicians are surprised too—they get minutely out of time quite frequently. Nothing to bother you. All in all, an absorbingly interesting Petrouchka.

Performance: B+ Sound: B+

Glazunov: Raymonda Suite. Bolshoi Theater Orch., Svetlanov. **Melodiya-Angel SR-40172,** stereo, $5.98.

Adam: Giselle (complete ballet). Bolshoi Theater Orch., Zuraitis. **Melodiya-Angel SRB-4118** (2 discs), stereo, $11.96.

No reissue is involved here—brand-new stuff, and the Russian sound is well up to the higher pricing, as is the remarkably authoritative Russian-style performing. Curious how the Soviet musicians somehow manage to avoid the tired and/or blasé feeling that creeps into so much Western recording of such standard and/or old fashioned works! The sound here is as though the performers had but this one chance-in-a-lifetime to get down their art on discs, which just might be the actual answer. We have long since reached the stage of over-production in our recording, notably in the popular and semi-pop areas of "classical" music.

The Russian ballet sound matches the Russian ballet. Hefty, strong, muscular, yet of an extraordinary perfection, too, like the dancing of the Russian men, whose legs seem somehow a bit too thick, or the ladies, who are for the most part less than ethereal in shape! In terms of audio, the graininess in the louder volume levels that still lingered on in most Soviet recordings until recently (uncompliant cutting heads?) is just about gone and the whopping big, fat sound is better than ever. One curious anachronism: solo and solo ensemble passages within the orchestral music—solo fiddle, or solo cello and harp, for instance—are recorded close-up and loud, as of c. 1940 in the West. Probably there is no actual compression of signal, but the close-up effect does tend to throw dynamic balance out of whack. We here tend to put the solos off in orchestral space, for a "natural" dynamic balance, even at the risk of quite low levels, once thought dangerous. Quiet tape (and disc) now makes them acceptable.

Performances: A– Sound: B+

High School

Third Annual L.M.E.A. District VI Senior Honor Band 1971-72. Dr. Charles A. Wiley, conductor. **RPC** (custom pressed), stereo. (*Recorded Publications Co., Camden, N.J. 08105.*)

Interesting. This professionally got-up record of a champ high school band in Louisiana was taped by an AUDIO reader on a TEAC 7030 after some correspondence with me concerning my article of awhile back on the usefulness of that type of "intermediate" tape deck. I am happy to report that he got helpful response from the TEAC factory service depot in the New York region—hopefully *without* mentioning AUDIO magazine. (A similar good report on KLH response has recently come in to me. A strictly anonymous request for info.) Always nice to know that our audio products are backed by this kind of aid and comfort.

Big band here, in a remarkably dead acoustic—but is it the mic set-up? Convenient picture shows all. Two E-V 1711 electret omnis for left and right, set up at either end of the big semi-circle of players, only a few feet out from the nearest performers, and quite widely separated. To fill in the center, they used an E-V cardioid 1751 *in front of* the conductor and low down—it is below the level of his head. Advent's Dolby noise reduction unit received channels one and two and the center mic went through a Shure M68FC mixer into both LINE inputs on the Advent. "We miked close, hoping for good definition," the man says. A competitor apparently had different ideas, using two AKGs in the air above the conductor and behind, with only a yard-plus separation. "His tapes are

very vague, with little or no separation and presence," says our friend.

Well, my reaction is that if *I* were there, I would set up halfway between these two gents. Separation and definition are just fine, but you need over-all ensemble feeling and, even more, an enveloping room sound, if your music is to sound alive and well as played back in the living room. Also, close-up mic setting tends to exaggerate all sorts of faults that do not ever reach the live audience. Even the Philharmonic's strings won't blend at a distance of a few feet. Evidently the other man thought our friend's mic placement "made the band sound bad" –if so, it was this proximity exaggeration he was talking about. It is always a danger.

On the other hand, three or four feet separation for a large band, spread out widely on a stage, is *not* enough, in any sort of acoustics. Like stereo speakers mounted in a single cabinet at the center of a wall. Divide your semicircle width into quarters, try the mics at the quarter and three-quarter points. That's a good rule to begin with. Wider apart if you can get away with it, with or without center channel and/or accent. (This assumes the semi-pro norm of two stereo tape channels, not three or more as in pro recording on wide tape.) And *back* far enough for a balance between separation/clarity and room sound–there's always a place where the two jump into a kind of focus, if you have the ear to spot it.

This Band plays very competently (even with close mics!) but the sound, definitely separated and with good middle, is nevertheless too lifeless for my taste. Maybe the hall itself wouldn't allow anything better. How about some professional reverb, then, in the processing? The music? Mostly ugh. Band competition music is not for the general listener, let me tell you. I liked the Holst "A Moorside Suite," a rather lush Impressionism. P.S. They don't even mention the music anywhere on the jacket, front or back! Only on the label. That shows.

Performance: Prizewinning.
Sound: B–

Julian & John. (Julian Bream, John Williams, Guitars.) **RCA LSC 3257,** stereo, $5.98.

Two famed guitar stars get together here for a two-guitar "classical" recital of some interest, ranging from an olde Englishe suite (Lawes) through, on side 1, works by two other guitarists of the early 19th century who also played together, Sor and Carulli, and on side

2 a brace of the inevitable Spanish works—Albeniz, Granados, Falla and Ravel. All but the Sor and Carulli are transcriptions for the two instruments.

It's a nice sound, one player on each side and the two guitars clearly differentiated (Williams' is more wiry in tone); the extraneous twangs and squeaks of the instruments, incidental to the playing, are so real that you jump. But on the whole it is less than fiery, most of the music relatively on the sedate side—considering what finger talent is available here. I really didn't think the Spanish playing anywhere near sultry enough. Rather too Anglo-Saxon. But these are relative words, judging on a very high level. Any old guitar player, even a rock player, will find the sounds very interesting.

Performances: B Sound: B+

Spohr: Three Sonates Concertantes for Harp and Violin. Susann McDonald, harp, Louis Kaufman, violin. **Orion ORS 7262,** stereo, $5.98.

Spohr was a famed violin genius and composer in Beethoven's time, the early 19th century, universally known then (ten symphonies, 34 quartets, eleven operas . . .) but later totally put aside. Our present ears have changed—he was no Beethoven but, on the other hand, he was a solid and fluent craftsman of beautifully styled music in the middle-Beethoven manner. It goes down most pleasantly today as, shall we say, foreward background music.

These three concerto-like sonatas were composed for Spohr's wife, a harpist, and himself. The harp has the main burden—husband Spohr played along relatively unobtrusively most of the time. Susann McDonald makes an excellent Mrs. Spohr here—she is a forthright, solid harpist with a fine sense of rhythm and harmony, never blurring her chords where they must be unblurred; my only mild criticism is that she doesn't really allow her "husband," the veteran violinist Louis Kaufman, to have his own say when he has the tune and she is plunking accompaniment chords. She stays loud. As for him, his technique is a bit worn at the edges today and the notes sometimes slur, but his musicianship and understanding are so fine that in two minutes you forget, and the sense comes alive. I found this music, all for the same two instruments, anything but monotonous—instead, it grows on you, as the sound of the two becomes familiar. A good record, and a lovely background.

Performances: B+ Sound: B

(Continued from page 24)

use of speech sounds such as "p," "a," "t," etc. Syllable articulation refers to the use of syllables such as "pat," "run," "eat," etc. Word intelligibility refers to the use of the complete word.

The effect of reducing the high and low frequency ranges upon syllable articulation of speech at a normal conversational level is shown in Fig. 9. A consideration of Fig. 9 shows that a relatively high articulation can be obtained with a very narrow frequency range. However, the quality of the reproduced speech is very much impaired by transmission over a narrow frequency band. From the standpoint of articulation, a limited frequency range may be actually superior to a wider frequency range because of the introduction of additional noises and distortions in a wider band, unless particular precautions are observed. In the case of speeches, plays, and songs a limited frequency range impairs the quality and artistic value of the reproduced sound.

Quality

The quality of reproduced speech is a subjective property describing the degree of resemblance of the reproduced speech to the original speech.

To obtain resemblance of the reproduced speech with the original speech requires a high order of performance particularly from the standpoints of frequency range, nonlinear distortion, transient response and noise.

To reproduce speech without any deterioration of the quality requires a frequency range of 70 to 15,000 Hertz. The effect of the frequency range upon the quality of speech is shown in Fig. 10. This data also shows that to reproduce speech without any deterioration of quality requires a frequency range of 70 to 15,000 Hertz.

A sound reproducing system which introduces nonlinear distortion generates new partials and modifies the original partials. As in the case of music the introduction of nonlinear distortion in the reproduction of speech deteriorates the quality of speech. Typical spectrums of nonlinear distortion for four values of nonlinear distortion are shown in Fig. 6. As in the case of music, there are three levels of nonlinear distortion, namely, perceptible, tolerable, and objectionable. To reproduce speech over the entire audio frequency range with imperceptible distortion requires a system with less than one percent nonlinear distortion.

The subject of transient response was considered in a preceding section. Poor transient response destroys the brightness of speech.

The exposition on noise relative to the reproduction of music also applies to the reproduction of speech.

PSYCHOLOGY OF SOUND REPRODUCTION

Perfect Transfer Characteristics

Modern sound reproduction involves two transfer characteristics, namely, the perfect and the ideal transfer characteristic. In the perfect transfer characteristic there is a constant relationship between the output and input parameters that define the signal. The perfect transfer characteristic provides the means for achieving realism in sound reproduction. To achieve realism in a sound reproducing system four conditions must be satisfied as follows:

1. The frequency range must be such as to include without frequency discrimination all the audible components of the various sounds to be reproduced.
2. The volume range must be such as to permit noiseless and distortion-less reproduction of the entire range of intensities associated with the sounds.
3. The spatial sound pattern (auditory perspective) of the original sound should be preserved in the reproduced sound.
4. The reverberation or acoustic ambience of the original sound be approximated in the reproduced sound.

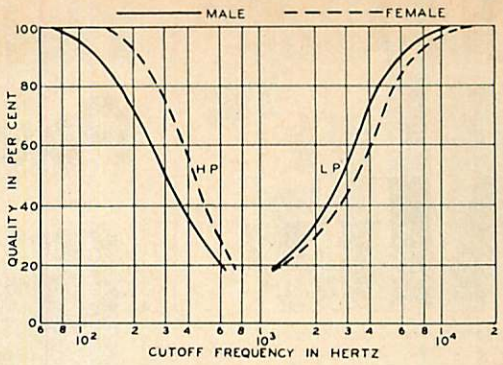

Fig. 10—The effect of frequency range upon the quality of speech. **HP**—High pass filter, that is, all frequencies below the frequency given by the abscissa removed. **LP**—Low pass filter, that is, all frequencies above the frequency given by the abscissa removed.

The requirements for satisfying the above conditions have been discussed in the preceding sections.

A high order of realism can be achieved if the four conditions outlined above are satisfied. However, with the electronic means available today the emotional responsiveness can be extended beyond that of simulating the realism of the original recorded music.

Ideal Transfer Characteristic

In the ideal transfer characteristic the relationship between the output and input parameters defining the signal is modified as dictated by subjective aspects involving realism and emotionalism. In general, in order to attain the ideal transfer characteristic by the application and implementation of modifications to elevate the subjective aspects of sound reproduction the start must be from a perfect transfer characteristic. In 95 percent of the records produced today some sort of modification is used to heighten the artistic and emotional impact and thereby lead towards an ideal transfer characteristic. Delayers, frequency and timbre modifiers, vibrato and tremolo generators, reverberators, and nonlinear and fuzz producers are some of the electronic devices employed to modify the original recorded music to produce the final product. In these modifications there may be changes in the spatial sound pattern from the original or conventional. For example, there are the possibilities of sound sources in rapid motion which is impossible in original sound. The reverberation or acoustic ambience can be very varied rapidly and from instrument to instrument. There are almost limitless possibilities in the modifications involving the subjective aspects leading to an ideal transfer characteristic.

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Weingarten Looks At Paul Simon

Sherwood L. Weingarten

LOVE, it's been written, is better the second time around. Similarly, some recordings require second or third hearings before they can be appreciated fully. The subtleties, the nuances, just aren't captured at first.

So it is with **PAUL SIMON** (Columbia, KC 30750), the first solo gig by the writer who for years made the Simon & Garfunkel team the chart-busting success it was.

After Art Garfunkel went into "Carnal Knowledge," Simon apparently went into himself. The result is this introspective LP, a tour de force filled with more images than a listener can deal with at one sitting. Although Simon's lyric statements are highly personal, he touches on so many universals that it's virtually impossible to leave the turntable without feeling you've looked into a mirror. And his music, still pretty much in the folk-rock bag, has that intangible something that forces you to keep it with you, that makes you want to whistle or hum.

If there is a difficulty, it is that some of the tone poems seem unfinished, seem to dangle in air awaiting another stanza or two. But even that flaw becomes intriguing as the listener tries to supply his own continuation.

Simon accompanies himself via guitar on nine of the 11 cuts, sticking to singing only on the hit single "Mother and Child Reunion" and playing percussion on "Paranoia Blues." He also is backed by a handful of musicians who complement his vocals exquisitely.

The tunes, including the only one he didn't write alone (the brief 1:20 instrumental, "Hobo's Blues," done in collaboration), were recorded in New York, San Francisco, Los Angeles, Paris, and Jamaica, a hop-scotching of the world that supports the feeling the lyrics point to, that he is still searching for himself.

Best things on the album are "Mother and Child Reunion," a gospel-rock opus that seems to be on almost every radio station simultaneously, and "Run That Body Down," a catchy tune that spotlights Simon's falsetto and a good electric guitar by Jerry Hahn.

But there's much more to inspect. Such as "Duncan," with its softly cool flute interludes by Los Incas that are mindful of "El Condor Pasa," and with its flashes of lyrical genius bearing Simon's brand ("holes in my confidence/holes in my jeans").

And "Everything Put Together Falls Apart," one of the most effective anti-drug songs ever, done in blues style.

And "Me and Julie Down by the Schoolyard," a bouncy calypso thing, bright and driving a la "Mrs. Robinson."

And "Peace Like a River," a mild revolutionary tract that declares "You know you can't outrun the history train/I've seen a glorious day."

And "Papa Hobo," which indicates that "It's carbon and monoxide/that

ole Detroit perfume/And it hangs on the highway/In the morning/And it lays you down by noon."

And "Paranoia Blues," a horror story of modern life that declares, "I got the paranoia blues/From knockin' around in New York City/Where they roll you for a nickel/And they stick you for the extra dime."

It's a grand tour of life, liberty and the pursuit of identity. Listen and you'll hear echoes of yourself.

Another disc that must be heard repeatedly, because so much initially is missed, is **MARK-ALMOND II** (Blue Thumb, BTS-32), even more moody than the group's extraordinary first outing.

This time, the original quartet (Jon Mark, who wrote all the material save one item; Johnnie Almond, Tommy Eyre, and Roger Sutton, who composed "Sunset") is bolstered by a drummer, Dannie Richmond, a factor that gives the jazz-blues-pop group a slightly heavier sound.

Highlight of the LP is "The Sausalite Bay Suite," a four-segment composition that musically shows Mark's love for the California area. Within the suite, which fills one full side, "The Bridge" sandwiches wild jazz, strongly brassy, with vocals; "The Bay" begins with a haunting flute and then showcases soft and dreamy vocal work; "Solitude" features a mournful sax interlude following a slow vocal opening, and "Friends" spotlights a slightly faster tempo.

Best thing on the flip side is "Ballad of a Man," which begins with wild sax riffs reminiscent of John Coltrane. The piano meanders in gently, followed by a vocal; this in turn is supplemented by piano, sax and drums and then a swinging all-together break which slowly fades into guitar and bass counterpoint. After being joined by piano, the instrumentalists go wild in another all-together segment that precedes the final vocal. It's a gas!

Also on that side, which carries the cover-all title "Journey Through New England," are "One Way Sunday," a breezy, rhythmic piece that is aided greatly by magnificent flutework, and "Sunset," with a strange, wavering vocal backed by mysterious, Eastern-influenced flute riffs and heavy guitar sounds.

Although the whole is not equal to the first album, it's still the kind of thing that demands attention, especially in a day when professionalism in music is often hard to locate.

In another vein entirely, The Undisputed Truth's latest effort, **FACE TO FACE WITH THE TRUTH** (Gordy, G959L), *can* be enjoyed the first time on at least one level, bathing in fantastic beats that are like a siren's call insisting that you dance. A second hearing puts appreciation on another plane, however, the listener being inundated with marvelous stereo effects, and the third time there's still another level, finding as a totality the well-packaged soul production.

Each of the seven numbers, on which the electric backgrounds are integrated so they do not intrude, is a beautiful merging of words and music, an almost perfect blend of talent by the two gals and a guy comprising the vocal trio.

The disc, distributed by Motown, starts with an FM hit (it's too long, at 6:50, for most AM outlets), "You Make Your Own Heaven and Hell Right Here on Earth." Meshing neatly are the voices, individual or in chorus,

and the instrumentation (which includes a Latin aura).

Following are "What It Is," which should become a discoteque standard; "Ungena Za Ulimwengu (Unite the World)" in medley with "Friendship Train," a combine that shines because of Melvin "Wah-Wah" Ragin's twangy electric guitar in the background, a heavy drum beat and vocals that sound like shower stall extracts (replete with gargling); "Superstar (Remember How You Got Where You Are)," a piece that moves like an express train, and Marvin Gaye's "What's Going On," a moderate tempo item that combines the best of all soul motifs.

It's not the kind of record those who prefer kitten-soft music will enjoy, but anyone with a spark of real vitality left should dig it until the grooves are worn.

Speaking of rhythmic recordings, **WOYAYA** (Decca, DL7-5327) is an extravaganza of Afro-Caribbean-jazz-rock, a unique combination that should mean ecstacy, especially, for percussion buffs. The seven-member group that stars, Osibisa (which means "rhythm" in the Akan language), is so expert at what it's doing that it's virtually impossible to hear everything the first time.

The group, which almost starved for a year while looking for gigs on the Continent, includes three members from Ghana, and one each from Grenada, Antigua, Trinidad and Nigeria. Backed by a choir on this, its second album, the group declares that, collectively, "We want to spread peace and happiness, and music is the only weapon we've got. We're ready to play to anyone, anywhere, and we know we'll get through to them."

They *do* get through, and evidence quickly can be obtained by hearing "Beautiful Seven," which opens with flute against the sound effects of a storm. The chorus enters, followed by jazzy, heavy Afro drums and then come solos by flute, guitar and congas. It cooks!

Other highlights include "Y Sharp," with its double-track guitar by Wendell Richardson and amazing polyrhythms; "Spirits Up Above," which features flugelhorn, electric piano, and choir (including Mary Hopkins); "Rabiatu," with fine bass work by Spartacus R; and "Survival," which starts with mouth-percussion by Loughtly Lasisi Amao and is assisted by wild drums, weighty brass and particularly great sax riffs.

It's an unusual sound, a refinement of the group's first outing, and one well worth the time spent creating—and hearing.

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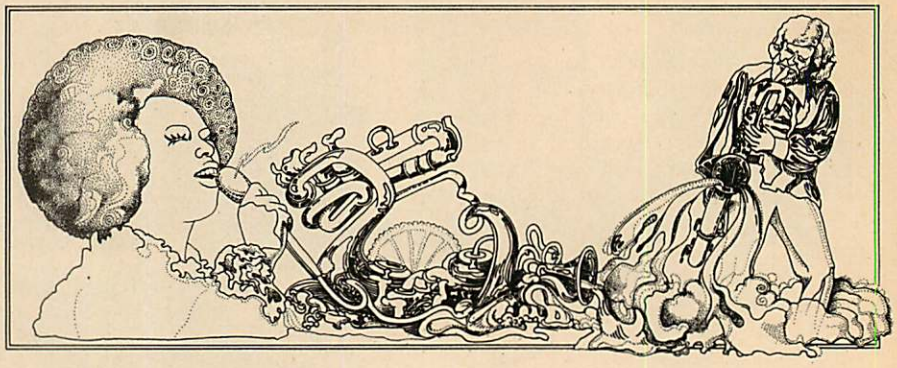
Jazz & Blues



Martha Sanders Gilmore

Phil Woods: Phil Woods and his European Rhythm Machine at the Frankfort Jazz Festival.
Musicians: Phil Woods, alto saxophone; Gordon Beck, piano; Henri Texier, bass, and Daniel Humair, drums.
Songs: Freedom Jazz Dance, Ode a Jean-Louis, Josua, and The Meeting.
Embryo SD 530, stereo, $5.98.

Maybe you all know about Phil Woods, but for those who don't, the alto saxophonist/clarinetist has contributed generously to the jazz world, having played with greats like Gene Quill, with whom he shared a combo in 1957, Dizzy Gillespie, Benny Goodman, Quincy Jones, and Oliver Nelson.

Good marks these, and from all indications in this unreservedly recommended recording by Woods and his appropriately named European Rhythm Machine, he must have graduated from the "college of music" with highest honors, earning a *magna cum laude* in musicianship. In truth, Woods spent a year at the Manhatten School and four at Juilliard, then transporting his talent to Paris, where he secured a firm footing and sailed on to win poll after poll in his own native countryland.

One can neither overpraise this musician's musician nor find enough words for the mastermind of this live performance at the Frankfurt Jazz Festival. The Woods Machine is an international one with cogs well-oiled and includes first rate musicians such as pianist Gordon Beck, an Englishman—George Gruntz left Woods for other commitments—bassist Henri Texier from Switzerland, and drummer Daniel Humair from France. They work together here like the Julliard String Quartet, participating in a kind of musical encounter group, the members of which are perpetually in a state of intense emergency, one with the other.

This is the epitome of creative jazz, the pinnacle of collective jazz improvisation, spontaneous combustion coupled with the tight-wire precision of a string quartet. Not only does the group work well together, one senses that they truly enjoy it. They appear to have an indefatigable urge to play and accomplish music in a great orgiastic, organically evolving happening.

Rippling, racing, writhing, roaring, they go in a non-stop suite of four tunes that create 51 engaging musical minutes. Elemental as fire and water is Woods' artistic brilliance, gushing forth and spilling over like a waterfall, his technical proficiency staggering. The amazing thing is that his fellow musicians share this facility as if they were made for each other.

Eddie Harris' "Freedom Jazz Dance" is precisely what the title implies, uptempo, wild and free, and conductive to a land of the midnight sun timelessness. More rapid than eagles the courses they fly, as Woods and Beck chat in an alto-piano dialogue, nodding back and forth, Beck playing spraddling chords as Woods moves easily over his instrument, conceptualizing with abandon. Humair supports it with a racing drum, accomplishing meticulously intricate cymbal and stick work and ticking off his solos like a countdown, exploiting his timbres to the limits.

Pianist Beck is out of the McCoy Tyner-Chick Corea school but remains his own man; we hear him on both electric and acoustic pianos. He comes right through when amplified but the mike could be closer to the acoustic

keyboard. Nonetheless, the sound is good overall for a live performance but could be better balanced. Woods dances back in, at once producing the sound of a tenor sax and a soprano against Humair's crystal-clear cymbal contrivances.

The foursome slide right into "Ode A Jean-Louis" dedicated to the renowned editor of *Jazz Magazine* in Paris. Jean-Louis Ginibre pronounces the group the best in Europe and in our listening experience we must agree. This Woods' original, our choice, is a jaunty, driving Charles Lloydish composition with a stalwart beat, beginning pensively and lyrically on piano as Beck ties a keyboard of tenacious sailor's knots. However, it is full of tempo changes and interludes with Woods way up high—the Maynard Ferguson of the alto sax—and supremely articulate against a rushing drum. Beck is all over the keys, bluesy, contemporary, of the space age, achieving an almost plucked sound upon his instrument. Henri Texier's bass solo is a spacious, selective, and deep-throated one enhanced by Humair's stunning sequence on drums as well as various other members of the percussion family, striking Indian innuendos, pit-a-pats, and jangles.

The four total musicians continue in an expressionistic "Josua," (we know the tune as "Jos*h*ua") by Victor Feldman, Woods emerging as though tuning his instrument in a beautifully misty segment. He then lights into the theme as if setting a forest afire, casting his eye toward the Coltrane style of post-bop polo playing, Woods definitely out of the woods in a heated fox hunt.

What a work-out it is for Texier whom we wish we could hear better. He infuses his attack with rapidly repeated notes, and as usual Beck achieves miraculous effects on piano, playing underwater cathedral chords set in pools of indigo.

Becks' "The Meeting" is a raunchy town-meeting kind of a tune that permits everyone to air his views. Beck gets off surprising intervals in low hip-swiveling mouse-ran-up-the-clock piano flights and Texier's bass solo smacks of twanging inch-wide rubber bands as he accompanies it with all matter of syllables beginning with d. Woods, a musician of great courage, generates cool heat, wringing everything out of the tune.

Ginibre comments in the liner notes, ". . . within Phil Woods lies part of the future of jazz." Yes, a magnificent part.

Performance: A++ Sound: B+

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#	A	B	#	A	B	#	A	B	#	A	B	#	A	B	#	A	B	#	A	B	#	A	B
1			16			31			46			61			76			91			106			121		
2			17			32			47			62			77			92			107			122		
3			18			33			48			63			78			93			108			123		
4			19			34			49			64			79			94			109			124		
5			20			35			50			65			80			95			110			125		
6			21			36			51			66			81			96			111			126		
7			22			37			52			67			82			97			112			127		
8			23			38			53			68			83			98			113			128		
9			24			39			54			69			84			99			114			129		
10			25			40			55			70			85			100			115			130		
11			26			41			56			71			86			101			116			131		
12			27			42			57			72			87			102			117			132		
13			28			43			58			73			88			103			118			133		
14			29			44			59			74			89			104			119			134		
15			30			45			60			75			90			105			120			135		

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7 ☐ Other _____

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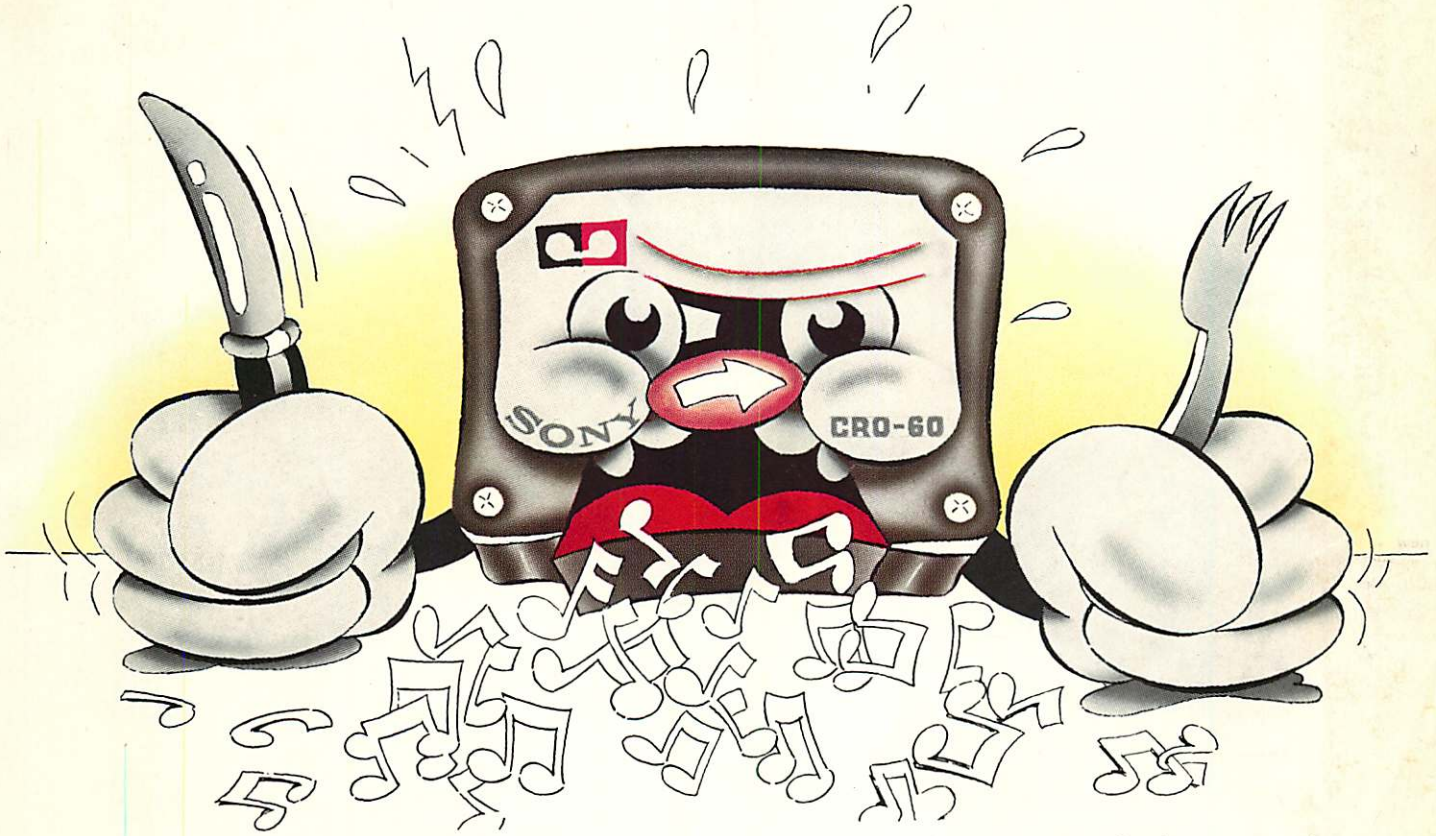
Sony's new chromium dioxide cassette tape is hungrier for high frequencies.



Sony chromium dioxide CRO-60 tape will record up to 50% more volume before you encounter distortion on playback. CRO-60 is hungrier than other tapes for high frequencies.

This means more recorded sound than standard cassette tapes before distortion sets in.

What you hear.

Far less distortion, a smoother frequency response, and a greater dynamic range than standard tape. Every aspect of the sound, especially the higher ranges, comes through with sparkling fidelity.

Sony CRO-60 gets it all together from bottom bass lows to high howlin' highs. And everything in between.

A Sony tape for every purpose.

The new Sony CRO-60 cassette tape becomes a member of a highly advanced line of tapes for every recording requirement.

In addition to standard open reel, cassette, and 8-track cartridge tapes, Sony also offers the finest in high performance tape: SLH-180 Low-Noise High Output tape on 7" and 10½" reels, plus Ultra-High Fidelity Cassettes.

These high-performance tape configurations take advantage of the added performance of today's highly sophisticated recorders by providing wider dynamic range, greatly improved signal-to-noise ratio, extended frequency response, and reduced tape hiss.

How's your appetite?

Now if your appetite has been whetted and you're hungry for more information or a demonstration of CRO-60 or any other Sony tapes, get on down to your nearest Sony/Superscope dealer (he's listed in the yellow pages) and get an earful.

SONY® SUPERSCOPE®

You never heard it so good.®

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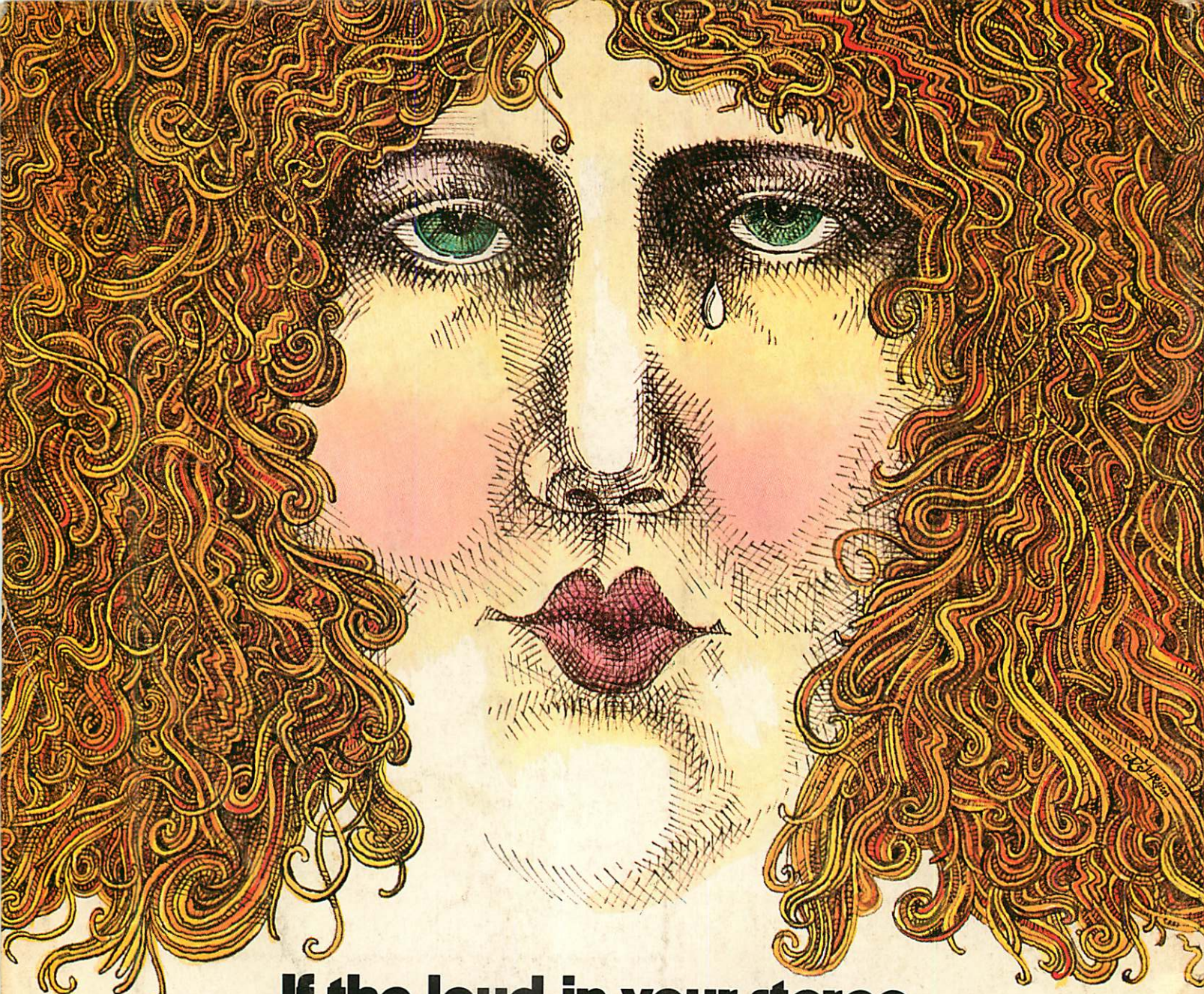

If the loud in your stereo gives her a pain in the head get a Marantz.

It's not that she's got super-duper sensitive hearing (like that spotted beagle two doors down), it's because most women hear better than men, so when she screams turn down the sound what she really means is turn down the damn distortion because the distortion is driving her bananas.

Not so with Marantz stereo. Take the Marantz 2270 stereo AM/FM receiver for $549.95. It delivers a walloping 140 watts RMS power at less than 0.3% distortion...which means virtually NO DISTORTION. And because Marantz measures distortion at continuous full power through the whole listening range—it won't bring tears to her eyes or a pain to her head. NO MATTER HOW LOUD. Other companies measure power and distortion only in middle listening range. So they quote their highest power and lowest distortion only in the middle. But on the low and high sides their power is down and their distortion is up. So if you pay for 140 watts be sure you get 140 watts at both ends and in the middle.

With Marantz you get exactly what you pay for. If all you need is 30 watts, take our model 2215 for $249.95. Want twice as much power? Our model 2230 gives you 60 watts RMS for $349.95. And our model 2245 at $449.95 delivers 90 watts RMS. ALL FULL RANGE CONTINUOUS POWER.

No matter which model you choose, remember this. You're getting Marantz quality. The same quality that goes into the magnificent Model 19 FM stereo receiver (shown) that costs $1200. YES. That's right, a cool $1200! But it is the absolute, ultimate, very best there is.

Visit your Marantz dealer. And take your wife along. (Or that spotted beagle two doors down.)

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We sound better.

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