AUDIO

FEBRUARY
1972 60c

The Authoritative Magazine About High Fidelity ® A

Canby "ETC"

THE NEW AMPLIFIERS

Amplifier IM Testing • Amplifier Q's & A's
Amplifier Design • A New Loudness Meter

Scott's unmatched

for purists who believe separate components are best

The Scott 431 AM-FM stereo tuner is the performance-for-the-price leader among separate component tuners. It's an all new model, but it has a storied and reliable history in the Scott 312 FM-only tuner which was the industry leader from 1964 to 1970.

For the 431, Scott engineers used a silver plated tuner with a cascode FET front end. The result is IHF sensitivity of 1.7 μV which is great in itself but not particularly important, since hardly anybody listens to FM under IHF conditions. What is important is the steepness of the sensitivity curve, which drops sharply, reaching a signal to noise ratio of better than 60 dB at a signal level of around 10 μV. What this buys you is essentially noise-free reception, even in suburban or fringe areas, of practically any station with enough signal strength to budge the panel meter.

Not only does the Scott circuitry achieve full limiting on weak signals (like 4 to 5 μV), but it also has plenty of headroom to prevent overload distortion when you tune to an unusually strong station nearby. The 431 tuner uses two six-pole LC filters in its integrated circuit IF strip. These give better skirt selectivity than highly touted crystal types, and this means you won't be troubled by interference from alternate channels.

The 431 is the only tuner we know of that gives you a multipath distortion meter to check your antenna position for best reception, and a 75 Ω antenna socket for professional or community antenna applications. Scott engineers have included a high quality AM tuner section for listeners who like to tune in an AM program occasionally. Other features include a front panel tape recorder output jack, function lights, and even a panel light dimmer.

The Scott 431 AM-FM stereo tuner sells for $219.90 which is considerably less than the price of the FM-only tuner it replaces. We believe you'll find it an outstanding value, particularly after you've seen and heard all the others.

The Scott 490 integrated stereo control amplifier is the 431's non-identical twin. It puts out 70 watts of continuous (RMS) power with both channels driven into 8 Ω over the frequency range 15 Hz to 20 kHz with less than 0.5% distortion. But where it really overpowers its competition is with single 4 Ω speakers or parallel combinations of 8 Ω speakers where it delivers a conservative 120 watts per channel with both channels driven. Speaker connections for up to three stereo pairs are provided and any two pairs may be used simultaneously without overloading the power supply or degrading performance. Active electronic protection circuitry plus fuses and circuit breaker protect both amplifier and speakers against faults.

Individual left and right channel VU meters with range switching allow power output monitoring on both loud and quiet program material. Tape recorder, microphone, and headphone jacks are placed on the front panel for convenient access. A second tape recorder may be connected at the rear for multiple recording or program production.

The 490 integrated stereo control amplifier outpoints its competition and at $299.90 is another performance-for-the-price leader.

Both the 431 tuner and 490 amplifier feature Scott's quick-change Modutron circuit boards, full two-year parts and labor warranty, and Scott's traditional 100% American design and manufacture. Before you buy separate components, see and hear the 431 and 490 "unmatched pair" at your Scott dealer's.

H.H. SCOTT®
where innovation is a tradition
H.H. Scott, Inc., 111 Powdermill Road, Maynard, Mass. 01754

Check No. 100 on Reader Service Card

pair

AUDIO

Successor to RADIO, Est. 1917

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FEATURE ARTICLES

AMPLIFIER & PREAMPLIFIER DIRECTORY

EQUIPMENT REVIEWS

RECORD REVIEWS

AUDIO IN GENERAL

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UNANIMOUS ACCLAIM!

First test reports on the Zero 100 by the industry's leading reviewers

Brief excerpts reprinted below. Let us send you the full reports.

HIGH FIDELITY *Sept. 1971*

Altogether, this new arm strikes us as an excellent piece of engineering; it probably is the best arm yet offered as an integral part of an automatic player. ☐ Operation is simple, quiet, and reliable. ☐ All told, we feel that Garrard has come up with a real winner in the Zero 100. Even without the tangent-tracking feature of the arm, this would be an excellent machine at a competitive price. With the novel (and effective) arm, the Zero 100 becomes a very desirable "superchanger" with, of course, manual options.

AUDIO *July, 1971*

The Zero-100 performed just about as we expected after reading the specifications. Wow measured .08 per cent — that is in the band from 0.5 to 6 Hz. Flutter, in the band from 6 to 250 Hz, measured .03 per cent, both of which are excellent. ☐ Thus, the Garrard Zero 100 is certainly the finest in a long line of automatic turntables which have been around for over 50 years. ☐ We think you will like it.

Stereo Review *July, 1971*

Indeed, everything worked smoothly, quietly, and just as it was meant to. If there were any "bugs" in the Zero 100, we didn't find them. ☐ Garrard's Zero 100, in basic performance, easily ranks with the finest automatic turntables on the market. Its novel arm — which really works as claimed — and its other unique design features suggest that a great deal of development time, plus sheer imagination, went into its creation. In our view, the results were well worth the effort.

The GRAMOPHONE *August, 1971*

Reproduction quality was excellent with no detectable wow, flutter or rumble under stringent listening conditions. End of side distortion, which is always a possibility with pivoted arms, was virtually absent, due no doubt to the tangential tracking arm.

Popular Electronics *August, 1971*

Our lab measurements essentially confirmed the claims made by Garrard for the Zero 100. We used a special protractor with an angular resolution of about 0.5°, and the observed tracking error was always less than this detectable amount. The tracking force calibration was accurate, within 0.1 gram over its full range. ☐ The Garrard Zero 100 operated smoothly and without any mechanical "bugs."

Rolling Stone *Sept. 16, 1971*

This unit has every imaginable gadget and gewgaw one might possibly desire, and *it works*. And considering how much it does, and how well it does it, at 190 bucks it doesn't even seem expensive. The changer has so much in it that an analysis of its innards is almost a case study in record player design.

Modern HI-FI Stereo Guide *Fall, 1971*

One could go on cataloguing the virtues of the Zero 100 indefinitely.

For 8-page test reports booklet and a 12-page brochure on the Zero 100 and the entire Garrard series mail to British Industries Company, Dept. B 12, Westbury, N. Y. 11590.

Name_____

Address_____

City_____

State_____ Zip_____

A genuine step upward in automatic turntables

GARRARD ZERO 100

The only automatic turntable with Zero Tracking Error

$189.50
less base and cartridge

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

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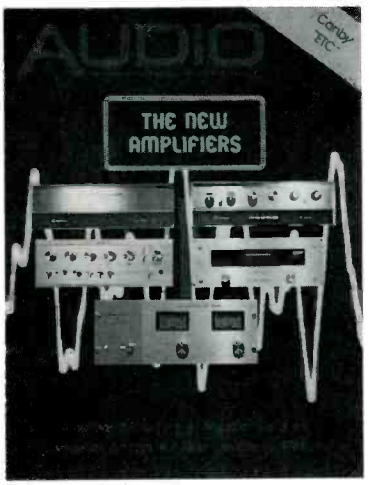
coming in March

Special Loudspeaker Issue
Buyers Guide
Loudspeaker Evaluation—
by Ralph West
Loudspeaker Q's and A's
Amplifier Testing—
by Andrew R. Collins

Equipment Reviews
will include:
Wharfedale W-70E loudspeaker
(held over from this issue)
TEAC 201 amplifier

Plus
Record and tape reviews and all the regular features

Late Flash!
Dolby Labs has announced that Sony Corp. has become a B-type licensee. No products had been announced by press time.



About the Cover: Shown are the 150 watt Sony 1130, the 200 watt Crown DC-150 with the IC-150 preamp, the 250 watt Marantz, and the Phase Linear, which puts out 700 watts. Want more power? Well, how about the new Crown DC-4000?

Audioclinic

Joseph Giovanelli

Equipment Fed in Parallel

Q. Is it possible to connect tuner and tape deck outputs in parallel, and then to the input of a power amplifier?

Is it possible to connect the input of a tape deck and amplifier in parallel, and then to the output of a tuner?—Joel Masser, Highland Park, Ill.

A. You should not connect a tuner and a tape deck in parallel, and then feed the input of a power amplifier or preamplifier. By so doing you stand a chance of losing both output and low frequency response.

Keep in mind the fact that, in addition to each piece of equipment feeding into the power amplifier, each one attempts to feed the other. It is well for a tape deck or tuner to "see" a high impedance. Because the tuner "sees" the low impedance of the tape deck's output, and because the tape deck "sees" the low impedance of the tuner's output, these devices do not look into the high impedance they require.

With the arrangement you are proposing you stand to lose at least 6 db of output, and perhaps more. You may find that the tuner works fine but that the tape machine does not perform well, or vice versa. Further, if the size of the coupling capacitors in the output circuits of the tuner and tape deck are comparatively low values, bass response will be lost because of the excessive loading applied to them. (This comes about because of the reactance of the capacitors' being higher than the impedance into which they look.)

Most of the time there would not be a need to connect a tuner and tape deck to an amplifier; they would not be used simultaneously. Therefore, a simple switching system should be used. If more flexibility is required, a simple jack field can be wired so that all devices can be connected together as is done in telephone switchboards.

On the other hand, if you want your tuner to feed into both your power amplifier's input and your tape recorder's input in parallel, this is fine. The impedance of both the tape machine's input and that of the amplifier is high enough so that no loading of the tuner's output will result. This still holds true even though the tuner's output looks into the combined impedance of both the amplifier and the tape deck's input circuits. If each of these input circuits is 200 K ohms, then the combined impedance of the two units will only be 100 K ohms, high enough not to cause excessive loading of the tuner. If you really wish to be safe, check the manual for your tuner and note the minimum impedance it should look into. Then check the impedance of both your tape machine and amplifier. If their combined value is higher than that of the tuner's recommended minimum, you can make the connections as desired.

Of course, if your amplifier has tape monitoring provisions, this is the best way of setting up your equipment. It permits greater flexibility without the need for changing connections.

Skating and Tracking Forces

Q. *I read somewhere that as stylus force increases, the less the need for antiskating correction. Then, why do manufacturers of arms and players increase the corrective force as tracking force increases, instead of decreasing it?*—Elliott Dennis, Brooklyn, N.Y.

A. If you have a tonearm which exhibits lots of skating force and if this arm tracks lightly, it is possible that the skating force will cause skipped grooves at times of high groove modulation. Actually, it is the combination of skating force, light tracking force, and the vertical component of the groove modulation which causes groove jumping. When more tracking force is added, skipping does not occur; the additional tracking force has overcome the tendency of the vertical groove motion to throw the stylus out of the groove. This does not mean, however, that the tendency to skate has been suppressed. It simply means that its effects have been overcome at least in terms of skipped grooves. In reality, the amount of skating force has actually increased.

One of the factors which produces skating force is the friction between the stylus and the groove walls. As tracking force increases, friction also increases, thereby producing an increase in skating force.

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.

This is the tape deck your components have been saving themselves for.

Right off the top, our RS-736US gives your components an incredible head start. Because its three heads are made of Hot Pressed Ferrite. And Ferrite (pioneered by Panasonic) improves frequency response a fantastic 25%. All by itself!

It also lets us create the world's narrowest, most precise tape-head gap. Which is exactly what makes the high fidelity so high. And it stays high. Because Ferrite heads live more than ten times longer than non-Ferrite ones.

As you might expect, our RS-736US has a top speed of 15 i.p.s. Which is nothing less than broadcast quality. (For flexibility, it also has two other speeds: 3¾ and 7½.)

And the controls are designed to keep everything well under control. You'll find a separate switch for tape and speed equalization. Two large VU meters to let you supervise separate sources (live and electronic). Slide controls. And a monitor switch (for each channel) to let you compare what's inside with what's outside.

To let you know where you're at, there's a cue lever. And for momentary stops, a pause control. A Noise-Free Device takes care of unnatural tape hiss. There's even an automatic adjustment for the tape tension. One sweet lever to control fast forward, rewind, stop, play and pause. And tinted dust cover.

Just like the decks you find in recording studios, the RS-736US lets you record sound *on* sound. Or sound *with* sound. Or mix music in, up and out. And add echo. And there's more.

200 kHz AC-bias. A signal-to-noise ratio that's better than 58 dB. And a frequency response curve of 20 Hz to 30,000 Hz at 15 i.p.s. We even include a chart that gives you the personal frequency response of each particular unit. So you'll know just what your components are getting.

Listen to the RS-736US. And hear why this tape deck is the one you, your customers (and your components) have been waiting for. Breathlessly.

PANASONIC®
just slightly ahead of our time
200 PARK AVENUE, NEW YORK, N.Y. 10017

Check No. 18 on Reader Service Card

Tape Guide

Herman Burstein

Compatability

Q. I own a Heath AJ-33A stereo tuner and AA-22 stereo amplifier. I am considering purchasing a TEAC A-4010S tape deck and two Pioneer CS-88 speakers. Will these new components be compatible with my present system?—Thomas P. Ross, APO San Francisco, Calif.

A. I see no reason why your proposed purchases should not tie in properly with your present equipment. In the case of speakers, let me add that choice depends not only on quality and reputation of the speakers but also very much on the individual hearing characteristics and preferences of the listener. In other words, I am saying that you should never buy speakers without listening to them first. (Probably this advice applies to other components as well, but perhaps not as strongly.)

Potpourri

Q. I would appreciate it if you could answer some questions that have been bothering me for some time. (1) Is there any advantage to recording at 15 ips rather than 7½ or 3¾ ips? Any disadvantages? (2) Is there any disadvantage to recording music at 1⅞ ips? (3) When tape becomes old, will crosstalk or distortion occur? Will the tape become brittle, crack, and tear easily? (4) Is there any difference in recording from one machine to another by use of a DIN jack rather than lines from the line output or speaker socket to the line input? Are DIN jack sockets standard on all machines? (5) How does a tape manufacturer rate the amount of feet of tape on a reel? For example, on a box marked 3600 feet, the end tab of the tape lists 2900.4 feet, and there isn't even this amount on the reel. (6) Will a long line from an amplifier or turntable to a tape recorder decrease the quality of the recording compared with a short line? What about a long line from the amplifier to the speakers? (7) When playing my 4-track tape recorder I hear a type of noise in the speakers that sounds similar to surface noise on some records. What could be the cause of this, and how can it be corrected? Could the recorder be recording the noise of the motor on the tape? —Robert Nelson, Pasadena, Calif.

A. (1) At high tape speeds one gets better frequency response, lower noise, less distortion, and less wow and flutter than at low speeds. (2) The answer to question one also applies to question two. (3) I don't believe that crosstalk and distortion are a function of tape age. Some tapes, particularly acetate, will deteriorate physically. (4) I can't see that the type of jacks employed will affect recording quality. Usually the quality of the signal obtained prior to the speakers is better than the signal at the speaker leads. DIN jacks are not standard on U.S. machines. (5) A 7½-in. reel holds 1200 feet of conventional tape, 1800 feet of 1-mil tape, and 2400 feet of ½-mil tape. I suspect an error in the marking on your box, and perhaps on the tape tab. (6) A long line from the signal source to the tape recorder input can result in treble loss, unless the source is of low impedance (about 1,000 ohms or less). A long line from a power amplifier to the speakers may result in a slight loss of power. If you are using #16 or heavier wire, the loss and its consequences (some increase in distortion because the amplifier has to work harder to make up the loss) are apt to be insignificant unless you appreciably exceed 100 feet. (7) You may be hearing noise produced by the electronics of your tape recorder—so-called modulation noise which occurs only in the presence of an audio signal, owing to physical and magnetic irregularities in the tape. Or the noise may be reproduced noise from records which you have copied.

Meter Pegging

Q. Does it hurt to peg the VU meter once or twice (for example by accidentally turning up the volume)?—Laird Brown, Dayton, Ohio.

A. VU meters are built to stand considerable overload, assuming they are true VU meters rather than some other kind of meter supplied with a VU scale. A true VU meter can continuously withstand a voltage five times as great as that required to drive it to 0 VU; and it can withstand for ½ second a voltage 10 times as great as that required to drive it to 0 VU.

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.

TEAC SL Series Tape Decks: the penultimates

Naturally, we'd like to believe that we are producing the ultimate and eternal in modern tape equipment. That would be fine if we were ready for retirement to the Smithsonian Museum.

But we're not. So we make penultimate machines like the 7030 SL. Machines that are always within an ace of being the ultimate. That leaves us some leeway to go even beyond what is ultimate for the moment.

To give our SL series decks the professional edge they need to make flawless recordings, we have left nothing to chance. You get precision electronics with selected low-noise silicon transistors. And bias-current switching. And large VU meters. And built-in mic/line mixing. And of course, 3-motor/solenoid operation.

As for immortality, we'd rather give the original retail purchaser of our penultimate machines a warranty on the critical high-density ferrite heads—good for his entire happy lifetime. Which is what we've done on the 7030 SL, as well as the 6010 SL and the 7010 SL.

The 7030 SL does for the audiophile what studio console equipment does for the recording engineer. It features 10½-inch NAB reels and professional speeds of 7½ ips and 15 ips. You can use it as a single-direction two-track recording, and two- or four-track playback deck.

It also gives you high-speed pushbutton cueing, autostop, and rewind. In other words, the 7030 SL is the deck that can produce the finest original master tapes, as well as yeoman recording at the highest professional level.

Then there's the home, professional, or background music four-track, two-channel 6010 SL with auto-reverse. It accepts 7-inch reels, and operates at speeds of 7½ ips and 3¾ ips.

And the home or professional 7010 SL with extended playback: it's a four-track, two-channel deck with autoreverse. Like the 7030, it accommodates 10½-inch NAB reels, but at speeds of 7½ ips and 3¾ ips.

All SL decks mate beautifully with TEAC's new 100-Series components and AN-180 Noise Reduction Unit for total TEAC systems of unexcelled quality.

The AN-180 not only brings the SL series decks up to 10 dB improvement in signal-to-noise ratio at 10K Hz, but functions as a simultaneous record/playback control center with every convenience for mic/line level control and mixing. It features two large professional VU meters and incorporates complete calibration controls, individual output controls, and source/tape monitoring.

Ultimately, isn't it better to have TEAC penultimates now?

TEAC® TEAC Corporation of America, 7733 Telegraph Road, Montebello, California 90640
TEAC Corporation, 1-8-1 Nishi-shinjuku, Shinjuku-ku, Tokyo, Japan • TEAC EUROPE N.V., Kabelweg 45-47, Amsterdam—W.2, Holland
In Canada: White Electronic Development Corp., Ltd., Toronto

Check No. 29 on Reader Service Card

What's New in Audio

Digitime ES-10 clock

This electronic digital clock has no moving parts and is said to be accurate within one minute per year. The walnut-cabineted display shows hours, minutes, and seconds in numerals which can be read up to 40 feet away. Price: $150.00.

Check No. 1 on Reader Service Card

Kenwood KT-7001 AM/FM stereo tuner

This top-of-the-line unit features. a frequency linear-type 4-ganged variable capacitor and 3 FETs FM front-end together with crytal filters and 4 ICs in the FM i.f. stage. The FM audio muting control has two steps—10 μS and 50 μS. The FM signal meter can be used as a multipath detector and as an aid in positioning the antenna. The AM section uses an FET and a ceramic filter. Specifications are: FM sensitivity (IHF), 1.5 μV; FM frequency response, 20-15k Hz +0, -1.5 dB; FM HD, less than 0.25% mono, less than 0.5% stereo, and S/N, better than 75 dB at 30 μV input, better than 60 dB at 5 μV input. Price: $279.95.

Check No. 5 on Reader Service Card

Telex 48-H cartridge player

This stereo tape cartridge changer has a built-in 30-watt amplifier and switches and selects 12 8-track cartridges in four automatic operation modes and skips empty spaces. Solid-state circuitry features preamp output and tuner input. Matching speakers are optional and spare magazines are available. Price: less amp, $249.00; with amp, $299.00.

Check No. 4 on Reader Service Card

Superex EA-500 headset amp

This solid state stereo headphone amplifier can be used as the heart of a second system or as a headphone amplifier applicable for four-channel use. Features include front and back panel controls and auxiliary speaker output terminals. Price: $79.95.

Check No. 8 on Reader Service Card

Olson M-329 microphone

This cardioid dynamic microphone features a slim line design with ON-OFF switch, removable stand adapter, and a 20-ft. cable with standard ¼-in. phone plug attached. Impedance is 50K ohms. Price: $17.95.

Check No. 14 on Reader Service Card

Old Colony record index

This recordings index kit consists of an adjustable rubber stamp, 250 1xl½-in. pressure sensitive labels, and 250 printed composer names with dates of birth and death. Complete instructions are included with the kit. Price: $8.95 postpaid.

Check No. 10 on Reader Service Card

Sherwood FM station directory lists all FM stations in the U.S., its possessions and in Canada first alphabetically by city and state (or province) and then by assigned frequency. Price: $1.95, from Sherwood Electronic, 4300A No. California, Chicago, Ill. 60618.

Caddco phone-line equalizer

The Phone-Tatch II electronically equalizes the telephone signal to produce a response comparable to radio broadcast quality on the receiving end. It can be used with any standard telephone to send voice and recordings with a flat response. Typical use is by record companies wishing to play new releases for radio stations. Price: $129.00.

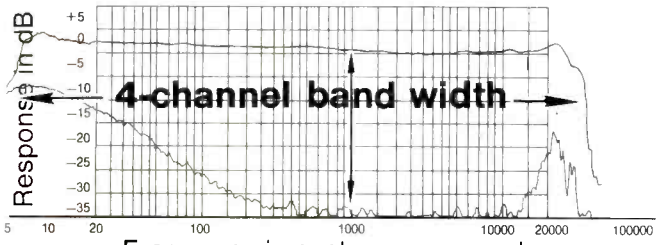
Check No. 16 on Reader Service Card

Approved for 4channel

Empire's top of the line cartridges now feature new high performance parameters designed for 4-channel capability. With even greater frequency response and compliance than ever before, these cartridges will track at forces so low they barely touch your records.

999VE/X Professional—Recommended tracking force ¼ to 1¼ grams. List price $79.95.

1000ZE/X Measurement Standard—Tracks as low as .1 gram in laboratory playback arms. List price $99.95.



Each 1000ZE/X and 999VE/X cartridge is individually adjusted to have a flat frequency response within ± 1 dB from 20-20,000 Hz. Stereo separation is better than 35 dB at 1 Hz and remains 25 dB or better all the way out to 20,000 Hz. Overall frequency response is a phenomenal 4-40,000 Hz. There are no electrical or mechanical peaks and total 1M distortion at the standard 3.54 cm/sec groove velocity does not exceed .05% at any frequency within the full spectrum. Uses a .2 x .7 hand polished miniature diamond for exceptionally low mass.

Empire cartridges are enthusiastically acclaimed by the experts; for example:

Stereo Review Magazine who tested 13 different cartridges rated the 999VE tops in lightweight tracking ability.

Hi Fi Sound Magazine called the 999VE *"a real hi-fi masterpiece . . . a remarkable cartridge unlikely to wear out discs any more rapidly than a feather held lightly against the spinning groove."*

High Fidelity Magazine said of the 1000ZE *"the sound is superb. The performance data among the very best."*

Records and Recording Magazine stated emphatically that the 999VE stereo cartridge is *"a design that encourages a hi fi purist to clap his hands with joy."*

FM Guide wrote *"...using the 1000ZE. It works beautifully . . . giving great results."*

Audio Magazine observing a remarkable 35 dB stereo spread between left and right channels in the 999VE said *"Outstanding square waves. Tops in separation."*

Popular Science Magazine picked the 999VE hands down as the cartridge for *"the stereo system I wish I owned"* designed by Electronic Editor Ronald M. Benrey.

X designates newest improved version.

For further details write: Empire Scientific Corp., 1055 Stewart Avenue, Garden City, N. Y. 11530.

empire

Mfd. U.S.A.

World Famous Long Playing Cartridges

Check No. 9 on Reader Service Card

Behind The Scenes

Bert Whyte

OUR FRIEND Joe Audiophile is in seventh heaven. His old Aunt Nelly remembered him in her will, and with the proceeds he has purchased his "ultimate" hi-fi system. Nothing cheap about Joe . . . he has the best of everything . . . super megawatt amplifiers, pre-amps with a plethora of controls which can be corrective or creative, digital readout tuner, big professional four-channel tape deck (naturally Joe's system is quadraphonic) and last but not least, those ultra wide range speakers with low frequency response down in the sub-basement . . . the kind that can handle low C organ pedal notes with ease. To gild the lily, Joe not only has B-type Dolby units, but professional A-type Dolby equipment. Main reason for this is that Joe has managed to wangle some 15 ips copies of some classical masters. In breathless anticipation, Joe has checked out his system to the last quarter-dB, threaded the 15 ips tape on his deck, and has prepared his ears for the state-of-the-art sonorities of his super system.

The first faint susurations of Ravel's "Daphnis and Chloe" are heard from the speakers . . . *molto pianissimo* . . . and Joe is in a transport of delight, for those lovely opening passages are unsullied by tape hiss. The music expands and develops, the strings as smooth as silk, the woodwinds mellifluous, the brass bright and articulate, Joe is really flipping now. Such incredible realism! Just listen to that flute and **WHUMP! RUMBLE!** Rumble, rumble. What the hell is that! Joe jumps up and stops the tape, rewinds the tape a bit and hits the play button. In a moment, the same extraneous low frequency noises assault Joe's ears. What has happened? Poor Joe is the victim of the monitoring techniques practiced by many record companies, in their studios and on location. Now if our disillusioned friend Joe had obtained the disc recording of the tape he was playing, he would have found those particular low frequency noises he heard on the tape would not be audible on the disc. How come? Quite simple, really. When the disc was cut the frequency response below 60 Hz was rolled off quite rapidly. Surely not, you say? Well friends, if I had a dime for every disc cut like this I would be sipping Dom Perignon on my yacht! What will really raise your eyebrows is that the engineers on this recording *didn't really hear* the low frequency noises on their monitor speakers and introduced the bass roll-off as a precaution and a matter of expediency. (With less bass response a longer-playing and louder disc can be cut) I hasten to add that there are many fine discs with response to 30 Hz, as evidenced by the excellent reproduction of bass drums and organ pedals. The use of bass roll-off (and, for that 11 KHz) is a matter of record company policy or the idiosyncrasies of chief engineers. In any case, this sonic emasculation is an all too common practice.

What are these low frequency noises that upset Joe? They can be caused by quite a variety of sources. Many halls in which classical recordings are made are afflicted with what is known as "room or hall rumble." These noises ranging from 60 Hz down to the subsonic level, are fairly low in amplitude, but can readily be picked up by the wide range condenser microphones generally in use in classical recording. You can walk into an empty hall with the recording mikes in place and usually not hear anything. But activate the mikes and listen through headphones and you often hear all manner of thumps and rumbles. The noises can be caused by a peculiarity in the construction of the hall and its proximity to street traffic and subways. Years ago, when we recorded in Carnegie Hall, we did not start to record before midnight, and the New York subway people furnished us with a schedule of the trains, which at that time of night ran about every 27 minutes. Thus, with the subway literally underneath us, our recording was done in 27 minute segments! In many recordings of the Boston Symphony that RCA made in Symphony Hall, in certain quiet passages you can hear the sound of a bus rumbling up through its gears, as it pulls away from the hall. Naturally, the sound of the bus must coincide with a pianissimo section for it to be heard. A good example of this is in the first few minutes of the low level passages of the Erich Leinsdorf recording of Stravinsky's *Firebird Suite*. Contrary to the ideas held by many record buyers, RCA does not roll-off bass in its disc recordings, keeping response fairly flat to 30 Hz. Hence, no trouble in hearing the bus in those certain passages.

It is a fact that the monitor speakers, mostly of the so-called "theatre-type," used by many record companies and countless recording studios, have almost no bass response below 50 Hz. The engineers who use this type of speaker just can't hear the low frequency "garbage" being recorded on their tapes. Why then do they use such speakers? For one thing, they are usually very rugged and reliable. And they can tolerate the high levels at which most monitoring is done these days. Of course, the over-riding consideration is that the disc is going to be rolled-off anyway, so who cares? Alas, poor Joe cares . . . naturally the 15 ips copy of the master didn't suffer the bass roll-off, so he was subjected to all the low frequency problems.

Most audiophile speakers have a better low frequency response than the above described monitors, and a fair percentage can do a good job of reproducing bass to a bit below 30 Hz. These speakers are equally available to recording companies as they are to audiophiles, and indeed, some of the more enlightened companies do use them for monitoring. I should modify that a bit by stating that this monitoring is usually for classical recordings in concert halls. When I recorded the London Symphony Orchestra and the London Philharmonic in Walthamstow, my favorite hall in England, I used huge wide range speakers with extended low frequency response furnished to me by the famous Gilbert Briggs of Wharfedale. The recording room (nominally the conductor's "Green Room"), physically separate from the hall, was draped with rolls of Fiberglas and burlap, to make the room quite "dead," as we were interested in the acoustics of the hall and not that of the hall plus the recording room. These speakers, driven by special commercial versions of 60 watt McIntosh amplifiers, gave us an excellent indication of low frequency as well as overall response.

The question naturally arises: If you are using monitor speakers with good low frequency response, which allows you to hear such things as hall rumble, what can you do about these unwanted sounds? The obvious answer is that if

Dick Sugar's been playing his Miracord 10H's 18 hours a week for 7 years.

We built our new 660H for people like him

Dick "Ricardo" Sugar broadcasts Latin music over New York's WHBI-FM, six days a week, three hours a day, from his own private studio. For the past seven years—6500 hours of broadcasting—his studio turntables have been Miracord 10H's.

We built the new ELAC/ Miracord 660H for people like Dick Sugar; people who want or need the highest quality in a turntable, and who want that quality to endure. So the new 660H has everything Dick Sugar bought his old 10H's for—plus all the improvements we've made since we built the 10H.

A broadcaster like Dick wouldn't settle for anything but the long-term speed accuracy of the 660H's hysteresis synchronous motor. Or for an arm that couldn't track down to a fraction of a gram with the finest cartridges, or an arm without an ultra-simple overhang adjustment to keep distortion nearly imperceptible.

Dick Sugar might not need the convenience of our pushbutton-controlled automation (the world's most flexible)—he gets more practice playing records manually each year than most people get in their lifetimes. But he'd appreciate the 660H's cueing lift; with it, he could float the arm right off a record without taking his eyes off his clock and VU meter.

What impresses him most about Miracord though, is reliability: "In the seven years I've had mine, I've had to replace styli, idler wheels and a few minor parts. But I've never had to send them to the shop. And my next turntables will certainly be Miracords—just like the ones before these were."

The ELAC/Miracord 660H. $139.50, less base and cartridge. Another quality product from Benjamin. ELAC Division/Benjamin Electronic Sound Corp., Farmingdale, N.Y. 11735/a division of Instrument Systems Corp. Also available in Canada.

BENJAMIN
ELAC/MIRACORD

Prices subject to change without notice.

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possible, you change the recording venue, to a location where the speakers do not reveal room rumble or other anomalies. Since this is not always practical, such things as sub-sonic filtering are a help (mainly to eliminate their audible harmonics) or narrow-band notch filtering, especially if the low frequencies have a pronounced peak. With audiophile speakers improving constantly in their low frequency response, it would behoove the engineers of many companies to use monitor speakers responsive to the entire frequency spectrum. Taking the expedient way out, rolling off the low frequencies, does not endear a record company to its quality-conscious customers. I can readily sympathize with our friend Joe, since I have many 15 ips copies of masters in my possesion, not a few of which are diminished by unwanted low frequency junk. I expect as usual, I'll get the cry that I am talking about a minority situation, and the mass public doesn't care, does not have the discrimination, and does not have the equipment, so why bother about this problem. Just remember, it has been the cranky audiophile over the years who has resulted in the present high quality of music reproduction. Let's not just look the other way, when this is something so easy to correct.

* * *

In reporting on the AES convention a few issues ago, and in mentioning the unique Neve console/Ampex recorder exhibit, I inadvertently left out the fact that the special recording made by John Woram of Vanguard, was a session using all Shure microphones, and paid for by Shure. My apologies for this omission. AE

In Memorium

Haskel A. Blair was a leader in the field of electronics for 48 years. After his graduation from the RCA Institute in 1923, he formed Blair Radio Laboratories, developing and manufacturing the first commercial resistance-coupled radio receiver, which was distributed nationally under the name Blair Radio.

Later Blair withdrew from set manufacture and assisted Sidney Young White of Loftin-White in pioneering the first direct-coupled amplifier. Shortly thereafter, he again went into his own business under the name of Blair Service Laboratories. Mr. Blair then proceeded to further develop and manufacture private label amplifier lines for Lafayette Radio, Federated Purchaser, and other famous mail order houses of that day.

In 1932, Blair teamed with David Bogen to design a new line of amplifiers. These were first marketed under the "Supreme Fidelity" label and later under David Bogen's name.

As the company grew, Blair found it increasingly difficult to handle both sales and engineering responsibilities, and finally decided to devote himself entirely to sales and administration. In 1945, he left Bogen to organize the Blair-Steinberg Company, which soon became one of the East's largest manufacturer's representative operations.

In 1959, Blair left his own company to assume the presidency of University Sound, where he guided the company's growth for 10 years. Due to poor health, he retired in December 1969. Since his retirement, Mr. Blair had been in an advisory capacity with University Sound.

Haskel A. Blair

The new ADC-XLM

Superb performance. Lowest mass. Unbeatable price. And it's guaranteed for 10 years.

If you're like most audiophiles, you've probably spent a great deal of time, effort and money looking for the "perfect" cartridge.

We know what you've been through. After all, we've been through it ourselves.

That's why we're especially enthusiastic about our newest cartridge, the ADC-XLM. It does everything a well designed cartridge should do. It may not be perfect, but we don't know of any that are better, and few that even come close.

Now, we'd like to tell you why.

The lighter, the better.

To begin with, it is generally agreed that the first consideration in choosing a cartridge should be low mass. And as you may have guessed by now, the LM in our model designation stands for low mass.

Not only is the overall weight of the ADC-XLM extremely low, but the mass of the all-important moving system (the stylus assembly) is lower than that of any other cartridge.

Translated into performance, this means effortless tracking at lighter pressures with less distortion.

In fact, used in a well designed, low mass tone arm, the XLM will track better at 0.4 gram than most cartridges at one gram or more.

A new solution for an old problem.

One of the thorniest problems confronting a cartridge designer is how to get rid of the high frequency resonances common to all cartridge systems.

Over the years, various remedies have been tried with only moderate success. Often the cure was worse than the disease.

Now thanks to a little bit of original thinking, ADC has come up with a very effective solution to the problem. We use the electromagnetic forces generated within the cartridge itself to damp out these troublesome resonances. We call this self-correcting process, "Controlled Electrodynamic Damping," or C.E.D. for short.

And if it seems a little complicated, just think of C.E.D. as a more effective way of achieving lower distortion and superior tracking, as well as extending frequency response.

Naturally, there's much more to the new ADC-XLM, like our unique induced magnet system, but let's save that for later.

Guaranteed reliability plus.

At ADC we've always felt that reliability was just as important as any technical specification. That's why we now guarantee every ADC-XLM, exclusive of stylus, for a full ten years.

But this unprecedented guarantee* involves something more than just an assurance of quality. It is also an expression of our conviction that the performance of this cartridge is so outstanding that it is not likely to be surpassed within the foreseeable future.

And something more.

In addition to the superb ADC-XLM, there is also a new low mass ADC-VLM, which is recommended for use in record players requiring tracking pressures of more than one gram. The cartridge body is identical for both units, and so is the guarantee. Only the stylus assemblies are different. Thus you can start out modestly and move up to the finest and still protect your investment.

And that brings us to the important question of price, which we are happy to say is significantly lower than what you might reasonably expect to pay for the finest. The suggested list price for the incomparable ADC-XLM is $50 and the runner-up ADC-VLM is only $40.

But no matter which low mass ADC you choose, you can be certain that they share the same outstanding characteristics... superb tracking, very low distortion and exceptionally smooth and extended frequency response.

*We guarantee (to the original purchaser) this ADC cartridge, exclusive of stylus assembly, to be free of manufacturing defects for a ten year period from the date of factory shipment. During that time, should a defect occur, the unit will be repaired or replaced (at our option) without cost. The enclosed guarantee card must be filled out and returned to us within ten days of purchase, otherwise this guarantee will not apply. The guarantee does not cover damage caused by accident or mishandling. To obtain service under the guarantee, simply mail the unit to our Customer Service Department.

Audio Dynamics Corporation
Pickett District Road, New Milford, Connecticut 06776.

Check No. 13 on Reader Service Card

Dear Editor

Mr. Allison Replies

The following is in response to a letter from Philip Bond, which appeared in the January "Dear Editor:" column.

Mr. Bond has touched on a basic problem in sound reproduction: What is heard as reproduced sound is the product of many processing steps. These include the concert hall (sometimes!), microphones, tape machines, mixing consoles, reverb devices, equalizers and cutters, stampers, the disc/pickup cartridge interaction, playback electronics, playback loudspeaker systems, and the listening room.

The response characteristics of many of these processes are known accurately and are controllable by the recording engineer. But he cannot control the characteristics of the playback system, and the one thing he can be certain of in respect to it is that the response is not flat.

What little work has been done on studies of loudspeaker/living room interaction demonstrates that the perceived sound field is primarily the total power output of the loudspeaker system, integrated and somewhat modified in balance by the room itself. On this basis, there are no *flat loudspeaker systems in common use and there never have been. Even those with relatively flat direct-wave output, on axis, roll off in power response at the high end.*

Monitor speakers are no better. Many are a good deal less flat than the best home-type systems.

Ideally every element in the reproduction chain should be flat, with deviations from flatness (when desired) controllable by the user. This should include loudspeakers too, of course. But even if it were practical to make such loudspeaker systems at reasonable prices—which it is not—what could be done about the hundreds of millions of loudspeakers in use now, all of which do have rolled-off high frequency power output?

The answer is that you continue to make records that sound properly balanced when played on these *loudspeaker systems, or you won't sell records. Thus records will continue to have inherently a "brighter" balance than is intended by the recording engineer to be actually heard. That will be true of "concert" recordings, jazz and chamber recordings, and even ambience-type four-channel recordings. Playing such records at home on truly flat loudspeaker systems will produce a sound considerably brighter than the producer had in mind.*

How do you break this self-perpetuating cycle? I don't know; it seems unlikely that it could be broken suddenly even if the loudspeaker technology were ready to break it. More than likely it will be a slow, evolutionary change. That prospect is the reason why AR's new LST monitor speaker system, the first system that is *capable of flat acoustic power response up to extremely high frequencies, is equipped with a selector switch to yield optional degrees of high frequency roll-off as well as flat output.*

Wants Cylinder Phono

Dear Sir:

I would like to obtain a cylinder phonograph (Edison or other) and would like to know if you are aware of any source in Canada or the U.S. where I might obtain such.

Dave Noon
19 Honeysuckle Cr.
London, Ont., Canada

Living-Room Room

Dear Sir:

In four-channel stereo, there is a big question about its feasibility in use: Who has a living room in which they can put four speakers without upsetting the entire furniture arrangement in the room?

Also, if a person is married, such as myself, is his wife going to stand for two more speakers in the living room? Especially if the speakers are each 3 by 5 feet?

And, another question I would like to have answered: How can you get the best results unless you sit in a chair (by yourself?) in the middle of the living room with all four speakers the same distance from you?

With all these questions, I wonder if four-channel stereo is practical.

Jodie Selzer
Pico Rivera, Calif.

1000-Mile FM Tuner?

Dear Sir:

I was duly impressed with the November AUDIO review of the Sherwood SEL-300 tuner. Unfortunately, I do not believe technical perfection in FM reception is an end in itself.

Here in the wilds of western Pennsylvania, I find little that is worthwhile in FM programming, regardless of fidelity. There is a seemingly endless parade of manic disc jockeys, redundant rock bands, elevator music, Nashville city-billy, and conventional assembly-line pop music. There is only one local station that offers classical music daily, and it is strictly monaural and often low-fi as well.

I own a receiver with a fairly sensitive, noise-free and distortionless tuner, but it is usually turned off, period. Thank God for phonograph records!

M. G. Balfour
Monroville, Pa.

Well, one of the advantages of a highly sensitive and ***selective*** *tuner is the ability to receive worthwhile programs in fringe areas. Who knows, maybe you could even get Cleveland with a good tuner.*—Ed.

We Like You Too

Dear Sir:

Just to say thanks for the valuable information. Your magazine has saved me not only time and research, but money as well. I only wish that other publications could offer as much as AUDIO has given. Please keep it up.

Demrey Berliner
Wald Port, Ore.

Beating Inflation

Dear Sir:

Subsequent to my agreement to renew, I decided that I wouldn't save anything because of inflation. I still feel that way, but I have so enjoyed the last several issues that I decided to pay up as an endorsement of your editorial policy. Keep up the good work.

Phil Blair
Euclid, Ohio

$ For Tapes $

Many readers must have tapes which they are particularly proud of. AUDIO will pay $50.00 for the best tape of the month—cassette or reel-to-reel. They will be judged on technical excellence and content. Selected tapes can be processed and marketed—if the owner wishes. Who knows, that old tape may make you a fortune! Please mark your entries TAPE COMP. and send them to AUDIO, 134 No. 13th St., Philadelphia, Pa. 19107.

SONY® achieves true integration

In all too many transistor integrated amplifiers, the preamp stage does not quite live up to the performance of the amplifier section.

Not in Sony's new TA-1130. Thanks to an FET front end, this integrated package has a preamp stage that really does full justice to its output section.

Why FET's

For the same reason that we use them in our tuners and receivers, and in our studio professional condenser microphones; because FET's have a far wider dynamic range than ordinary transistor types.

And the preamplifier needs that range. Because it has to be sensitive enough to handle the lowest-output, moving-coil cartridges, yet still accept the highest output cartridges without overloading. (The power amp has it easier: you keep its input level fairly constant with your volume control.)

SONY® F.E.T. Amplifier

Power to Spare

But if the power amplifier doesn't need that range, it does need power. The output section of TA-1130 has it: 230 IHF watts (into 4 ohms), with continuous power rated at 65+65 watts into 8 ohms. (With all that power, we made sure that both transistor and speaker protection circuits were included.)

Nothing Stands Between You and the Sound

Both sections are powered by balanced positive *and* negative supply voltages (not just positive and ground), so there need be no coupling capacitors or interstage transformers between you and the sound.

Without them, the TA-1130 can extend its power band width down to 7 Hertz, and actually exceed its rated damping factor of 100 all the way down to 5 Hz.

An Abundance of Audiophile Conveniences

Of course, the TA-1130 has all the control facilities that you could ask for: low and high filters, tape monitor, a speaker selector, and even an Auxiliary input jack on the front panel. The selector switch is Sony's instant-access knob-and-lever system.

There's even provision to use the TA-1130's power amp and preamp sections separately, to add equalizers, electronic crossovers, or 4-channel adapters to your system.

In fact, you can even get the power output section separately, as the model TA-3130 basic amp. It makes a great match for our TA-2000F preamp, too.

Your Sony dealer has both models available, and at down-to-earth prices for the performance they offer. Sony Corporation of America, 47-47 Van Dam Street, Long Island City, New York 11101.

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Editor's Review

SOME OF THE NEW amplifiers are listed on pages 47 to 49, and it will be apparent that there is a definite tendency for higher and higher powers. This trend can be seen on the other side of the Atlantic too—although what is considered low to medium power here would be rated high in Europe! Incidentally, the output powers are listed in rms watts. To be strictly accurate—and why not?—it must be said that this expression is a misnomer. There ain't no sich animal. What is really meant is not a root-mean-square power, but the power equivalent to the rms voltage measured across the appropriate load resistance. Another instance where standardization is required.

Dynamic Testing

On page 46 in the "Q and A" article, I made a passing reference to a bridge system of amplifier evaluation developed by the British Acoustical (Quad) Company. As we go to press (this page is always written last!), more details arrived and so an article on this ingenious device will appear in the March issue. We have known for many years that sine wave amplifier tests were unsatisfactory, that square waves and pulse measurements do not tell the full story, and what was needed was a scientific, repeatable method of testing under *speech and music* conditions. The *Walker* bridge might be too complicated for reviewing amplifiers, but it would be an ideal lab tool for designers.

Crown Fire

Fire Thanksgiving Day caused an estimated $1 million or more damage at Crown International, Elkhart, Indiana. Approximately 60 percent of the facility was completely destroyed, despite the efforts of eight fire departments which were called to battle the blaze. Crown officials noted at press time that production had already started again and would be at pre-fire levels before the first of February.

Quadraphonics

The quadraphonic position is still indeterminate with each matrix advocate thoroughly convinced of the superiority of his own system and the Discrete School saying "a plague on all your houses." I have had several decoders in my home for some weeks now but suitable discs have been hard to come by. All I can say is this: The old E-V system worked fine on E-V recordings, but tended to lose bass when used with two-channel records. It is caused by phase cancellation and does not happen with the later version (Stereo 444) or the CBS SQ system. This produces an impressive *surround sound* with two-channel program sources and achieves good separation with SQ discs. The sense of location with the David Frost demonstration record is uncanny. Not as good as discrete four-channel tapes—but perfectly acceptable. So far only three of the new SQ releases have been received and these were a little disappointing. One is Barbra Streisand's "Stoney End" and here we have Barbra up front with background singers mostly at the rear. Nice, but not exciting. The second record is "Indian Reservation" by The Raiders. Unfortunately this one was spoiled by too much intentional distortion (fuzz?) and was quite painful to listen to. The third record is Santana's "Abraxas." Here, the listener is placed right in the middle of the performers. If you like Santana (a 120 dB Cuban rock group), you'll find it an exciting experience—I found it shattering. . . . Curiously enough, one of the records I liked best with the SQ decoder was made by ABC using the Sansui system. It is "Welcome to Vienna" by Beverly Sills with the LPO. The rear channels supply reverberation and *ambience*, and the effect is absolutely delightful. Before leaving the topic of quadraphonic sound, I ought to congratulate Bill Putnam of URC (United Recording Co.) for producing a most useful disc. Bill recorded the same pieces with four different systems for comparison purposes—the Sansui, E-V, CBS, and UMX. The only snag is you need all four decoders for really serious evaluation. Incidentally, the UMX stands for Duane Cooper's Nippon-Columbia system. More about this one later, with a report on the URC record.

Humor in Advertising

Wily engineers in Japan, Taiwan, Hong-Kong, and points West have used considerable ingenuity in squeezing transistor radios into the most unlikely places—books, cameras, clocks, cigarette lighters, and so on. I take the following from a TEAM catalog, "ALLIGATOR—inside this green and yellow alligator lies a radio! One eye turns him ON or OFF, the other a tuning dial. Sound comes from the scales on his back." And this one, "TOY SOLDIER—flip his ear and listen through his hat for AM entertainment." Ideal for commercials, I suppose. *G.W.T.*

The Pick-Up Pros.

Artie Altro makes the WOR-FM sound, while Eric Small, Sebastian Stone and Promotion Director, Kim Olian look over a new album.

WOR-FM, the country's leading FM/Stereo rock station, has been using Stanton cartridges since its inception.

Program Director Sebastian Stone likes the smooth, clean sound the Stanton delivers; the way it is able to pick up everything on the record so that the station can assure high quality transmission of every recording.

Eric Small, Chief Engineer for WOR-FM, likes the way that Stanton cartridges stand up under the wear and tear of continuous use. "We standardized on Stanton a couple of years back," Small said, "and we haven't had a cartridge failure since. Studio Supervisor Artie Altro concurs.

Whether you're a professional or simply a sincere music lover, the integrity of a Stanton cartridge delivers the quality of performance you want.

There are two Stanton professional cartridge series. The Stanton 681 Series is engineered for stereo channel calibration in record studios, as well as extremely critical listening. The 500 AL Series features design modifications which make it ideally suited for the rough handling encountered in heavy on-the-air use. In fact, among the nation's disc jockeys it has become known as the "industry workhorse."

All Stanton cartridges afford excellent frequency response, channel separation, compliance and low mass and tracking pressure. And every Stanton cartridge is fitted with the exclusive "longhair" brush to keep grooves clean and protect the stylus. They belong in every quality reproduction system—broadcast or high fidelity.

For complete information and specifications on Stanton cartridges, write Stanton Magnetics, Inc., Terminal Drive, Plainview, L.I., N.Y. 11803.

STANTON

All Stanton cartridges are designed for use with *all* two and four-channel matrix derived compatible systems.

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The Measurement of Loudness

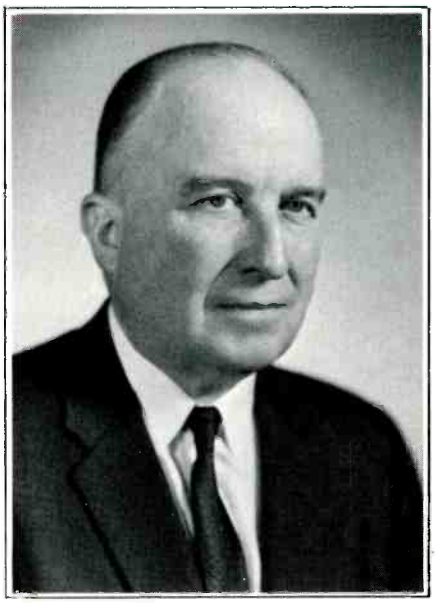
Harry F. Olson*

THE ULTIMATE significant subjective destination of original or reproduced sound and noise is the human ear. Therefore, the varied responses of the auditory system are particularly important factors in the reproduction of sound. One of the response functions of the human hearing mechanism is loudness. The purpose of this paper is to describe a loudness meter based upon the fundamental principles of the loudness response of the human hearing mechanism.

When a sound or noise of any quality or structure impinges upon the human ear, the magnitude of the resultant sensation is termed the loudness. It is the intensive attribute of an auditory sensation in terms of which sounds may be ordered on a scale extending from soft to loud. Loudness depends primarily upon sound pressure but it also depends upon frequency and waveform of the stimulus. The units on the scale of loudness should agree with common experience estimates about the magnitude of the sensation. The measurement of loudness is a significant part of the audio art because the loudness of a sound or noise plays an important role in the reproduction of sound.

Loudness is functionally related to sound pressure level, frequency, and waveform. Turning this around, the sound pressure level as measured by a sound level meter does not indicate the loudness of a sound. However, a conversion can be made in the readings of a sound level meter employing octave band pass filters to obtain the loudness. This is indeed a long and tedious process, as the exposition in this paper will show. What is required is a loudness meter that indicates the loudness of a sound in real time. Furthermore, the loudness indication should agree with the loudness as perceived by the listener.

*RCA Laboratories, Princeton, N.J.



There are many uses for a loudness meter. For example, the loudness meter can be used to monitor the loudness of an audio program so that the peak permissible levels of all manner of audio program material will provide the same loudness to the listener. In the production of contemporary recorded music one of the objectives is to obtain the maximum loudness. For a certain maximum amplitude level of the signal, which is determined by the constraints of the record, a loudness meter can be employed to obtain the maximum program loudness by modifications of the frequency balance and timbre present in the signal. There are many other uses for the loudness meter in the measurement of sounds and noises.

Loudness Scale

The establishment of a loudness scale is a very complicated matter. A large number of investigators in many countries have carried out research on the loudness of a complex sound. A detailed description of the work is beyond the scope of this paper. Therefore, only the basic data on loudness required for the development of a loudness meter will be presented.

The unit of loudness is the *sone*. A sone is defined as the loudness heard by typical listeners when confronted with a 1000 Hz tone at a sound pressure level of 40 phons.

The loudness level of a sound is given by

$$P = 20 \log_{10} \frac{p}{p_0}$$

where p = loudness level, in phons,
P = measured sound pressure, in microbars, and
p_0 = a sound pressure of 0.0002 microbars

The loudness level [1] of a sound or noise is expressed as n phons, when it is judged by normal listeners to be equally loud compared to a pure tone of frequency 1000 Hz consisting of a plane progressive sound wave radiating to the observer, the sound pressure of which is n (decibels) above the standard ref-

Shakespeare. Dickens. Stevenson. Poe. Sony. Balzac.

Add another classic to your library from Sony/Superscope ...the bookshelf-size Sony model 540 three-motor three-head stereo tape deck.

Get all of these outstanding Sony features in the most beautifully compact, beautifully priced ($349.95) three-motor tape deck on the market today.

Three Motors. One precisely controls tape speed and two provide ultra-fast rewind and fast-forward modes for optimum tape handling ease.

Three Heads. Separate erase, record and play heads give better frequency response and also provide for tape/source monitoring, allowing you to check the quality of a recording while in progress.

Built-in Sound-on-Sound and Echo. Switching networks on the front panel facilitate professional echo and multiple sound-on-sound recording without requiring external patch cords and mixer.

Mic/Line Mixing. Dual concentric level controls regulate the record levels of microphone and line inputs independently also allowing simultaneous mix and record.

Two Large Illuminated VU Meters—calibrated to NAB standards.

Plus Lever Action Solenoid Controls.

Also ask about the Sony 650 (two-track: $475.00. Quarter-track: $449.95) & Sony 850 ($795.00) at your Sony/Superscope dealer.

After all, when it comes to tape recorders Sony wrote the book.

SONY SUPERSCOPE

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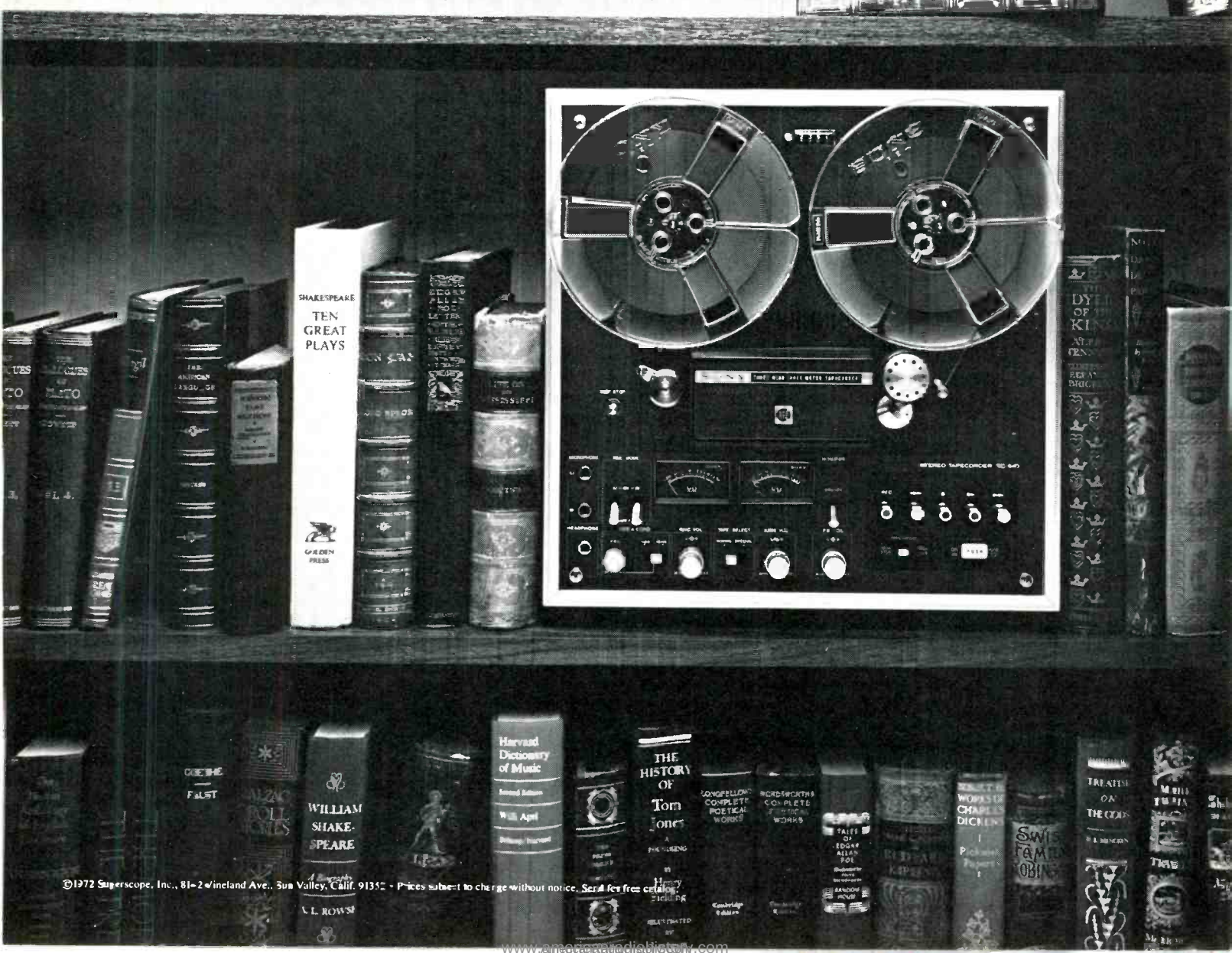

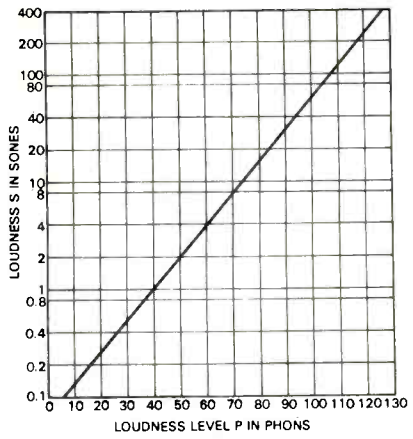

Fig. 1—The relation between the loudness in sones and the loudness level in phons.

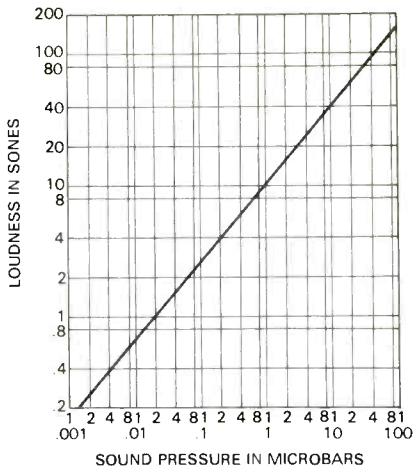

Fig. 2—The relation between loudness in sones and the sound pressure in microbars.

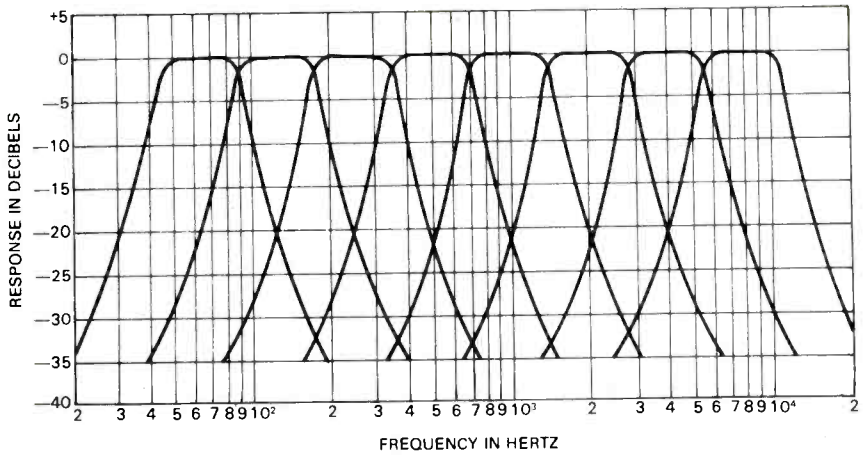

Fig. 3—The frequency response characteristics of the octave band pass filters.

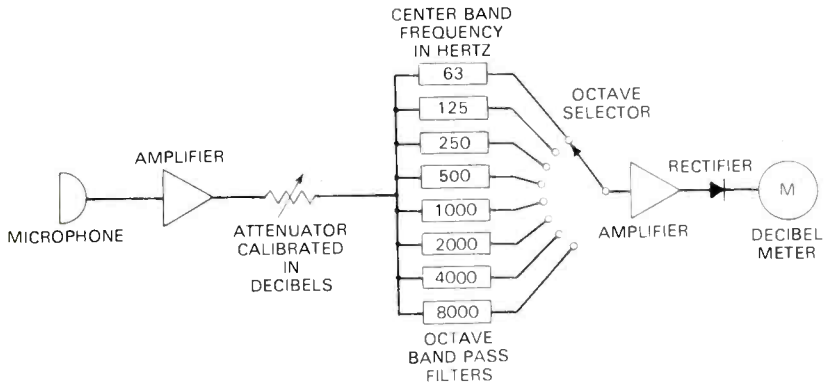

Fig. 4—Schematic diagram of a sound level meter for measuring the sound level in an octave.

erence sound pressure of 0.0002 microbars.

The relation[1] between loudness in sones and loudness level in phons is given by

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

where S = loudness, in sones and
P = sound pressure level, in phons, given by equation 1.

The relation between the loudness in sones and the loudness level in phons is shown by the graph of Fig. 1.

The relation between loudness in sones and sound pressure in microbars, shown by the graph of Fig. 2, indicates that there is a nonlinear relationship between the loudness in sones and sound pressure in microbars.

Measurement Of Loudness

In order to provide a measure of the loudness for the complex sounds of speech, music, and noise, there must be a means to separate the complex sounds into manageable segments. In particular, to establish the loudness of a complex sound, at least three specifications must be available as follows:

1. A scale of subjective loudness. This is termed the *sone scale* described in the preceding section.
2. The equal loudness contours for discrete frequency bands of the complex sound.
3. The rule by which loudness adds as the discrete frequency bands of the complex sound are added.

If specifications 1, 2 and 3 can be established, then the loudness of the

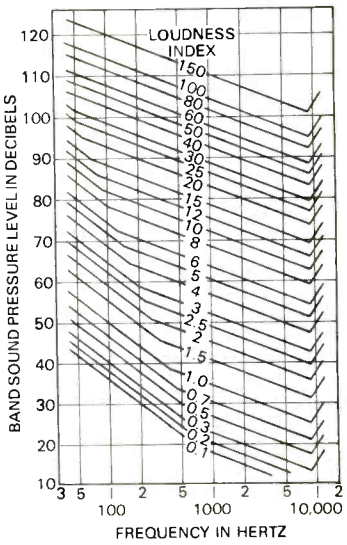

Fig. 5—Contours of equal loudness index for octave bands in the audio frequency range.

complex sounds of speech, music, or noise can be determined. The objective and subjective information[2,3,4] relating to the specifications of items 1, 2 and 3 have been established by investigators concerned with the subject of loudness. Furthermore, these investigators have shown that the loudness of a complex sound can be determined from the physical data on the complex sound in conjunction with the specifications of items 1, 2 and 3.

The specific method for determining the loudness of a complex sound is to split the audio frequency range into frequency bands. This is a complex procedure in which the complexity increases with the number of frequency bands. From a practical standpoint there should be as few frequency bands as possible without sacrificing frequency selectivity. A suitable frequency band appears to be the octave. The frequency response characteristics of the octave band pass filters employed in this development project are shown in Fig. 3.

The system for determining the sound pressure level in the eight different octave bands in the audio frequency range is shown in Fig. 4.

When the sound pressure level in each octave band has been measured, the next step is the proper summation of these data to provide the total or overall loudness of the complex sound. In this investigation and development, the procedure selected for calculating the loudness of a complex sound is the one developed by S.S. Stevens.[2] This is also the standardized procedure[5] as given in ISO-R532 Method A. In accordance with this Standard, the relation between the total loudness and the loudness index in each octave band is given by

$$S_T = 0.7\,S_M + 0.3\,\Sigma\,S$$

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 is obtained from the graph of Fig. 5. The sound pressure level in each octave band is determined by means of the system of Fig. 4. Employing the geometric mean frequency for each octave band, the loudness index for each octave band is determined from Fig. 5. Then the total loudness of the complex sound in sones is computed by means of equation 3.

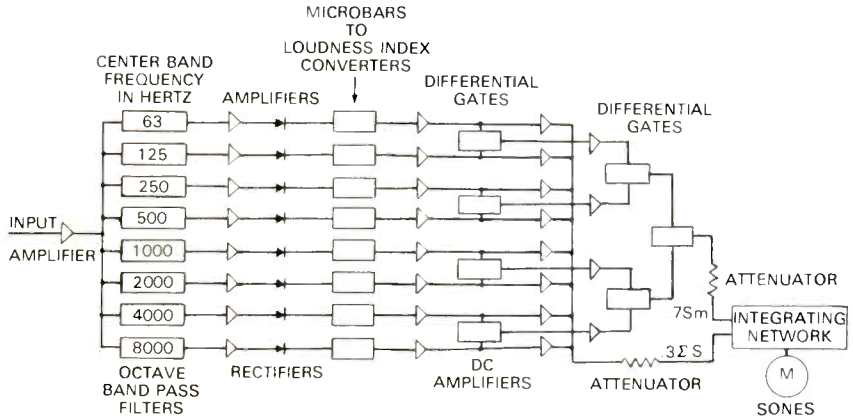

Fig. 6—Schematic diagram of the elements of a loudness meter.

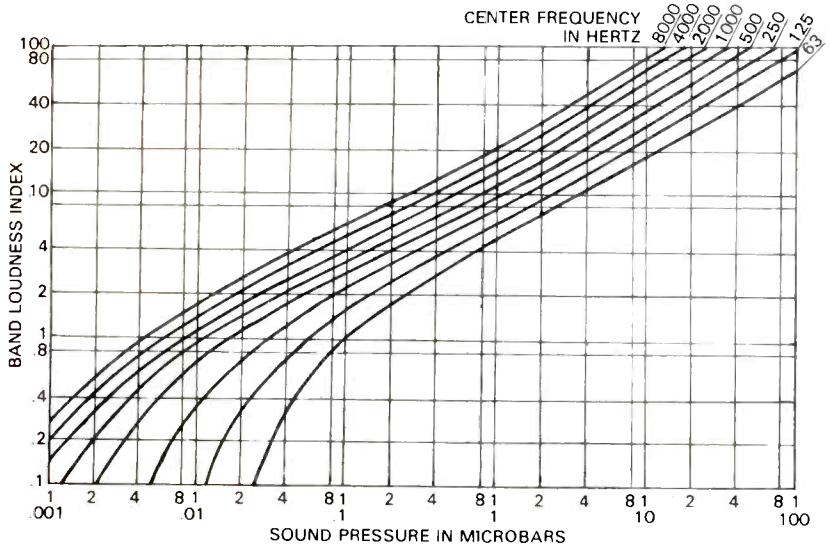

Fig. 7—The relation between the loudness index and the sound pressure in microbars for the octave bands of Fig. 3.

Loudness Meter

To provide a loudness meter requires an automated instrumentation of Fig. 4 incorporating the data of Fig. 5 and the procedures of the preceding section operating in real time. Specifically, equation 3 shows that the loudness meter must provide the following: the measurement of the loudness index in each channel, the summation of the loudness indices in all the channels, the selection of the channel with the greatest loudness index, the proper relation and summation of the sum of the loudness indices and the highest loudness index, and an indicating meter with the proper dynamics to depict the loudness of the complex sound in sones from the summation input.

A schematic diagram of the loudness meter[6] is shown in Fig. 6. The signal input is fed to eight octave band pass filters. The frequency response characteristics of the filters are shown in Fig. 3. The output of each band pass filter is followed by an amplifier coupled to a rectifier, which in turn is followed by

a microbar-to-loudness-index converter. The input-output characteristics of the eight microbar-to-loudness-index converters are shown in Fig. 7. These converters are in the form of nonlinear active elements as a part of operational amplifiers and their output is fed to a d.c. amplifier. The output of these amplifiers provides the loudness index for each octave channel, and the loudness index outputs from the eight channels are added by means of separate direct current amplifiers and fed to the attenuator coupled to integrating network and the sone meter. In order to determine the channel with the highest output, the eight microbar-to-loudness-index converters are fed to differential electronic gates in the form of a net-

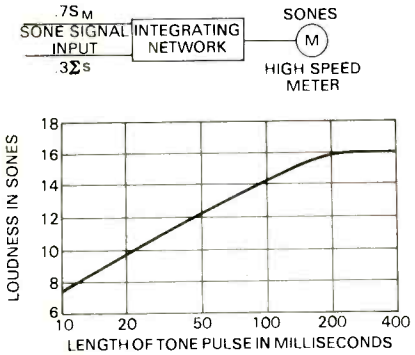

Fig. 8—The integrating network and high speed meter of the loudness meter. The graph depicts the relation between the loudness in sones and the length of the tone pulse in milliseconds.

work tree, the output of which is fed to an attenuator coupled to the integrating network and the sone meter. The two attenuators are adjusted to obtain the correct values of $0.7S_M$ and $0.3\Sigma S$. Under these conditions the sone meter will indicate the loudness in sones of an audio signal input to the loudness meter.

The remaining and very important subject is the dynamics of the amplitude characteristic of the indicating meter. The amplitude response of the indicating meter system should correspond to the ear response to individual, repetitive and overlapping short, medium, and long time pulses of sound and continuous sounds. Since most sounds of speech and individual musical instruments are of short duration, this then becomes a very important problem. The basic question is the loudness of a complex sound as a function of the time the sound persists. Obviously, a short pulse of sound of amplitude equal to a long pulse of sound will exhibit a lower loudness level. From published data and data obtained from this development (loudness as a function of the time length of the sound pulse), the graph shown in Fig. 8 was drawn. As would be expected, the loudness of a relatively short time pulse of sound decreases with the duration of the time of the pulse. This data was used to develop an integrating network in conjunction with a high speed indicating meter. A block diagram of the integrating network and the high speed meter for indicating the output of the loudness meter in sones is shown in Fig. 8. The integrating network consists of active growth and decay networks applied to an operational amplifier. Since the main intended application for this meter was the determination of the loudness of speech and music, the integrating network was tailored to provide the correct indication of loudness for this type of program material.

The signal input to the loudness meter should correspond to the level of the reproduced sound. For example, the average listener prefers a loudness level of the reproduced sound of 80 phons. The input to the loudness meter should be adjusted so that a level of 80 phons will give an indication of 16 sones.

Performance Of The Loudness Meter

A large number of subjective tests have been carried out to determine the performance of the loudness meter employing reproduced speech and music. A few of the tests and results will be described.

Test No. 1. The reproduced sound level of a *musical* program was varied over wide limits. The observers agreed that the indication of the loudness meter agreed with their sensation of loudness.

Test No. 2. The reproduced sound level of a *speech* program was varied over wide limits. The observers agreed that the indication of the loudness meter agreed with sensation of loudness.

Test No. 3. The same musical program was reproduced in highly compressed and uncompressed conditions. The compressed program was reproduced at a level of 2 dB lower than the uncompressed program as read on a conventional volume indicator (VU meter). The loudness meter indicated a level 3 sones higher for the compressed program. Here the two meters indicated a reversal in the readings. The subjective evaluation by the observers agreed with the loudness meter. This shows the conventional volume indicator does not indicate loudness.

Test No. 4. Speech was recorded at a low speaking level and at an almost shouting level. The two were reproduced at the same top level of 80 dB as indicated by a conventional volume indicator (VU meter). The shouting speech indicated a higher loudness on the loudness meter. Again the observers agreed with the loudness meter.

Test No. 5. Employing a contemporary musical program, the loudness meter was used to provide the maximum loudness for the same peak level as the unchanged program. The main operations were compression and changes in the frequency distribution. Employing a reproduction peak level of 85 dB as indicated on a peak reading level meter, the modified program indicated a loudness 6 sones higher than the unmodified program. This is an increase in loudness level of 6.7 phons which is indeed a considerable increase in the sensation of the loudness.

Summary And Conclusion

A loudness meter has been described which indicates the loudness of an audio signal. Since the ultimate significant subjective destination of all original or reproduced sound is the human ear, a meter which indicates the loudness as perceived by the ear is an important audio instrument. For example, the loudness meter will become a very useful tool for determining the loudness of any simple or complex sound or noise, for monitoring the maximum permissible level of all manner of audio programs, for obtaining the maximum loudness of an audio program for a certain maximum peak level, etc.

The author wishes to express his appreciation to R. A. Hackley, D. S. McCoy, and D. G. Murray for contributions to the development work of the loudness meter.

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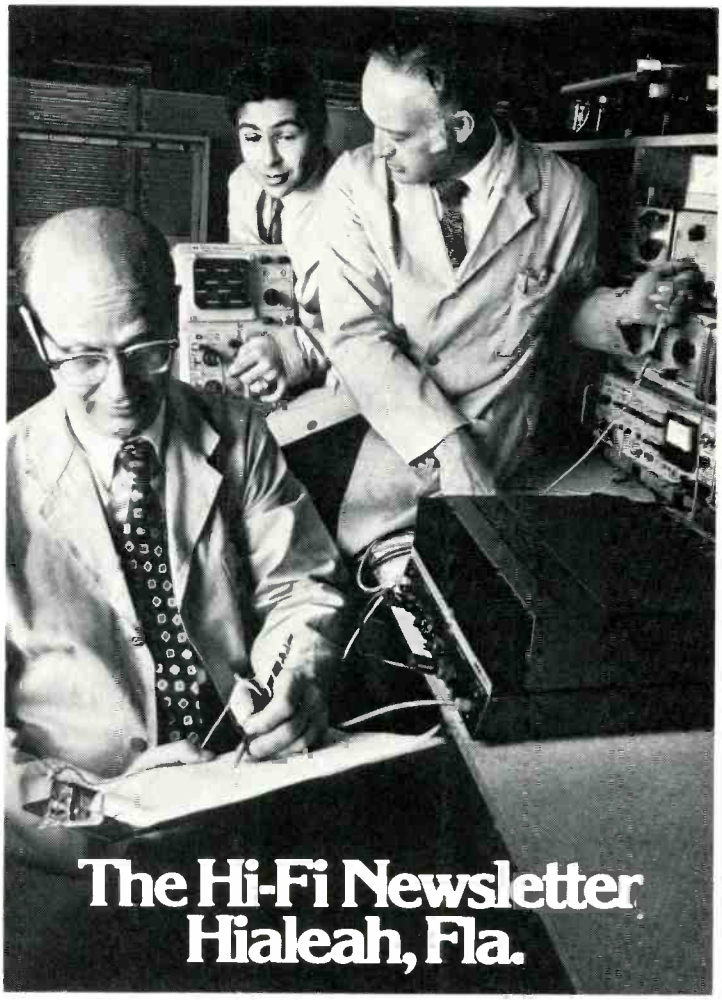

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A 700-Watt Amplifier Design

Robert Carver*

THIS ARTICLE DISCUSSES some of the requirements modern high fidelity systems impose on the power amplifier. Renewed efforts to cope with previous shortcomings in power amplifier performance has led to a whole host of new technical problems and, necessarily, solutions. These problems, their recognition, their practical solutions, and their significance will be examined within the framework of existing power amplifier technology.

The author is an audiophile, a true-blue, dyed-in-the-wool high-fidelity enthusiast, lover of instruments and instrumentalities, lavishly scored orchestral showpieces, choruses and cathedrals. The sonic details of a single drumroll can put me into a state of rapture that Timothy Leary himself would have envied. I have searched, like Sir Gallahad for the Holy Grail and T.R. Thompson† for the Lost Chord, for the low frequency pedal note that would leave the trolls of Ireland impotent. I have sought high frequency performance that would interest and please any passing bat. In short, I am a music lover for whom the quest for realistic reproduction of music has taken on a consuming devotion.

A look at the best of the available basic power amplifiers discloses that bandwidth, distortion, and noise figures extend far beyond the limits of audibility, and in some cases, even the limits of laboratory measureability. It might be concluded that power amplifiers have reached such levels of perfection that further advances could not possibly provide any audible improvements and would be simply "gilding the lily." In any event, it would seem, for example, that decreasing distortion from 0.5% to 0.05% or increasing the signal-to-noise ratio from 90 dB to 93 dB (twice as quiet) would not have any audible effect.

This conclusion might be justified because the deviations from perfection introduced by the rest of the signal-processing chain (speakers, cartridges, and record surfaces) are several orders of magnitude greater than those introduced by the virtually perfect (by comparison) power amplifier. Further, it would seem reasonable to assume that two different amplifiers whose specifications in terms of power, distortion, frequency response, crosstalk, etc., are almost identical should be sonically indistinguishable from one another when compared in listening tests.

However, high fidelity enthusiasts have long observed that different amplifiers do, in fact, sound different and that some amplifiers seem to deliver a more robust low end along with sweeter, silkier highs. Yet their specifications, together with extensive laboratory testing and analysis can reveal no logical reason. A mystery. An engineer recognizes that a mystery is really only a lack of understanding born of insufficient data or the incomplete evaluation of existing data. In the case of the high fidelity power amplifier, it is simply that the human ear is capable of hearing and resolving on-going musical detail that has somehow eluded vast arsenals of laboratory test equipment.

Our own experiences are illustrated in the following experiments and examples. Extended listening comparisons have resulted in several interesting observations. First certain high quality transistor amplifiers "sounded better" by a small margin than high quality transistor amplifiers of identical power rating, in spite of the fact that the latter amplifiers had far "better" electrical specifications in terms of distortion, damping, bandwidth, etc. This difference in subjective sound quality was particularly dramatic when listening to high quality speaker systems using electrostatic components. Particularly, the high end was much airier and open, with much less apparent sibilance during high energy transients.

Let me digress a bit at this point and mention that particular care had been taken to eliminate the last vestige of crossover distortion in the inferior amplifier. At that point, we were virtually certain that crossover distortion was not the culprit. As shall be shown, this assumption proved to be valid.

The second observation was that two different high power, rather expensive transistor amplifiers introduced a mild "snapping" sound into the music when used with some acoustic suspension speaker systems. The "snapping" occurred primarily during low frequency high level passages and on some solo drum instrumentals. Interestingly, the snapping sound was not at all objectional during the drum solos—it tended to give each individual drum beat an added impulse and the illusion of tremendous transient response. However, on sustained low frequency notes, for example, the pedal notes of a pipe organ, the snapping was extremely

†Actually, it was Adelaide Proctor. *(Ed.)*

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annoying and clearly an indication of amplifier misbehavior.

In the third observation, in which a vacuum tube amplifier rated at 60 watts RMS per channel was compared with a transistor amplifier also rated at 60 watts RMS per channel, it was observed that the tube amp sounded somewhat more powerful. We discovered that we were able to increase the sound level significantly before objectionable distortion occured when using the tube amp. In fact, the 60 watt/channel tube amp sounded the same, exactly the same, as a fine transistor amplifier rated at slightly over 100 watts/channel. Two tube amplifiers were used, both vintage models, a Citation II and a Marantz Model 9. The transistor amp was of modern design and is very highly regarded.

When all of the transistor amplifiers included in our listening test were compared, an interesting pattern emerged, which was two-fold. First—relatively low power transistor amplifiers, those under 60 watts, and those built into receivers and integrated amplifiers, never exhibited *any* form of overt of obvious misbehavior. The only "fault" it was possible to render judgment against was their low power and consequent inability to produce satisfying music levels without severe overloading. On the other hand, two of the high power units exhibited the "snapping" phenomena and this we considered to be overt misbehavior and a grevious fault. (As we shall see later, the trouble was due to the protection circuits.)

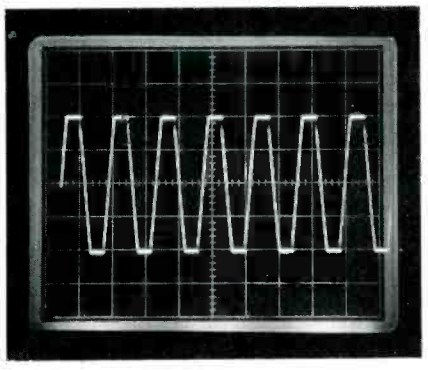

Fig. 1—Amplifier #1, a 60 W/chan. unit with regulated power supply, operating into an 8 ohm load at clipping point, which 60 watts. Both channels operating.

The second part of the emerging pattern was that, given two transistor amplifiers of similar power ratings, it was found that units with a regulated power supply sounded the least powerful; that units with separate power supplies (two power transformers) sounded subjectively more powerful; and, interestingly, units with a single, common power supply sounded the most powerful. Without exception, the units that appeared "most powerful" sounded significantly "cleaner" and more "open" when compared with the other units. All amplifiers were operated at identical listening levels, and each was operating just below the point of audible overload using the "most powerful" sounding unit as the reference. All of these units had similar RMS power ratings. (As a matter of course, the a.c. power line voltage was adjusted slightly to give each amplifier identical continuous sine wave power output.)

At this point, the task at hand is to identify the reasons for the subjective differences on a rigorous, scientific level, and approach the problems from an engineer's viewpoint.

The first investigation centered around determining why some amplifiers with identical power ratings did not subjectively sound equally powerful. For our tests we used a commercially available 60 watt/channel amplifier with a regulated power supply and compared it with a unit specially built and designed for the experiment. It was designed to deliver 60 watts/channel with both channels in operation and it used a single unregulated power supply. An oscilloscope was installed across the speaker terminals and the test was arranged in the familiar A-B fashion. It was possible to switch from one amplifier to another instantly while simultaneously listening to music and observing the output of each amplifier on the 'scope.

It became immediately obvious why the second unit sounded more powerful. We observed that the second unit's output voltage would rise considerably higher prior to clipping than the unit with the regulated supply. It sounded more powerful because, in fact, it was more powerful when operated with music into a high fidelity speaker system.

To understand this, it is necessary to make a detailed examination of how the power supply of an amplifier effects the available output voltage swing.

The absolute value of the power supply voltage is what determines the maximum output voltage swing. If the power supply voltage is, for example, 63 volts, then the amplifier can deliver at its output terminals up to 63 volts peak to peak. Once current begins to flow, as the amplifier is delivering power to the load, internal losses cause this voltage to plummet downward. In the case of a 60 watt/channel amplifier whose power supply is unregulated, the supply *must be able to maintain* 63 volts under full load with both channels operating into 8 ohm load resistors. Since the supply is unregulated, and yet it must somehow supply 63 volts, it must necessarily be designed to deliver a substantially higher voltage during no-load or higher impedance load conditions in order to "make up difference" due to internal losses. In the case of a typical transistor amplifier, voltage losses in the power supply are approximately 30%. Hence the power supply voltage must be an unloaded 95 volts.

A regulated power supply can be thought of as "loss free" because its output voltage remains constant and does not vary from a no-load condition to a full load condition. In the case of the 60 watt/channel amplifier, it is regulated to 63 volts—never higher, never lower.

Never higher, never lower. Therein lies the reason that the amplifier with the unregulated supply sounds more powerful. Speaker systems are not of constant impedance; they vary over a wide range, from below 8 ohms and climbing to a high of 30 ohms or more. At resonance, the speaker impedance is at a maximum and if substantial power is to be delivered, the amplifier must have substantial output voltage capabilities. The expression for power is $P = V^2/R$. From this it is readily seen that if the impedance R increases, the voltage must increase or the power delivered will decrease. If the power supply is regulated, it cannot increase, and the available power under dynamic conditions is severely curtailed.

Oscilloscope photographs in Figs. 1 through 6 graphically illustrate these effects. Referring to Fig. 1, the 60 watt/channel amplifier with the regulated supply is being driven to the clipping point (point of overload) with a con-

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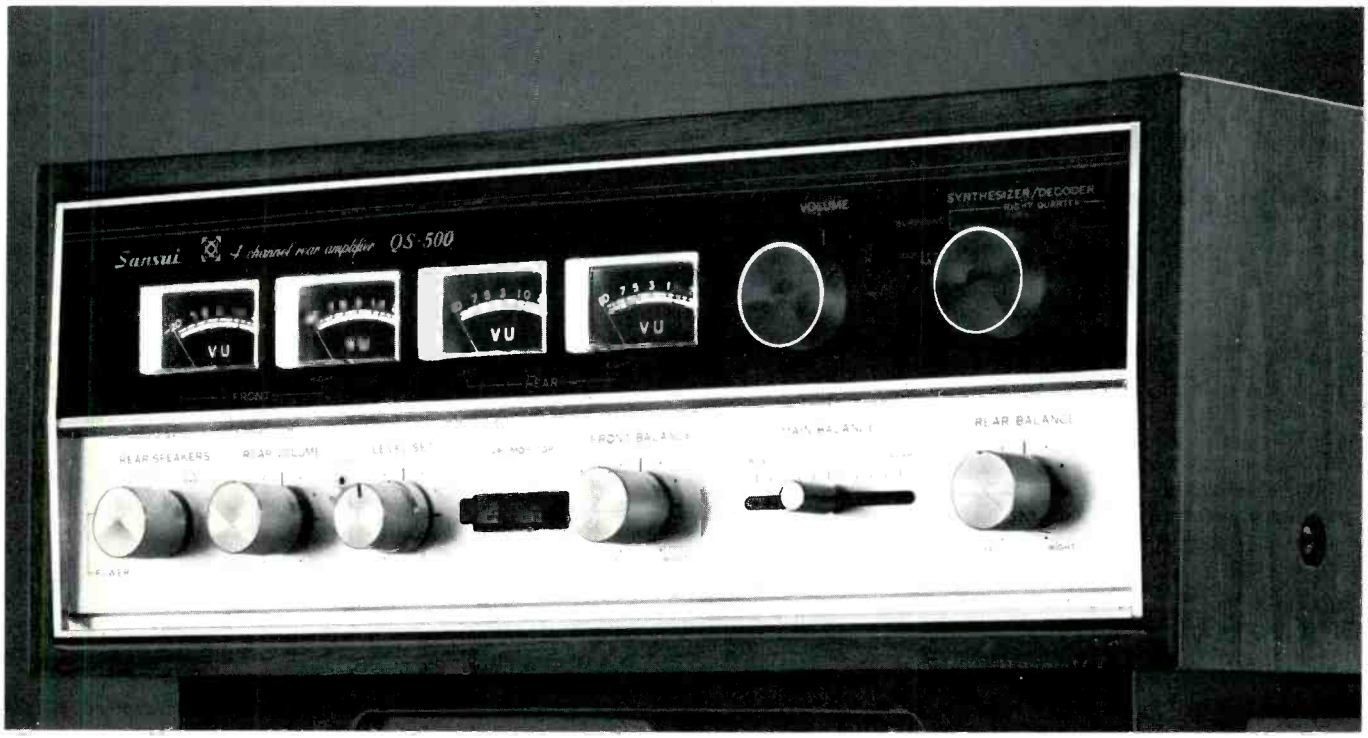

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An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $209.95.

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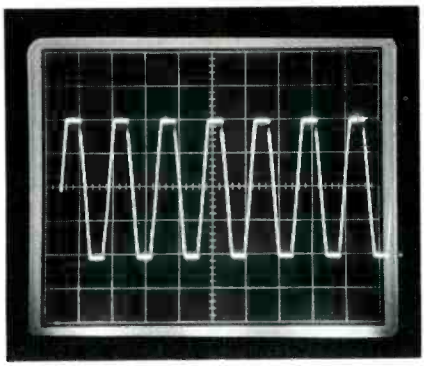

Fig. 2—Amplifier #2, a 60 W/chan. unit with dual power supply. The clipping point is the same as Fig. 1, 60 watts, both channels operating.

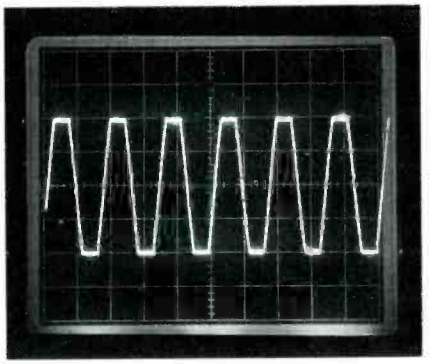

Fig. 3—Amplifiers #3, a 60 W/chan. unit with a single power supply. The clipping point is also 60 watts, both channels operating.

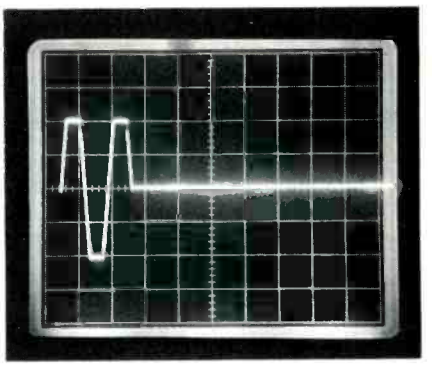

Fig. 4—Amplifier #1 with low frequency tone burst simulating drum beat. Clipping occurs at 60 watts. The load is an 8 ohm acoustic suspension loudspeaker.

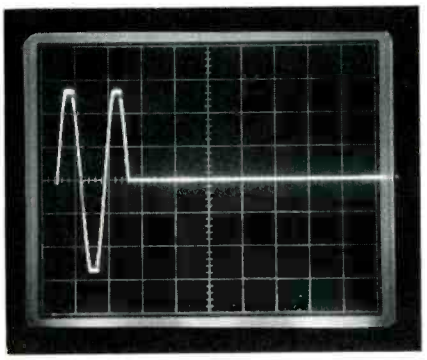

Fig. 5—Amplifier #2, with the same tone burst and speaker load, delivers about 20% more voltage than amp #1 under dynamic music conditions. Clipping is just under 90 watts.

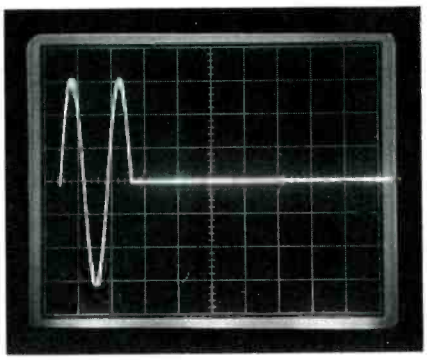

Fig. 6—Amplifier #3, with the same tone burst and speaker load, delivers about 30% more voltage than amp #1 under dynamic music conditions. Clipping is over 100 watts.

tinuous sine wave signal. Both channels are operating. Only one channel is shown in the photo. In Fig. 2, the unit with two power transformers in its power supply is being similarly driven to the clip point. Fig. 3 shows the amplifier with the unregulated power supply similarly driven. Notice that the clip point is the same for all three units, 63 volts peak to peak. In Figs. 4, 5 and 6, a low frequency tone burst is used to simulate a drum beat. The load is an eight ohm acoustic suspension loudspeaker. The unit with the regulated supply (Fig. 4) clips at its previous voltage level, 63 volts. However, the units with the unregulated supplies Figs. 5 and 6 are able to deliver a higher voltage prior to clipping. The unit with the single unregulated power supply is clipping at a voltage level approximately 30% higher than its sine wave continuous clipping level. Thirty percent is almost a ⅓ increase, and since power is proportional to the square of the voltage, the power increase is approximately 1.3 x 1.3 = 1.69. Almost seven-tenths more effective power is available from this amplifier.

From another point of view, for any given average power level, the second amplifier will be clipping significantly less during musical peaks, and is thereby generating significantly less distortion. This is why the second amplifier sounded "sweeter and airier."

We repeated these experiments with our vacuum tube amplifier and compared results. It turned out that the tube unit behaved in a manner similar to the amplifier with the unregulated supply, with an interesting exception. When the tube amplifier was very lightly loaded, with a load of around 30 ohms or higher, its voltage swing could go extremely high, producing almost 50% more than the fully loaded condition. This high impedance load is the load condition that an electrostatic midrange or tweeter unit imposes on an amplifier. The power demands are rather moderate because the load impedance under dynamic conditions is relatively high, and therefore the voltage requirements of the electrostatic screens are high. Present day electrostatic mid- and high-range screens require their power at high voltage levels, precisely where a vacuum tube amplifier excels.

These findings are summarized in graph form in Fig. 7. Notice that the "best sounding" amplifier (7C) has available additional operating area that is "forbidden" by the amplifier with the regulated power supply (7A). Figure 7B shows the operating area of an amplifier with two power transformers, and Fig. 7D depicts a 60 watt amplifier idealized to represent a "Perfect" 60 watt/channel amplifier. Notice that the available operating area is almost double that of the unit with the regulated supply. The "perfect" 60 watt/channel amplifer would have, as a design goal, a very high voltage power supply. It would sound very clean and very powerful. The high voltage design approach produces the very best possible "sounding" amplifier, but, as is often the case, there is a tradeoff against other desirable characteristics.

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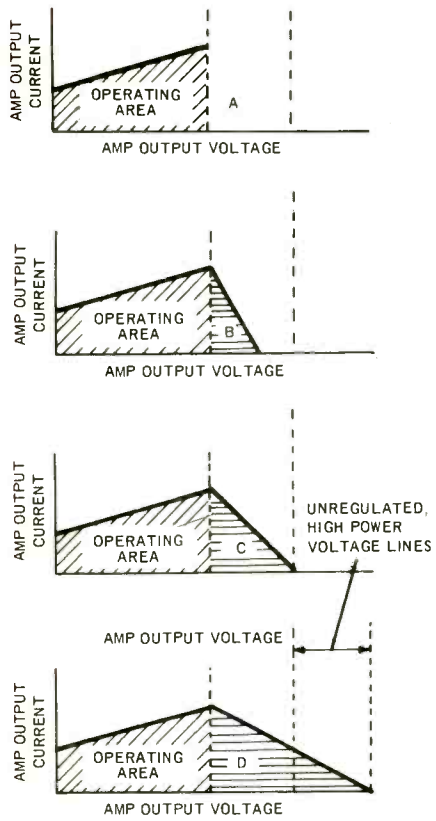

Fig. 7—Why four different amplifiers, each rated at 60 watts/channel sound subjectively different. **A**, this area is forbidden because of the tight power supply regulation. **B**, This area is available to an amplifier with dual power supplies. **C**, This area is available an amp with an unregulated power supply. **D**, This area is available to an amplifier with an "idealized" design.

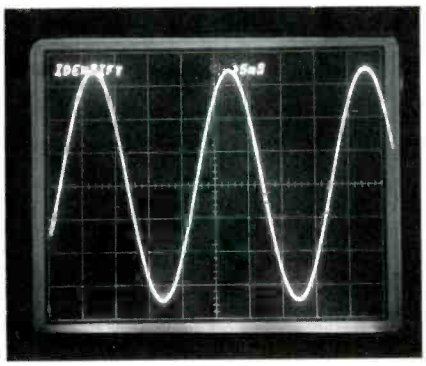

Fig. 8—Output of a high power amplifier operating at 40 Hz into an 8 ohm resistive load. Power level is 150 watts.

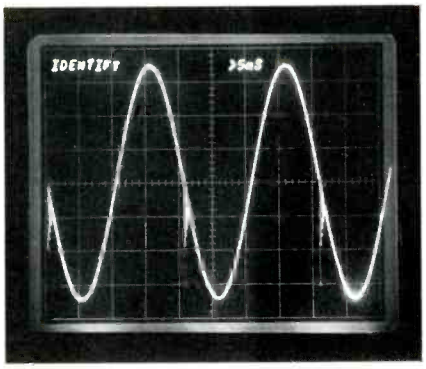

Fig. 9—The same amplifier as Fig. 8 operating at 40 Hz into an 8 ohm loudspeaker load. The tearing at the center of the waveform is due to false triggering of the protective circuits. The power level is again 150 watts.

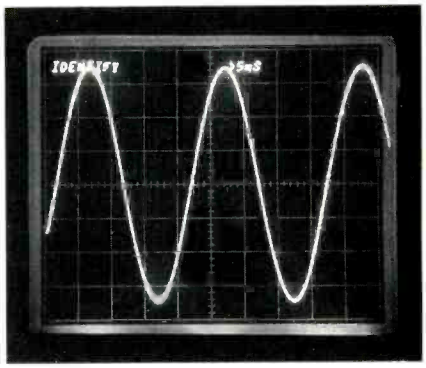

Fig. 10—The same amplifier as in Figs. 8 and 9 with the same loudspeaker as Fig. 9, but with the amplifier's protection circuits removed. Note the perfect waveform.

The liability assumed with the high voltage amplifier is that the normal operating temperature of the amplifier must be higher than with the conventional design. If the designer is willing to accept this drawback and is willing to design into his unit an extra margin of thermal stability, an amplifier using this approach would be without peer.

A detailed examination of high powered amplifiers in the 100 to 150 watt/channel range reveals shortcomings and problems unique to these units.

A severe design problem that must be undertaken when building a high power amplifier is to design an adequate protection device for the unit. All high power amplifiers must incorporate some form of protection circuit to prevent their destruction in the event of an accidental overload. The protection circuit must limit the output of an amplifier if it is operated into an improper load, but it must not *in any way* limit the output of the amplifier when operated into a proper, normal, or loudspeaker load. These two conditions represent conflicting requirements imposed on a protection circuit, and it shall be shown that in many instances these conflicting requirements have resulted in protection circuits that do not completely protect the amplifier, or worse, often limit the output in some manner that results in an audible degradation of the musical signal. In the most severe cases, outright amplifier misbehavior results.

Fig. 8 is a 40 Hz output signal delivered into an 8 ohm resistive load. The power level is 150 watts. Note that the signal is perfect. Fig. 9 is the same amplifier operated into a complex load whose impedance is also 8 ohms. The load is an 8 ohm acoustic suspension loudspeaker. Notice the large spikes that are occuring on the downward slope of the sine wave. These spikes are caused by false trigger action of the protective circuitry built into the amplifier and cause the "snapping" sound mentioned previously. The spikes are called "flyback" pulses and are generated as follows. As the sine wave reaches its peak value and begins to decrease, the energy that has been stored in the magnetic field associated with the inductive component of the loudspeaker impedance is forced to flow back into the amplifier. The protective circuit senses this reverse energy flow as an overload and commands the amplifier output stage to shut down. This happens instantly, and when the output stage turns off, the energy is prevented from flowing back into the amplifier. The result is a large voltage spike due to the collapsing magnetic field in the loudspeaker. An easily understood anology is an automobile spark coil and a set of points. When the points interrupt the flow of current, the collapsing magnetic field inside the coil generates a high energy spark. In an analogous manner, the voltage at the loudspeaker terminals rises until clamping diodes (built into all large amplifier output stages) conduct and prevent any further increase. The audible effect is the "snapping" misbehavior and occurs during heavy low frequency demands. Fig. 10 is the same amplifier

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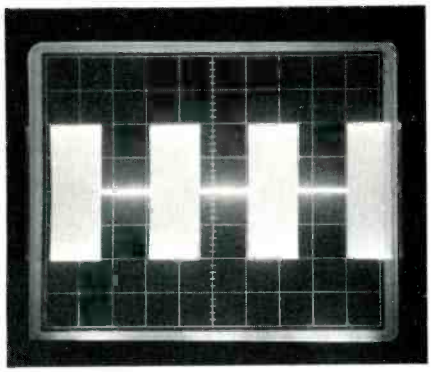

Fig. 11—A 15 KHz tone burst output of a high power amplifier into an 8 ohm inductive (loudspeaker) load. Note the perfect response.

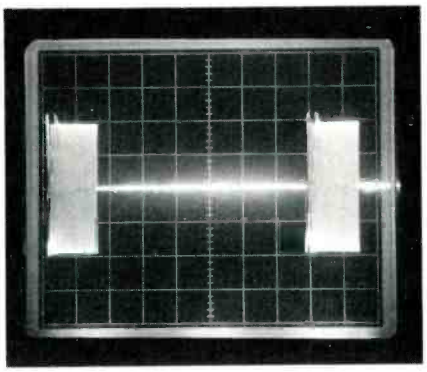

Fig. 12—The same 15 KHz tone burst with the repetition rate set for 500 Hz. Note the limiting and distortion on the leading edge of each burst. This is caused by the protection circuits confusion of the simultaneous low repetition rate and high burst frequency with an overload.

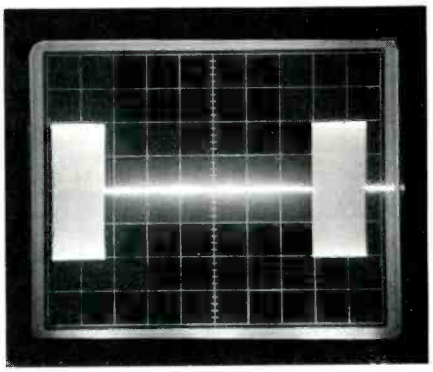

Fig. 13—Same conditions as in Fig. 12, except that the protection circuits have been disconnected.

but with the protection circuits disconnected and operated into the loudspeaker load. Observe that the sine wave is again perfect.

Figures 11, 12 and 13 show the output of an amplifier rated at over 100 watts operated into a loudspeaker system. In Fig. 11, the signal consists of a 15 kHz tone burst whose ON and OFF times are equal. Observe that the amplifier output response is perfect.

Fig. 12 consists of the same 15 kHz tone burst but with the following characteristics. The OFF time is very long compared to the ON time. The repetition rate of the tone burst is very low. In this instance, 500 Hz. This particular tone burst simulates the simultaneous output of a low frequency musical note (the repetition rate) and a high frequency musical note (the internal tone burst frequency). This would, in a musical sense, correspond to the simultaneous reproduction of a low frequency woodwind note and, say, a harp. Notice that the first few cycles of the tone burst are limited and distorted. This is because the protection circuits in the amplifier confuse the simultaneous low and high frequencies with an overload, falsely trigger, and limit the amplifier output. It is only under certain combinations of simultaneous low and high frequency demands that the protection circuits are falsely triggered into operation. Fig. 13 shows the same output as Fig. 12, but with the protection circuits removed. Again, note that the response is perfect.

The audible effect of this particular amplifier misbehavior is much more subtle than the previous example. The effects range from a slight "edginess" and "stridency" to outright breakup associated with the highs. As Mr. C.G. McProud put it, "It's when an opera singer hits her high C at the end of an aria."

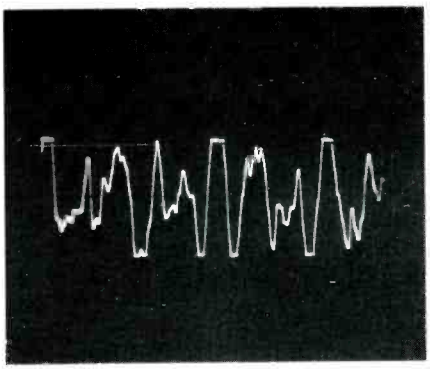

Fig. 14—Instantaneous single sweep photo of an opening piano allegro. Note the flattening that is occurring near the peaks as the amplifier overloads. The average power is about 38 watts. The amplifier is a 120 W/chan. unit.

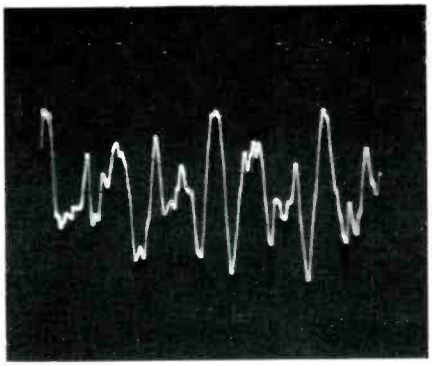

Fig. 15—Same type of photo as in Fig. 14, but the amplifier is a 350 W/chan. unit. Note that the peaks are not clipped.

A general review of all of these photographs graphically indicates the need for improvement in current power amplifier performance. These shortcomings served to solidify the goals and objectives an amplifier design should reach.

A perfect amplifier should be powerful enough never to overload, even during low frequency passages and on musical peaks. The protection circuits should never falsely trip and generate high distortion or amplifier misbehavior, yet they should safeguard the amplifier in the event of an accidental short circuit or from any other form of abuse. An amplifier must have a mechanism to protect the loudspeaker from accidently dropped tonearms or amplifier failures, and all of these qualities must be built in.

How powerful? This question has been asked and answered more often and in more ways than is easily imagined. Simply stated, an amplifier should be powerful enough to prevent overload and clipping when operated at a satisfying listening level. Instant overload recovery is not enough.

The best speaker systems today obtain their smooth, wide range low distortion performance by significantly sacrificing efficiency. That's simple physics. The best are incredibly good, but they require large peak power and output voltage capability of an amplifier. Figure 14 shows a 120 watt amplifier reproducing the opening allegro

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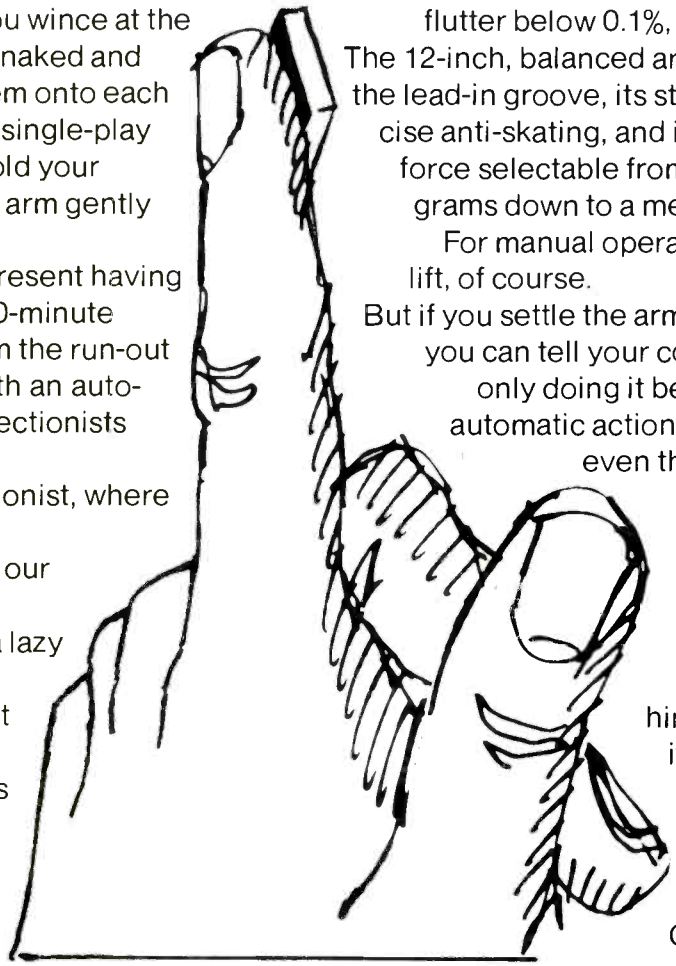

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piano note from Part III, of Beethoven's *Emperor* concerto performed by Rudolf Serkin. The volume level has been adjusted so the piano volume level approximates a live piano. The speaker system is a modern unit which employs active equalization. Observe that piano note peaks are being clipped. This leads to harshness and may cause listening fatigue. Figure 15 is the same passage but with a 350 watt amplifier. Note that clipping does not occur. The sound is smooth, sweet, and open. The subjective volume level is identical in both cases. The average power level in both cases is approximately 38 watts.

If the goal is to eliminate the severe amplifier distortion that occurs on musical peaks and during low frequency passages, and if the best wide range speakers available today are utilized, a minimum of 200 watts/channel is required. A maximum of over 500 watts/channel is required when using some of the very latest, highly inefficient speakers. The important point to remember when dealing with these high power levels is that the peak to average power ratio of musical material is approximately 10 : 1. This means that when a 200 watt/channel amplifier is operating full tilt into a set of loudspeakers, the long time average power delivered to the loudspeaker is only 20 watts. In addition, these loudspeakers are designed to safely sustain extremely high impulsive power levels. For example, the new Acoustic Research LST loudspeaker system can safely sustain 1000 watts for brief time periods. It is this capability that will allow a high level drum beat, a low frequency pedal note, or an opera singer hitting her high C at the end of an aria to be safely accommodated by the loudspeaker system.

The first step in designing a 700 watt amplifier was to evaluate existing design approaches to high power. Primarily, the problem is one of obtaining the required high output voltage. Three hundred fifty watts @ eight ohms, two channels, requires an unregulated power supply capability of over 200 volts. Until very recently, the very best existing transistors had sustaining voltages of only 120 volts, and, at that, a designer was pushing the state of the art to build an amplifier with a 120 volt supply (150 watts). The standard solution to higher voltages is to use low voltage transistors and use a step-up transformer or auto-transformer at the output of the amplifier. The disadvantages of this approach are many. Excessive phase shifts through the transformer generate stability problems, increase distortion, reduce the bandwidth, and transformers are excessively heavy and expensive. We computed that an amplifier using step-up transformers or auto-transformers would weigh over 130 pounds!

A second design approach consists of connecting two or several low power amplifiers together in series to obtain the required high output voltage. Amplifiers connected in this fashion are said to be "in bridge" and their separate output voltages add together or double. Since power increases as the square of the output voltage, doubling the voltage would quadruple the power. For example, two 150 watt units in bridge would yield four times 150 or 600 watts.

This design approach is a fairly workable one, but it too suffers severe and fundamental drawbacks. The input and the output grounds are not common. Rather, they are "floating" above chassis ground and any attempt to use such an amplifier in a multiple unit installation would raise havoc with the grounding system. Another drawback is that a stereo amplifier would require four separate amplifiers connected internally to obtain two channels; this plus the required double power supply would even further add to the complexity, weight, and cost.

Solving the primary problem of transistor voltage breakdown required close work with a major transistor manufacturer. The basic power transistor used in the 700 watt amplifier design is a 600 volt television horizontal sweep transistor. This basic power transistor was modified extensively in order to obtain the best suitability for high power amplifier application. Energy breakdown levels, current gain, pulse safe operating area, and other transistor parameters were carefully adjusted in order to optimize their use.

Another of the many problems associated with transistor amplifier design is the problem of crossover or "notch" distortion. Historically, this was a severe drawback in early transistor amplifiers. It was successfully solved by allowing the output transistors to operate in a mode which was somewhat less efficient than ideal and represented one of many engineering compromises. In order to eliminate crossover distortion, it was necessary to allow a small amount of idling current to flow at all times. This idling current would generate a small amount of heat but was perfectly acceptable for small, low voltage amplifiers that had at most two pair of output transistors. For a large 700 watt amplifier, the amount of heat that would be generated by idling current flowing in 24 output transistors would be excessive. It was necessary to incorporate a novel biasing circuit that would allow the output stages to operate without idling current (pure class B) and to simultaneously completely eliminate crossover distortion. This biasing circuit is used in integrated circuit "op-amps" but had previously never applied to power amplifiers. The success of this approach depends on the careful attention to specific power transistor parameters in the low current region. Crossover distortion appears as high intermodulation distortion at low levels. The best transistor amplifiers have attained IM figures of well below 0.05%. Production 700's attain IM figures at 750 milliwatts of between 0.01% and 0.02%.

Speaker protection is accomplished by a "crow bar" circuit in which heavy fault-current (for example, caused by accidently dropping a tone arm, or an output transistor failure) is forced to flow through a pair of fuses rather than through the loudspeaker. Since the "crow bar" forces heavy fault-current to flow through the fuses and not through the loudspeaker, they open immediately and prevent any possibility of damage.

The problem of amplifier misbehavior caused by false triggering of the protective circuits was solved by incorporating a totally new protection circuit design which monitors, from microsecond to microsecond, the *energy** that is being absorbed by the output transistors during normal operation. All previous protection circuits have monitored the *current*, or in the case of large amplifiers, the *power*. The energy limiting approach results in an amplifier that can provide approximately three times as much power as an amplifier equipped with current limiting or power limiting circuits.

Whenever a loudspeaker engineer makes an attempt to extend or smooth the frequency response of his design, or to lower the distortion, the laws of physics demand that the loudspeaker become ever less efficient.

These two facts of life, the conflicting requirements of sonic perfection versus loudspeaker efficiency has always set an upper practical limit on loudspeaker performance. The recent availability of truly high power amplifiers has allowed speaker designers a new freedom, and without question, the best speaker systems of tomorrow will be capable of truly awesome performance. Æ

*Energy is the time integral of power. Expressed mathematically, Energy, $E = \int VI\,dt$, where V = Voltage, I = current, and with the limits of integration chosen to be over one half cycle of the waveform.

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Intermodulation Distortion:

A Powerful Tool for Evaluating Modern Audio Amplifiers

Gerald Stanley & David McLaughlin

THIS ARTICLE has been written to suggest a more helpful way of reporting amplifier distortion specifications to the prospective buyer. The comparative merits of two types of distortion testing will be presented, leading to the conclusion that one test shows some clear advantage over the other.

The widespread appeal of high fidelity has been strengthened by the broad range of equipment currently available. The increasing variety is an undisguised blessing since it allows every enthusiast the freedom to satisfy personal tastes in building his own system. Unfortunately though, the process of purchasing a system becomes more complicated with this diversity. The expense involved and the individual nature of a high fidelity system usually results in a great deal of evaluating and comparison by the careful customer, who naturally wants good performance for good money. Any performance information that can make the evaluation easier will be very beneficial.

Obviously, the effective communication of technical performance data is not an easy thing. First of all the information has to be presented in terms that the buyer can easily handle. After all, why should it be necessary for someone to have an intimate knowledge of audio electronics in order to make an intelligent purchase? It is also important that standard terms be used by all manufacturers in order to facilitate comparisons between different brands of equipment. Finally, since knowledge and equipment fall short of perfection, a constant updating of test procedures becomes essential. Unfortunately for the customer, the information he needs does not come from all manufacturers in a standard form, and traditional rating methods give way very slowly to more effective practices. This is not to say that current performance specifications are not helpful in making buying decisions, but to point out that they could be more helpful.

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One of the most often quoted and inadequately defined technical specifications in the audio field involves the distortion produced in audio amplifiers. The term "distortion" covers a multitude of audio evils. Basically it describes a change in the original signal introduced by the electronic and mechanical equipment employed in reproducing the signal. An example is drawn in Fig. 1. The goal of any audio reproduction system is to approach to a greater or lesser degree (for a greater or lesser number of dollars) a perfect duplication of an original production of a piece of music. The sound of the original performance, whether it comes from Van Cliburn or Flatt and Scruggs, becomes the standard. Any changes in the original sound can be described as some form of distortion.[1] In the process of translating an original performance onto a disc or tape, a certain amount of distortion is introduced. When the record or tape is played, the high fidelity reproducing system introduces other subtle changes and the resulting sound moves a little further from the original. As you would expect, the degree of change or distortion depends on the overall quality of all equipment that has been used in the process. Interestingly enough, the distortion may not even sound unpleasant, but as long as it represents a difference from the original, it is distortion by definition. To minimize overall distortion, then, it is generally important to have each piece of equipment in a system[2] produce a minimum amount of distortion. This seems rather obvious, but because of the difficulty of comparing distortion specifications which are stated differently, it is not always easy to determine which equipment will produce the least objectionable distortion.

Fig. 1—Example of distortion

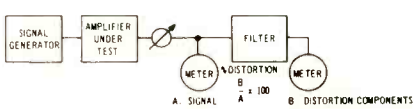

Fig. 2—Harmonic distortion test setup.

Two basic methods have come into use for measuring distortion in audio amplifiers. Unfortunately the results of one method do not necessarily indicate the results of the other. To compound the problem, the methods are used with varying degrees of thoroughness, which give varying amounts of useful information about the performance involved. Simply stated, the truth is that the buyer is not being helped as much as he could be.

To begin with, the problems involved in evaluating amplifiers are rather significant. For instance, distortion tests are not performed while the amplifier is actually handling music. (See "Amplifier Q's and A's—Mainly for Beginners" in this issue.) Of course, the equipment will actually be used to play music, but the situation is too complex to permit a practical distortion test to be performed. Therefore, the actual testing requires some simplification. The test conditions must also be standardized, so they can be duplicated accurately by anyone wishing to check the results. Supply voltages, signal level test equipment capabilities, loads and so forth must be specified wherever they have a significant effect on the outcome of the test. When these variables are defined, more meaningful comparisons can be made between different brands of equipment. The test should also illuminate thoroughly the particular qualities (good and bad) of the equip-

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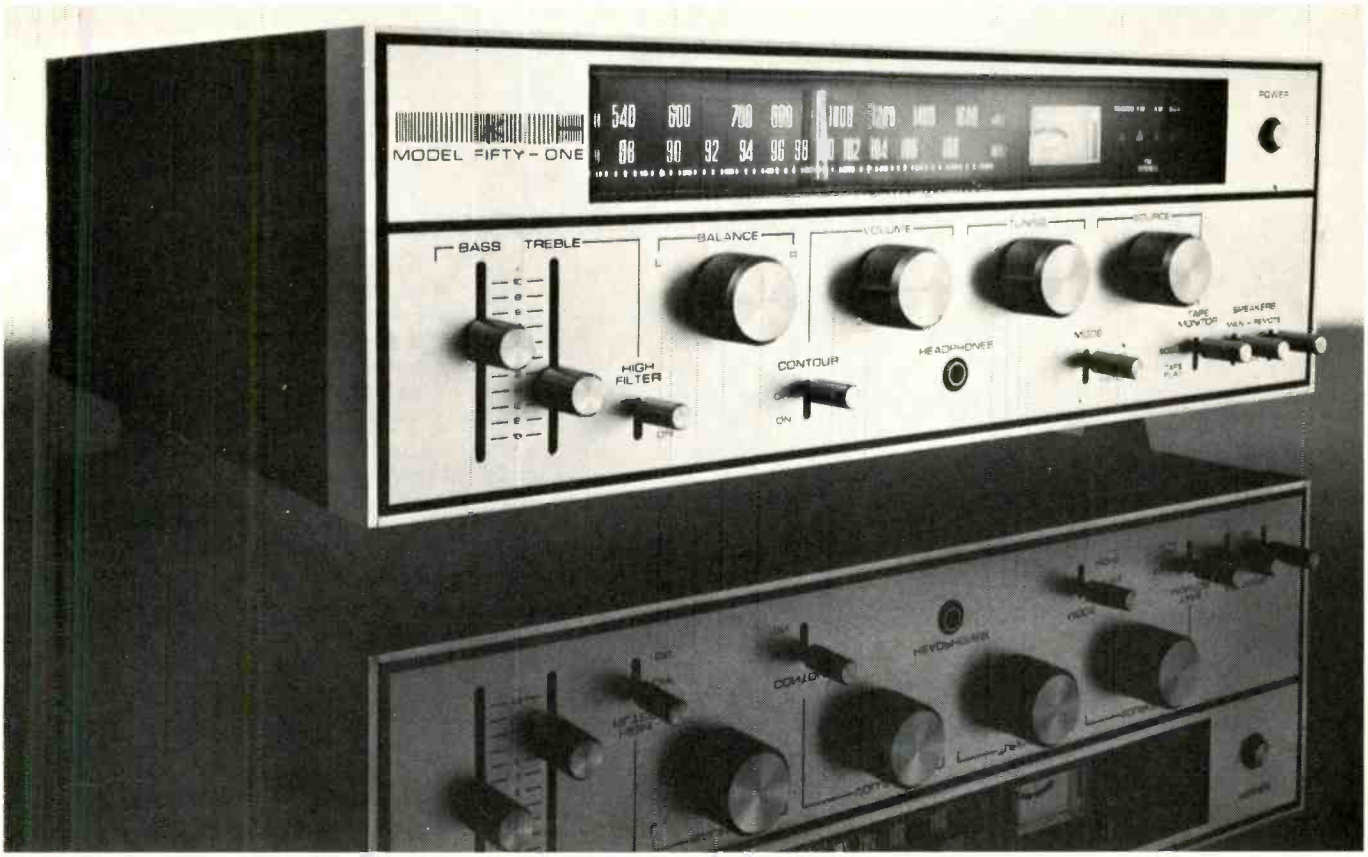

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ment being tested. For instance, a test could be made which would show excellent performance at a particular operating point of an amplifier while completely ignoring the performance at other equally important operating levels. To summarize, a test should be a simplified and repeatable version of actual operating conditions, which adequately covers the range of performance expected. Both of the methods commonly used to evaluate audio amplifier distortion are simplified, repeatable versions of actual operating conditions, which can be used to check the whole range of expected performance. One, however, offers particular advantages in the evaluation of modern audio amplifiers.

First, let us consider the traditional method—harmonic distortion testing. This involves evaluating an amplifier's performance as it handles a one-frequency signal. The complex musical signal is thus approximated by a single frequency. The test signal must be as free of distortion as possible, so that its inherent distortion is not confused with the distortion introduced by the amplifier. Essentially, the test signal is passed through the amplifier and the resulting output signal is checked for changes from the input. The general arrangement of equipment is shown in Fig. 2. The output signal is measured, after which the original test frequency is filtered out. The remaining output signal measured, on the assumption that what is left over consists of unwanted distortion components added by the amplifier. As typically produced (ignoring effects of hum and noise), this distortion is called harmonic distortion because the unwanted additions to the single tone can be separated into the harmonics of that tone. By way of illustration, if 440Hz is used for the test signal, the second harmonic will be 880Hz, the third harmonic will be 1320Hz, and so on. In this case, harmonic distortion measurements should indicate the prominence of these distortion frequencies: 880Hz, 1320Hz, etc. Figure 3 gives an example of the appearance of harmonic distortion on an oscilloscope display. Figure 4a shows where the harmonics appear on a frequency spectrum. Some idea of the relative sounds involved can be gained by sitting down at a piano and sounding middle A (440Hz). The first harmonic (880Hz) would be A one octave higher. The next octave would produce the third harmonic (1320Hz) and so forth. Since these are all in harmony, playing them together will obviously not produce an unpleasant sound, but the sound will definitely be different from the sound of middle A alone. In the actual test, a wave analyzer may be used to look at each of the harmonics individually, to see how much each contributes to the total distortion. In some equipment, the second harmonic may be the largest component, while in other equipment the third or some higher harmonic may contribute the most. Usually a total harmonic distortion (THD) figure is stated, which ideally expresses the rms sum of all the harmonic distortion components together as a percentage of the rms fundamental signal.[3] For the sake of thoroughness, the tests should be repeated at different frequencies and at different power levels, although this takes much more time and effort.

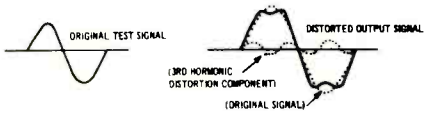

Fig. 3—Example of harmonic distortion.

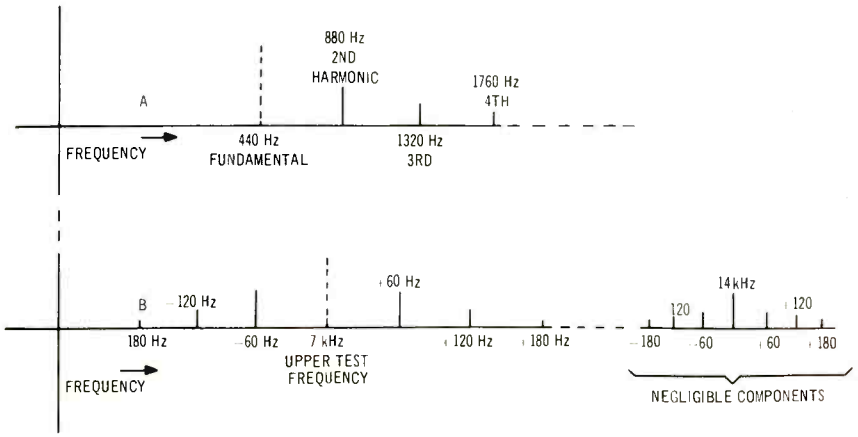

Fig. 4—A, Harmonic distortion components, **B**, intermodulation distortion components.

Fig. 5—Example of IM distortion

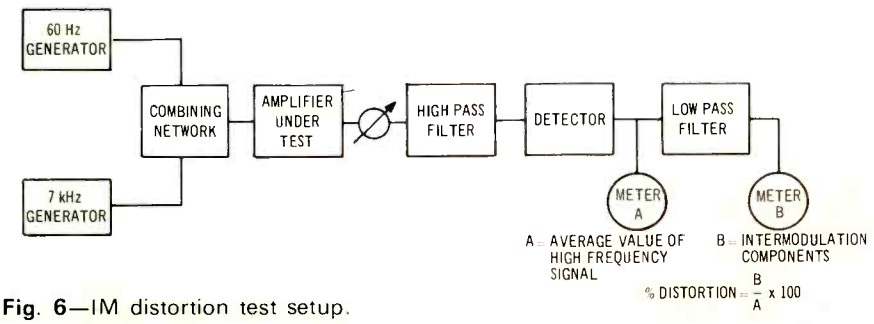

Fig. 6—IM distortion test setup.

The second and acoustically more relevent method of distortion testing measures intermodulation (IM) distortion. This type of test evaluates amplifier performance as it handles a two-frequency signal. The complexity of a musical signal is again simplified, this time being approximated by the interactions of two frequencies. As defined by the Society of Motion Picture and Television Engineers (SMPTE), the IM distortion test signal is made up of two frequencies in a 4:1 amplitude ratio of low frequency to high frequency. Typically the two frequencies are 60Hz and 7KHZ (Fig. 5). The general test arrangement is shown in Fig. 6. The output from the amplifier passes through a filter which removes the low frequency (60Hz) test signal. The remaining output, consisting of the high frequency test signal (7KHZ) plus the distortion modulation components, is AM detected[4], after which everything but the distortion products is removed by a second filter. The distortion modulation components are measured and expressed as a percentage of the total AM detected signal. The primary distortion measured comes from the interaction of the two test frequencies. The 60Hz frequency will modulate the

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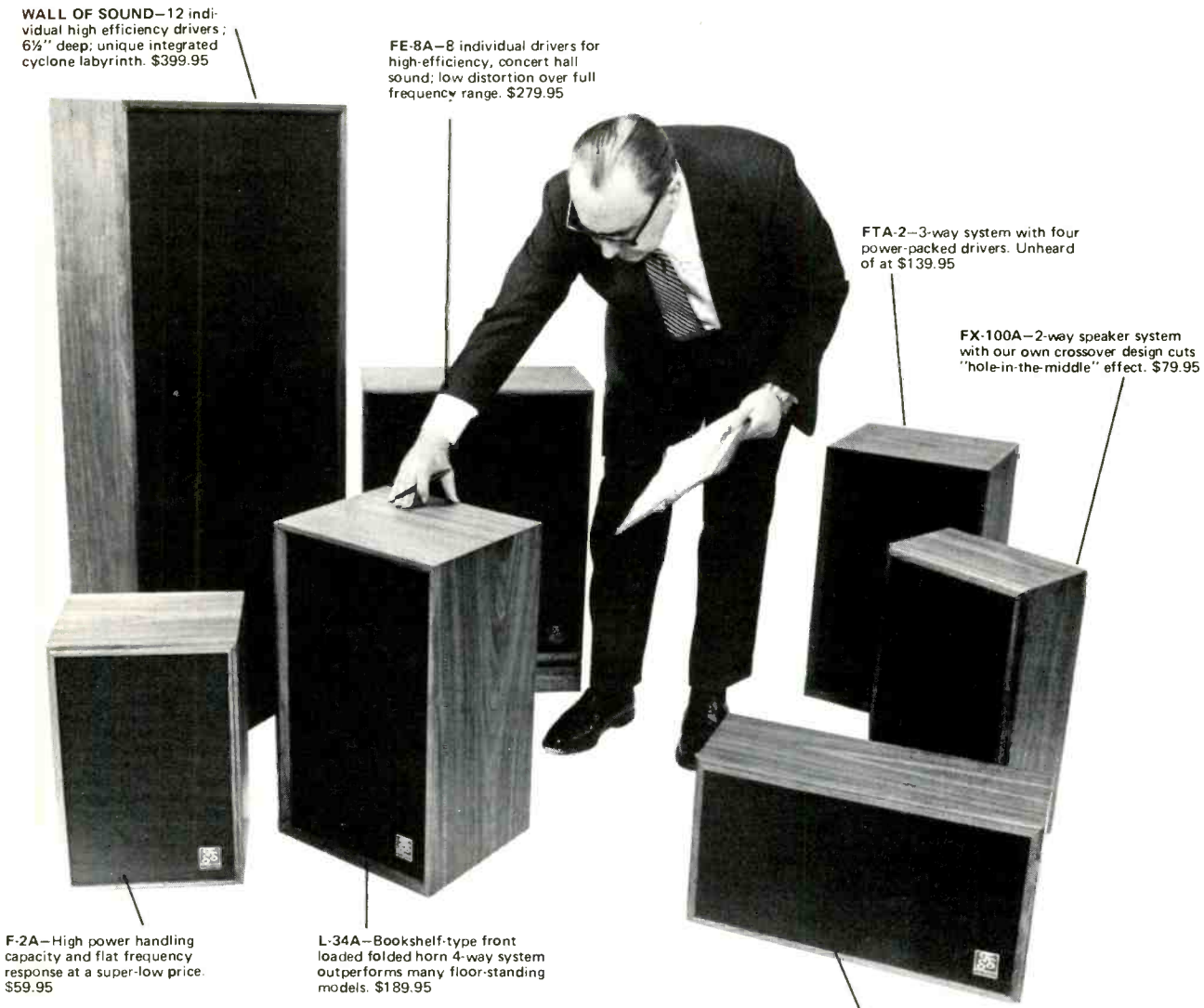

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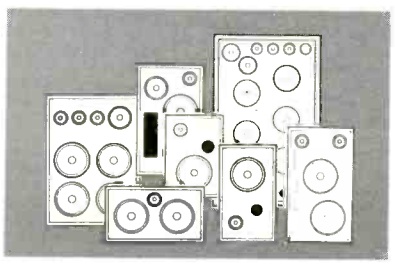

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7KHZ frequency and form sum-and-difference frequencies, such as the sum of the two (7060Hz) and the difference between the two (6940Hz). Other sum-and-difference frequencies will also appear involving the harmonics of both frequencies. Figure 4b shows what some of these will be on the frequency spectrum. For the purpose of practical measurement, only the distortion components around 7KHZ are significantly large and these are the ones measured as distortion. Figure 5 shows how IM distortion of the test signals might appear on an oscilloscope display. Again using the piano to illustrate, an idea of the kind of sound involved here can be gained by sounding middle A again, and then sounding middle A along with the white keys on either side of it (G and B). These two notes are between 50Hz and 60Hz different from A, and when played together with A, demonstrate the kind of dissonance resulting from intermodulation distortion.

Depending upon the particular conditions of the test, such as the characteristics of the equipment being tested, the frequencies used may be changed and the 4:1 amplitude ratio between frequencies may vary. Generally the 4:1 ratio of 60 Hz and 7KHZ is used because it provides a realistic example of the musical situations for which an audio amplifier is designed. IM tests should be run at a wide range of output power levels to reveal problems that may show up only at particular levels. As an example which will be discussed in more detail later on, IM testing shows excellent sensitivity to low power crossover notch distortion, which is a traditional sore spot of some solid state amplifier designs.

Now that we have briefly discussed both methods, you might naturally ask how they are related, but this is not a simple nor brief proposition. A great deal of discussion has been published[5] with impressive mathematical support to describe this elusive relationship, but the results do not apply to most equipment. Several common (and sometimes desirable) characteristics of electronic equipment can each or all remove any predictable relationship between IM and harmonic distortion. At a given peak power level, and within the normal operating range of high fidelity amplifiers, IM distortion typically runs from two to six times as high as harmonic distortion. In any individual case, however, it is necessary to run both tests if both harmonic and IM figures are needed. This lack of a simple means by which to compare IM and harmonic ratings suggests that the customer would prosper if one method were consistently used, in which case he could make meaningful comparisons. For a number of reasons, IM testing is the logical choice.

To begin, there are significant weaknesses in the harmonic testing procedure. First, the harmonics detected as distortion are not always offensive to the listener. The piano experiment suggested above should illustrate this, along with the fact that musical sounds are frequently made up of harmonic combinations. Second, the single-frequency test signal does not resemble typical program material and the results do not indicate the kind of complex interactions that occur between different frequencies. This can result in ignorance of serious deficiencies in the equipment. Third, the usual THD figure groups all harmonic components together, which can mask the fact that most of the potentially offensive distortion comes from high order (higher frequency) harmonics[6]. An amplifier generating mostly high order distortion products may then sound worse than another with the same THD rating which produces lower order distortion. Fourth, THD measurements group noise along with harmonic components and thus

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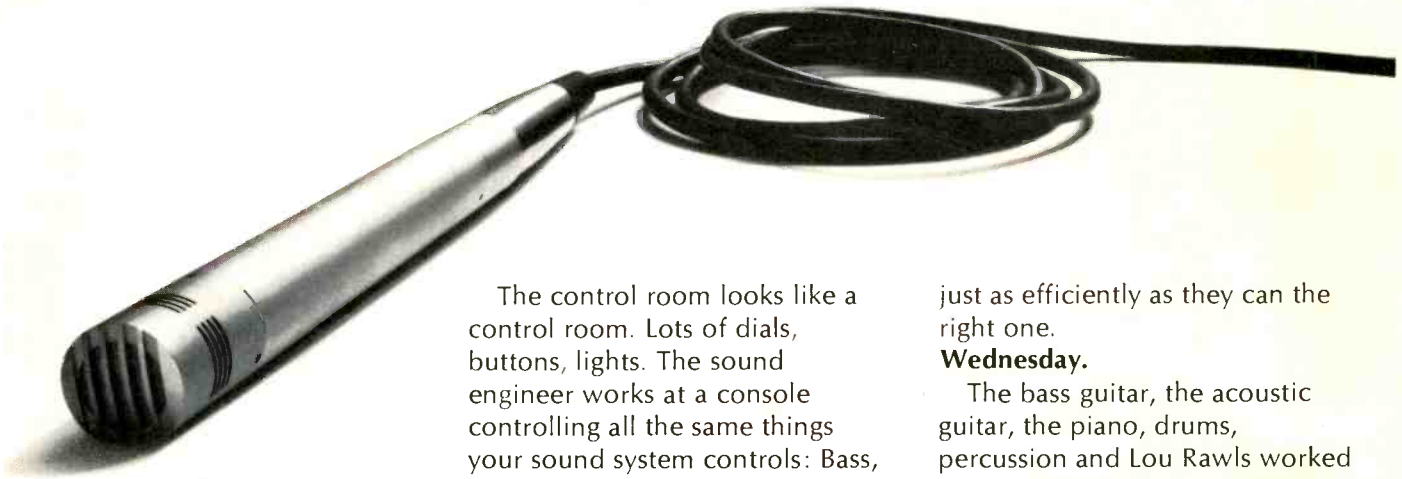
Wednesday for piano. Thursday for horns.



Close your eyes. Lou Rawls is singing. He says, "Believe in me." And you do.

An acoustic guitar, way off to the left somewhere, scratches the back of your ear. Trap drums hug the bass guitar in the center of the sound. Strings, woodwinds, percussion, trombones, fourteen different pieces of pure sound come together.

And you're there with them—hearing, sharing, capturing a moment that never happened.

They don't make records like they used to.

Until very, very recently the goal of any musical recording was to recreate an event that had happened somewhere. The "live" performance was perfection; the only purpose of recording was to record.

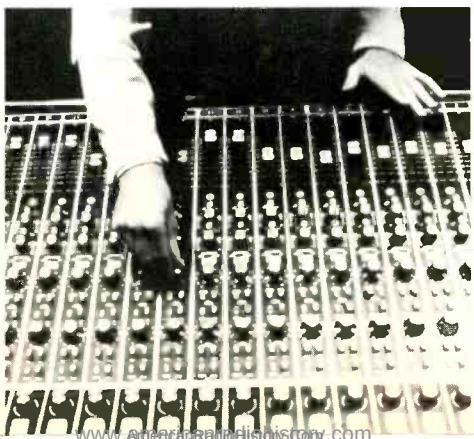
It's not that way any more. Not with the new music.

The last album you bought, the one with fifteen or twenty artists performing together, likely took a month to record, another month to mix. Many of the musicians performed as soloists, the rest in small groups. Only three people were there from the first day to the last: The arranger, the producer and the sound engineer.

The control room looks like a control room. Lots of dials, buttons, lights. The sound engineer works at a console controlling all the same things your sound system controls: Bass, treble, volume, balance, etcetera. The only difference between your system and this one is a little more sensitivity, capacity, precision and maybe two or three hundred thousand dollars.

The control room and the studio are acoustically isolated. Very important. The only way sound can come out of that studio is through a speaker in the control room. See those beauties all in a row? JBL speakers, thank you.

Out in the studio, there are yards and yards of cloth hung here and there between musicians, over instruments and next to microphones. The cloth dampens sound. It keeps each instrument's sound near the microphone assigned to it. That's important. Musical instrument microphones are very precise and very literal and can pick up the wrong sound just as efficiently as they can the right one.



Wednesday.

The bass guitar, the acoustic guitar, the piano, drums, percussion and Lou Rawls worked the same session.

The tambourines start in the big studio but are banished to the isolation booth because their sound is leaking into other microphones.

Look at the five microphones on the drums; three for the traps and two for the bass drums. Each is there to retrieve a particular tonal quality.

See the mike inside the piano, under the top, over the sound? If you really want to hear good piano, that's the place.

Thursday.

Horns, woodwinds, strings—each takes his turn until all have had their say.

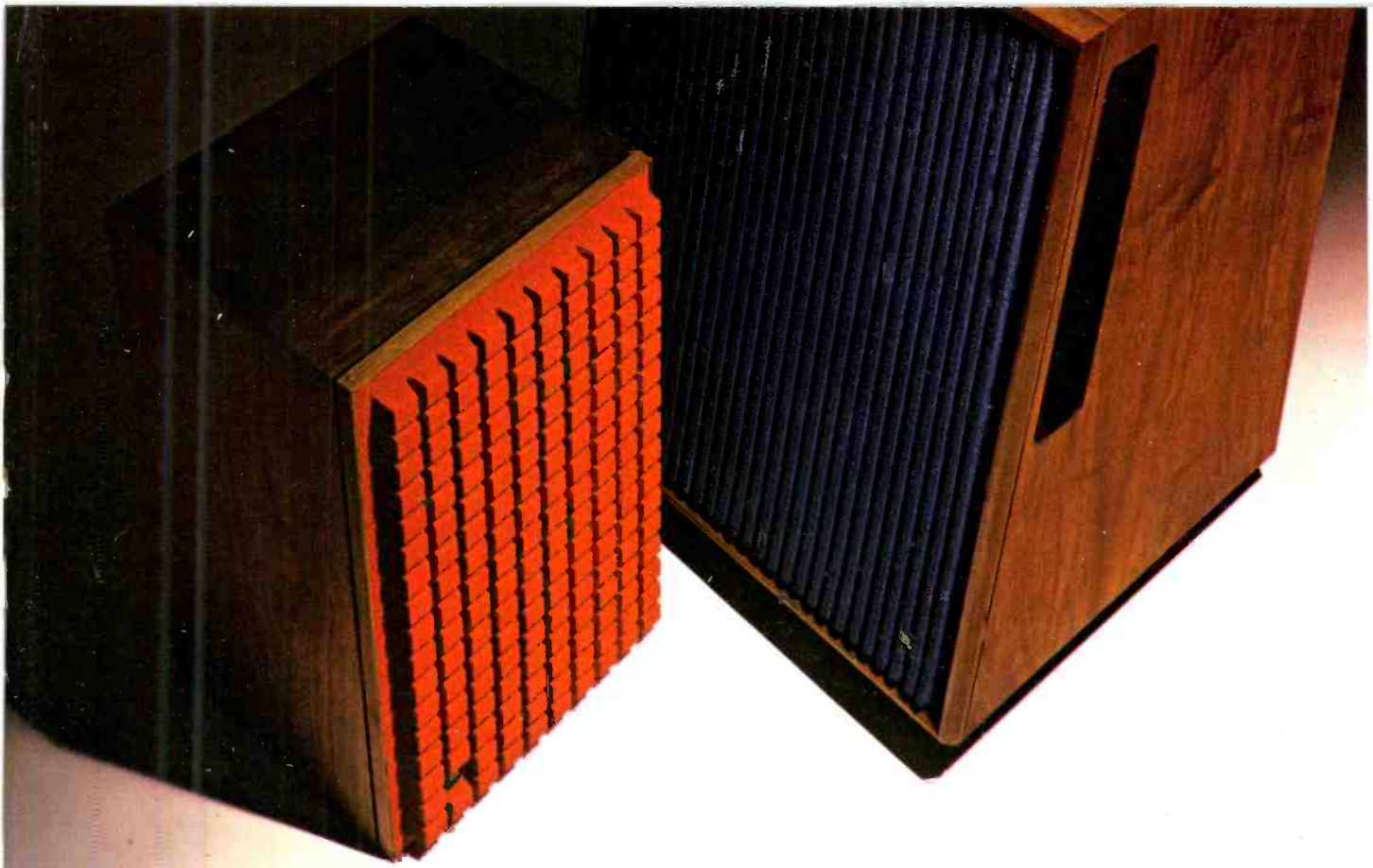
Finally, fourteen channels are filled, each with a component of the total sound, ready to be blended.

Monday.

The mix-down begins. Fourteen tracks heading toward two.

Each monitor speaker holds a separate sound. And now each is heard in turn, solo and then in unison.

The sound engineer steps to the podium and brings up the bass guitar for rhythm. It goes in the center of the stereo perspective. He tightens it slightly, adding equalization at 50 Hz.



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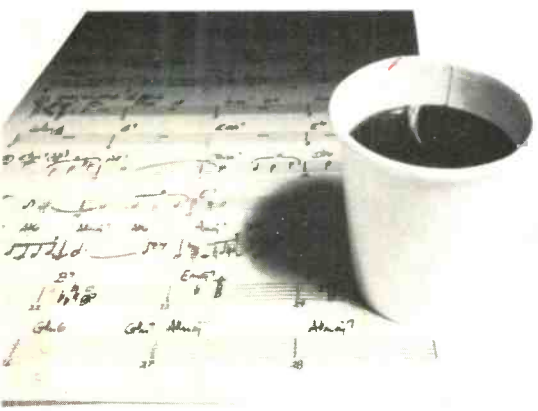
L200 STUDIO MASTER

Just like JBL's professional studio monitor only more so. High acoustic output, uniform spatial distribution, smooth frequency response and the extraordinary capability of handling a full 100 watts of continuous program material, yet produces 80db sound pressure level at 15 feet with only 1 watt input. Gracefu tapered form, oiled walnut enclosure and sculptured Crenelex grille in Smoke or Raven or Aegean or Burgundy. 33"x24"x21". $597.



Guitars over there. Woodwinds here. How do they do that? Besides the left-channel and right-channel placements, the sound engineer uses tiny delays in sound and drops in volume to place the sound "away" from you or "near" you. Your brain does the rest, putting each sound in stereo perspective.

Traps left and traps right. A little equalization to brighten them; some echo to give them depth.

Now the bass drum; then the acoustic guitar on the left with the piano on the right to balance it. **Wednesday, again.**

The tambourine comes into the center with a bit of echo to make it fuller. French horns left and right and the sweetening process: Bass trombones for resonance. An oboe solo for delicacy and a room full of strings — violins, cello, viola — to make the whole thing smooth and round.

And, finally, all monitor speakers are in agreement. One last button is pushed, and the master recording is made.

That's all there is to it.

The art of recording is changing. The business is changing. More creative scope, more ideas, more discipline. A whole new incredibly complex art form has emerged.

We're glad to be a part of it. In fact, most major recording studios in the world produce their records mastered on JBL monitors.

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Our thanks to Lou Rawls and MGM Records for allowing us to document the recording, mixing and mastering of the title song from the MGM movie, Believe in Me.

may produce a mischaracterization of a product. Fifth, harmonic distortion testing instruments may have residual distortion levels above the distortion levels of the amplifiers under test. It is difficult to inexpensively produce and analyze a test signal with distortion lower than state-of-the-art audio amplifiers. Sixth, the test procedure is unwieldy. In the usual process, some fine tuning is involved to completely remove the test signal before the harmonics are measured, a procedure which needs to be repeated at different frequencies, and then at different power levels for each frequency. This results in a sensitive operation being performed many times for a single piece of equipment. Many of the aforementioned weaknesses could be lessened by the use of a wave analyzer, but this would not help the problems of expense and time involved.

In contrast, IM testing offers clear advantages over harmonic testing. First, the sum-and-difference frequencies detected as distortion by IM testing are not harmonically related to the original signals and therefore constitute a much more audibly obnoxious type of distortion (as suggested by the piano experiment). Second, the use of a two-frequency test signal provides a simple but more realistic approximation of musical material, and the test results indicate the interactions between frequencies that can be expected in actual use. Third, the use of the 4:1 SMPTE amplitude ratio gives an inherent prominence to more audible high-order distortion products, which in turn brings about better agreement of IM test results with listening tests[7]. Fourth, SMPTE IM measurements concentrate on a relatively narrow band of frequencies around the upper test frequency, a situation which serves to keep hum and other noise out of the final test results. Fifth, it is possible to obtain reasonably-priced IM distortion measuring equipment with residual distortion levels below those of state-of-the art audio amplifiers. Sixth, since there is no tuning needed to filter out the test frequencies and since two frequencies in combi-

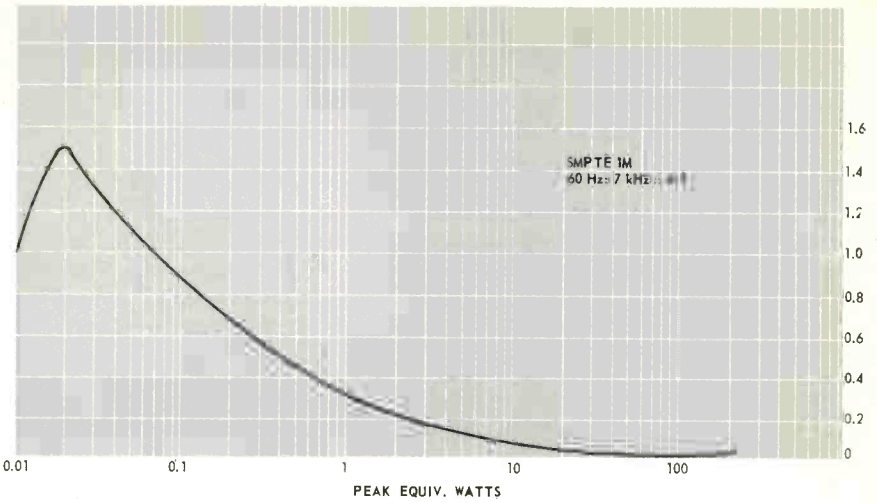


Fig. 7—IM evidence of crossover notch at low power.

nation provide a test for the entire audio bandwidth, the only change necessary during the test is in the power level. With proper equipment, IM testing can thus be done very quickly and efficiently.

Despite these advantages, IM distortion testing has found limited use and has sometimes been used to poor advantage. It is most important to cover an adequate range of power levels if an amplifier is to be thoroughly tested. As mentioned before, crossover notch distortion has plagued many solid state amplifiers. Fortunately, this type of distortion generates high order terms which quickly show up in SMPTE IM measurements *if* the tests are made at the levels (as low as 10 milliwatts) where crossover problems occur. Testing down to a level of 1 watt (a commonly used lower test limit which is frequently understood by the expression "all power levels below rated output") hardly ever reveals the cross-over notch distortion (e.g. In a 100 watt amplifier this is only 20dB below full output whereas music may cover 70dB.) Figure 7 illustrates the kind of IM increase that can occur at low power levels.

To summarize, harmonic distortion testing, on the surface is very simple conceptually and can be useful in equipment for which SMPTE IM testing would be inadequate (such as a graphic equalizer where low and high frequencies follow different signal paths.) But for many situations and in particular the case of audio amplifier testing, IM distortion measurements offer distinct advantages both to the manufacturer and to the consumer. Due to the simplicity of such tests with a modern, inexpensive IM analyzer, serious customers should insist on a fully documented plot of IM distortion versus output power, a request which quality manufacturers will happily fulfill. AE

1. A separate problem is noise, which involves the addition of unwanted sounds not related to the sound being reproduced, such as hum from power supplies, etc. Important kinds of distortion included in the definition above, but not considered in this discussion, are phase distortion and amplitude distortion. Phase distortion deals with the shifting of the complex relationships among the different tones of a musical signal and is generally much more subtle than harmonic or intermodulation distortion. Amplitude distortion results from variation of gain with frequency and shows up as poor frequency response.

2. This assumes that the equipment has been chosen so that the different components will be compatible with each other, or noninteractive. (For example, damping factor is a measure of noninteractiveness of amplifiers and loudspeakers.) Otherwise, some part of the system will be improperly loaded or driven and distortion will occur regardless of the quality of the equipment.

3. Commercial THD analyzers actually measure the average of the distortion signals taken as a percentage of the average distorted amplifier output, rather than measuring rms figures.

4. This operation in effect demodulates the high frequency signal from the high pass filter. From the demodulated signal an average value is taken as a reference for the percent distortion. The intermodulation components (low frequencies) are then separated from the high frequency by the low pass filter.

5. See, for example, Callendar, M.V. and S. Matthews "Relations between Amplitudes of Harmonics and Intermodulation Frequencies," *Electronic Engineering* (June, 1951), P. 230, and D.E. O'N. Waddington "Intermodulation Distortion Measurements," *Journal of Audio Engineering Society* (July, 1964), Vol. 12, #3, P. 221.

6. Shorter, D.E.L. "The Influence of High Order Products in Non-linear Distortion," *Electronic Engineering* (April, 1950), P. 152.

7. Callendar and Matthews, *op. cit.*

8. See also "Amplifier Requirements & Specifications," AUDIO, (April, 1971), Vol. 54, #4, p. 32.

Amplifier Q's and A's--Mainly For Beginners

Q. *Is it still necessary for amplifiers to be divided into a preamp and a power unit? Why should I be bothered with all those connecting cables?*

A. Years ago, in the tube era, were several advantages in having separate units. For some cabinet installations, the main amplifier with its massive power and output transformers could be placed at the bottom, leaving the control unit to be mounted in the most convenient position. Secondly, the radiated hum field from the power transformer was more difficult to control in an integrated unit. Thirdly, the sheer size of a high-power integrated unit was a disadvantage in itself. But with solid-state techniques these advantages have tended to disappear. Power transformers can be much smaller and there are no output transformers to contend with. And so, integrated amplifiers with powers up to 100 watts per channel are every bit as good as separates. But for very high powers—of the order to two or three hundred watts, there is the problem of size and heat dissipation, and so separates are to be preferred.

Q. How about receivers? Are separate tuners and amplifiers better?

A. Much the same arguments apply here too. Two big problems with FM tuners using tubes was drift caused by heat dissipation, and, secondly, size. Now, many receivers have very elaborate amplifier sections and give a high standard of FM performance too. Even so, separate tuners are still recommended for those who want the last dB of performance. And, of course, they are even more versatile—why buy a new set of equipment if all you need is better FM reception?

Q. *I can see that transistors have many advantages over tubes—freedom from microphony, less hum, small size, and they do not age. But aren't these advantages realized at the expense of noise and distortion?*

A. Definitely not! Taking the question of noise first, modern audio transistors can have a significantly lower noise level than the very best tubes—which is one reason why they are extensively used in studio equipment and microphone preamplifiers working with extremely small signals. As for distortion, it must be said that many early solid-state amplifiers had a higher distortion than their tube counterparts. Crossover distortion was a problem at low volume levels and another factor was the actual *distribution* of spurious harmonics. Although the overall measurable distortion might be quite low, the proportion of high order harmonics, like the fifth, seventh, and ninth, was high. It has long been known that these high order harmonics are subjectively more unpleasant and in fact, several proposals have been made for a realistic "weighting factor." The effect, as far as the listener is concerned, is a harshness of the sound, variously interpreted at the time as a brilliance, a clarity, or "that transistor sound." But, of course, during the past few years, developments in circuitry and improvements in transistors have changed the picture completely. Modern solid-state amplifiers have a lower distortion and better signal-to-noise ratio than possible with tube amplifiers. Elimination of the output transformer (necessary with tubes) has meant that the designer can achieve stability, wide bandwidth, good transient response, and a damping factor effective over the whole band. True, all these parameters *can* be met with output transformers but not too easily and certainly not cheaply. For instance, to maintain the low frequency response, a high primary inductance is required, but the windings have to be sectionalized to reduce self-capacity or high frequency and stability will suffer. As a matter of interest, some time ago, Peter Walker demonstrated a bridge method of evaluating the distortion of an amplifier using any kind of input signal, *including speech and music*. Briefly, it involved the balancing out of the input signal with the output—what's left is distortion, a deviation from the original. It could be displayed on an oscilloscope or amplified and fed into a loudspeaker if so desired. Obviously, this method must be almost foolproof as it takes into account IM, THD, transient mutilations, frequency deviations, thermal effects, and so on. I said *almost* as phase effects could cause instability unless precautions are taken. At the demonstration, Peter Walker proved that the distortion detected by the bridge was greater on his old and respected Quad tube amplifier than on his 303 transistor amplifier!

Q. *If I buy an add-on power amplifier for quadraphonic sound, will I need the same power for the rear channels?*

A. Yes. Many recordings demand equal power from all four speakers although a few use ambience only for the rear channels. *Overall* sound level, however, should be about the same as for conventional two-channel, although opinion is divided on this issue.

Q. *What noise level is inaudible? My amplifier is rated at 65 dB for* PHONO, *yet the background noise is quite loud.*

A. This is not an easy question to answer because there are so many factors involved. Here are some of them: Distribution of the noise (i.e., the proportions of low and high frequencies), loudspeaker characteristics, room characteristics, and method of measuring. A speaker system with a "peaky" treble will over-emphasize hiss, and obviously a low frequency hum of 60 Hz would be more audible from a loudspeaker with a resonance in that region. Again, a hum that would be completely inaudible on a small bookshelf speaker might be unbearably loud on a large corner horn system. In practice, a signal-to-noise ratio of 50 dB or above (referred to full amplifier rated output) would be unobjectionable.

Q. *Is there any point in buying an amplifier having a higher output than I need? Would it sound cleaner at low levels?*

A. In general, it is wise to allow as large a factor of safety as possible. It would surprise many people to know that what often passes as a roughness in the sound or is dismissed as a recording defect is actually overloading. Many of our present day loudspeakers are relatively inefficient (0.5% is not uncommon) and they really *do* need a fair amount of power, especially in a large, well-damped room. Usually, there is no detectable difference between very large and small amplifiers at low listening levels, although it must be said that transient peaks are often larger than many people imagine! A lot depends on the amplifier's overload characteristics—some clip peaks cleanly without fuss, while others produce an excruciating noise! *G.W.T.*

New Amplifiers and Preamplifiers

The following are specifications for amplifiers and preamplifiers recently introduced. Note that they are supplied by the manufacturer and are not the result of tests by this magazine. A more complete directory, giving data on earlier models, was published in the September, 1971, issue. Single copies may be obtained for 60¢ from the Subscription Manager, AUDIO Magazine, 134 No. 13th St., Philadelphia, Pa. 19107.

***Power Output**—Wattage rms per channel, usually with 8 ohm loads, both channels driven simultaneously.

***THD**—Total Harmonic Distortion measured at 1000 Hz for full rated power output. Top-of-the-line units have less than 0.5% THD.

***IM**—Another form of distortion, also measured at rated power output. *IM* means intermodulation and refers to the sum-and-difference tones produced by the interaction of two wanted tones. Should be less than 1.0% up to full power.

***Power Bandwidth**—The range, in Hz, over which the power output does not fall by more than half, i.e. 3 dB. Top units rate at 20 to 30,000 Hz.

***Frequency Response**—Again, a range in Hz, but measured at the 1 watt power output level (rather than at full output as with bandwidth). Limits depend on engineering philosophy.

***S/N, Phono**—The signal-to-noise ratio through the phono input. Anything over 60 dB is a good figure.

Two-Channel Preamplifier

Marantz 3300

Freq. Resp.: 6 to 80,000 Hz −3 dB
THD: 0.2% **IM:** 0.2%
S/N, Phono: 100 dB
Phono Sensitivity: 1.35 μV
Features: Straight-line tone controls, speaker switch, 2 tape monitors, variable central channel output.
Price: $395.00

Four-Channel Integrated Amplifiers

JVC DCA-V10
Power Output: 15 watts/channel
THD: 0.5%
Freq. Resp.: 8 to 100,000 Hz
S/N Ratio: 90 dB
Features: 4-chan. CD-4 indicator, phone jacks, and remote control jack.
Price: Not yet fixed.

Dynaco SCA-80Q
Power Output: 40 W per chan.
THD: 0.5% **IM:** 0.5%
Power Bandwidth: 8 to 50,000 Hz
Freq. Resp.: 15 to 50,000 Hz ±0.5 dB
S/N, Phono: 60 dB
Features: Quadaptor, balancing switch.
Price: $169.95, kit; $249.95, wired.

Pioneer QA-800
Power Output: 20 W per chan.
THD: Less than 0.5% **IM:** Less than 0.8%
Power Bandwidth: 15 to 50,000 Hz
Freq. Resp.: 8 to 70,000 Hz ±1 dB
Features: Quadralizer, 2 or 4 chan. operation, 2 phono, tape and AUX inputs, filters, 20 dB muting switch.
Price: $349.95

Rotel RA-314
Power Output: 21 W per chan.
THD: 0.2 **IM:** 0.5%
Power Bandwidth: 25 to 30,000 Hz
Freq. Resp.: 20 to 35,000 Hz +1.5 dB
S/N, Phono: 60 dB
Features: 4-chan. discrete and matrix, 2 phone jacks.
Price: $229.95

Fisher TX-420
Power Output: 15 W per chan.
THD: 0.5% **IM:** 0.8%
Power Bandwidth: 30 to 20,000 Hz
Freq. Resp.: 20 to 25,000 Hz ±2 dB
S/N, Phono: 65
Features: 4-chan. 8-track player, matrix decoder.
Price: $299.95

Kenwood KA-8044
Power Output: 22 W per chan.
THD: 0.5%
Power Bandwidth: 15 to 70,000 Hz
Freq. Resp.: 15 to 50,000 Hz ±1 dB
S/N, Phono: Better than 65 dB
Features: Handles discrete or coded sources, synthesizes, 4 VU meters, front and rear tone controls.
Price: $299.95

Two-Channel Integrated Amplifiers

Nikko TRM-400
Power Output: 16 W per chan.
THD: 1.0% **IM:** 1.0%
Power Bandwidth: 30 to 20,000 Hz
Freq. Resp.: 20 to 30,000 Hz ±1 dB
S/N, Phono: 60 dB
Features: Filters, 2 outputs, mag.-cer. switch.
Price: $109.95

Marantz 1060
Power Output: 30 W per chan.
THD: 0.3% **IM:** 0.5%
Power Bandwidth: 15 to 40,000 Hz
Freq. Resp.: 15 to 40,000 Hz ±2 dB
S/N, Phono: 65 dB
Features: 2 front mic inputs, step tone controls, spkr. switch.
Price: $189.00

Revox A78
Power Output: 40 W per chan.
THD: 0.1% **IM:** 0.3%
Power Bandwidth: 10 to 40,000 Hz
Freq. Resp.: 20 to 20,000 Hz ±1 dB
S/N, Phono: 80 dB
Features: Sep. adjust. inputs, step tone controls.
Price: $325.00

Pioneer SA-800
Power Output: 34 W per chan.
THD: 0.5% **IM:** 0.5%
Power Bandwidth: 5 to 50,000 Hz
Freq. Resp.: 5 to 80,000 Hz ±1 dB
S/N, Phono: 80 dB
Features: Direct coupled output, 2 tape mon., step tone controls.
Price: $239.95

TEAC AS100
Power Output: 30 W per chan.
THD: 0.2% **IM:** Less than 0.2%
Power Bandwidth: 10 to 40,000 Hz
Freq. Resp.: 5 to 200,000 +0 −2 dB
S/N Ratio: Better than 90 dB
Features: Step tone controls, front panel tape jacks, 2 AUX and PHONO inputs, spkr. switch.
Price: $299.50

Standard PM-158
Power Output: 7.5 W per chan.
THD: 0.5% **IM:** 0.2%
Power Bandwidth: 30 to 25,000 Hz
Freq. Resp.: 20 to 30,000 Hz ±3 dB
S/N, Phono: 60 dB
Features: Mag. or x-tal switch.
Price: $69.95

Olson AM-375
Power Output: 40 W per chan.
THD: 0.4% **IM:** 0.1%
Power Bandwidth: 20 to 20,000 Hz
Freq. Resp.: 10 to 25,000 Hz ±1 dB
S/N, Phono: 60 dB
Features: Distortion level indicator.
Price: $139.00

Sherwood 9500C
Power Output: 45 W per chan.
THD: 0.9% **IM:** 0.6%
Power Bandwidth: 8 to 35,000 Hz
Freq. Resp.: 20 to 20,000 Hz ±0.5 dB
S/N, Phono: 65 dB
Features: Spkr. switch, filters, 2 AUX inputs.
Price: $199.95

Hitachi IA-1000
Power Output: 70 W per chan.
THD: 0.1%
Power Bandwidth: 10 to 100,000 Hz
Freq. Resp.: 10 to 100,000 ±1 dB
S/N, Phono: 65 dB
Features: Step tone controls, filters, tape mon., spkr. switch.
Price: $319.95

Four-Channel Power Amplifiers

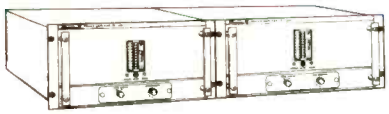
Pioneer QM-800
Power Output: 25 W per chan.
THD: 0.5% **IM:** 0.5%
Power Bandwidth: 10 to 50,000 Hz
Freq. Resp.: 5 to 80,000 Hz ±1 dB
S/N Ratio: 90 dB
Features: 4 VU meters, meter level switch, input level switch.
Price: $299.95

Add-On Convertors

Sanyo DCA1500X
Power Output: 40 W per chan.
Power Bandwidth: 50 to 15,000 Hz
Freq. Resp.: 20 to 20,000 Hz
S/N Ratio: 60 dB
Features: Matrix or discrete switch, 2 or 4 chan., headphone jack.
Price: $99.95

JVC VN-5101X
Power Output: 15 watts/channel
Freq. Resp.: 20 to 50,000 Hz
S/N Ratio: Better than 70 dB
Features: CD-4 demodulator, 5 tone controls, master volume, remote balance control jack.
Price: Not yet determined.

Two-Channel Power Amplifiers

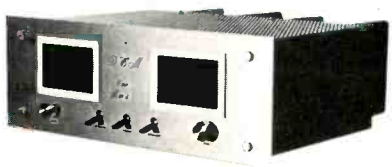


Crown DC-4000
Power Output: 2,000 W per chan.
THD: Less than 0.1%
IM: Less than 0.1%
Power Bandwidth: 20 to 20,000 Hz
Freq. Resp.: 0 to 20,000 Hz ±0.1 dB
Features: Peak reading power output indicator.
Price: Not yet determined.

Sansui QS-100
Power Output: 15 W per chan.
THD: Less than 0.8% **IM:** Less than 1%
Power Bandwidth: 25 to 40,000 Hz
Freq. Resp.: 20 to 50,000 Hz ±1 dB
Features: Synthesizer/decoder, 4 VU meters, front/rear and left/right balance switches.
Price: $209.95

Pioneer QL-600
Power Output: 10 W per chan.
THD:0.5% **IM:**1.0%
Freq. Resp.: 20 to 20,000 Hz ±1 dB
Features: Matrix or phase shift switch, 4 VU meters, 4 level controls plus meter controls.
Price: $199.95

Phase Linear 400
Power Output: 200 W per chan.
THD: 0.25% **IM:** 0.25%
Power Bandwidth: 0 to 20,000 Hz
Freq. Resp.: 0 to 250,000 Hz
Features: 2 VU meters.
Price: $499.00



Dunlap-Clarke D 800
Power Output: 225 W/chan.
THD: Less than 0.075%
IM: Less than 0.1%
Power Bandwidth: 10 to 50,000 Hz
Freq. Resp.: 20 to 20,000 Hz. +0.5dB
Features: Meters optional, levels controls and speaker selector.
Price: $449.95

Crown DC1200
Power Output: 600 W per chan.
Thd: Less than 0.25%
IM: Less than 0.25%
Power Bandwidth: 20 to 20,000 Hz
Freq. Resp.: 0 to 20,000 Hz ±0.1 dB
Features: Peak-reading output indicator, protection against shorts, mismatching, open circuits.
Price: Not yet determined.

Equipment Profiles

BIC/LUX 71/3R AM/FM Stereo Receiver

MANUFACTURER'S SPECIFICATIONS

Tuner Section, FM. Sensitivity, IHF: 2.0 μV. **S/N**: Better than 60 dB. **THD, Mono**: 0.3%. **Capture Ratio**: 2.5 dB. **IF Rejection**: 70 dB. **Image Rejection**: Better than 50 dB. **Spurious Response Rejection**: Better than 75 dB. **AM Suppression**: —70 dB. **Stereo FM Separation**, 1kHz: 40 dB. **Tuner Section, AM. Sensitivity, External Antenna**: 20 μV. **Image Rejection**: —75 dB. **I.f. Rejection**: —80 dB.

Amplifier Section. Power Output, rms, both channels driven, 8 ohm loads: 50 watts per channel; 4 ohm loads: 60 watts per channel. **Rated THD**: 0.3% **Rated IM Distortion**: 0.3%. **Frequency Response**: 10 Hz to 50 kHz ± 1 dB. **Power Bandwidth**: 15 Hz to 30 kHz. **Damping Factor**: Greater than 50 at 8 ohms. **Hum and Noise**: Volume control at minimum, better than 75 dB; Phono inputs, better than 60 dB, with reference to rated sensitivity and output.

General. Dimensions: 18½ in. W. by 13¾ in. D. by 6 in. H. **Retail Price**: $550.00, optional walnut exclosure extra.

If the name seems unfamiliar, a word of explanation may be in order before discussing this outstanding receiver from BIC/LUX. BIC stands for British Industries Co., the people who introduced and popularized the Garrard record changers in the United States. Lux is a well-known and respected audio equipment manufacturer in Japan which has been in the business of producing high quality audio equipment there for over four decades. The introduction of the Model 71/3R to this country (Lux products are already widely distributed in Europe) represents British Industries' entry into electronics, and a most auspicious entry it is, too. The amplifier section of this all-in-one receiver outperforms just about every separate integrated amplifier in this power category, while the tuner section sports a new form of center-tuning sensing circuitry which makes it a joy to use.

To begin with, the 71/3R is a BIG unit, ruggedly built and beautifully packaged. Signal source selection is accomplished by means of a vertical row of push buttons at the left of the panel. External inputs include a pair of phono stereo inputs (2 mV and 10 mV sensitivity) and a pair of high-level auxiliary inputs. The black-out dial area becomes illuminated in white light when the AM button is depressed and in green when FM is selected. When other sources are chosen, the dial scale itself vanishes and the selected source is designated in illuminated red letters in the lower portion of the blacked out dial area. The dial area also contains a signal-meter, a massive tuning knob coupled to an effective flywheel, and the CENTER-TUNE indicator light. Stereo reception is indicated by the word STEREO which becomes illuminated beside the CENTER-TUNE light. At the extreme right of the dial area are four miniature push-button/rotary control combinations. Three of these are used to pre-set favorite FM stations by means of adjacent miniature replicas of the main FM dial scale. Rotation of the pre-set knob sets desired pre-set frequencies while depressing the same knob (providing the main FM selector is also depressed) selects the given pre-set station automatically after it has once been set. The lowest of the four miniature controls is depressed for manual tuning. This knob has two positions of rotation as well: one for "distant" FM reception and one for "local." The lower half of the extruded gold-anodized front panel contains the rest of the amplifier controls. Included are a pair of TAPE IN, TAPE OUT phone jacks (duplicating the tape jacks on the rear panel), a TAPE MONITOR switch, a stereo-mono MODE switch, BASS and TREBLE controls (dual concentric knobs enable adjustment of bass or treble for left or right channels separately), switches for LOW and HIGH filters and LOUDNESS compensation, dual concentric, clutch-action volume controls, MAIN and REMOTE speaker switches, a stereo phone jack, and a separate push-push power ON/OFF switch. Two departures from conventional receiver design should be noted. For one thing, there is no balance control. Since dual concentric, clutched volume controls are used, once relative level between left and right channels has been established, the two controls operate together, maintaining perfect tracking at other volume settings. Most conventional balance controls inevitably intro-

duce passive gain loss, but by eliminating their need in this way, the BIC/LUX 71/3R actually picks up a couple of dB of signal-to-noise advantage while still affording a means for perfect left-right balance. The second departure from conventional design are a pair of turnover selector knobs, each associated with its respective pair of tone controls. The problem with most tone control circuits is that however well calibrated they may be, they tend to lift or attenuate several octaves of the audio spectrum. Thus, if a bit of adjustment of, say, all frequencies below 150 Hz is required, resetting the bass control of most sets will also affect frequencies up to 500 or 1000 Hz. If attenuation is required, low and high frequency filters often can accomplish the desired effect, but if slight boosting of the "ends" of the spectrum is needed, this receiver's tone control arrangement facilitates such correction. Each "turnover" selector has four settings (OFF, 150, 300 and 600 for the bass side and OFF, 6K, 3K and 1.5K for the treble) which determine the frequency at which boost or attenuation begins. In the OFF positions, the tone controls are removed from the circuitry entirely, insuring perfectly flat response for the purists. Variable crossover selection is sometimes found on the very best integrated amplifiers but this is the first time we've encountered it on a complete receiver.

The rear panel layout of the BIC/LUX 71/3R receiver, shown in Fig. 1, contains, in addition to the main line fuse, a pair of speaker fuses, one for each channel. Two unswitched and one switched convenience a.c. outlets are provided, and antenna connections are available for either 75 ohm or 300 ohm transmission lines, as well as for an external AM antenna wire. Speaker terminals are spring loaded so that the stripped end of your speaker wire is firmly gripped when the terminal is released. This arrangement almost precludes the possibility of "short circuits." An AM ferrite antenna rod can be swung away from the chassis surface to minimize the attenuating effects of the metal heat sink. The usual array of input and output jacks and a grounding terminal completes the back-panel layout.

The internal layout of the chassis contains 11 modular sections, some of which are mounted below chassis surface and can therefore not be seen in Fig. 2. Of particular interest to us was the unique CENTER TUNE circuitry, which British Industries Co. (with some justification) has called a COMPUTER circuit. A close-up view of the FM i.f. and COMPUTER circuit board (Fig. 3) gives an idea of its complexity. Actually, the FM i.f. circuits occupy only the upper third of this p.c. board. The entire lower section is devoted to the COMPUTER circuitry which utilizes no less than 18 transistors, eight signal diodes, and four extra tuned circuits. This circuit, in effect, senses three signal characteristics, noise, distortion, and accuracy of tuning. What's more, it operates for both FM and AM reception, allowing only perfectly tuned signals to be heard. In its FM use, the circuit is quite different from any conventional muting circuits which we have seen. When the LOCAL-DISTANT switch is set to the DISTANT position, signals as low as 1.5 μV will be heard when properly tuned in, and yet there is absolutely no interstation noise present even when such weak signals are detuned. Further, there is *no* transitional region. That is, the signal is either received with minimum distortion or it is rejected—and no sound whatever is heard. As you tune across the dial, signals are received or "turned on" with absolutely no popping or clicking sounds and as you leave each one, the sound is again "turned off" without any "side effects." Interestingly, the signal strength meter (which might seem redundant) serves a useful purpose in the tuning procedure. As you approach a station frequency, the meter needle begins to deflect—often quite a bit—long before sound is heard. At one exact point in the "cresting" of the meter needle, sound comes on—and the CENTER-TUNE light becomes illuminated, indicating that perfect tuning has been achieved.

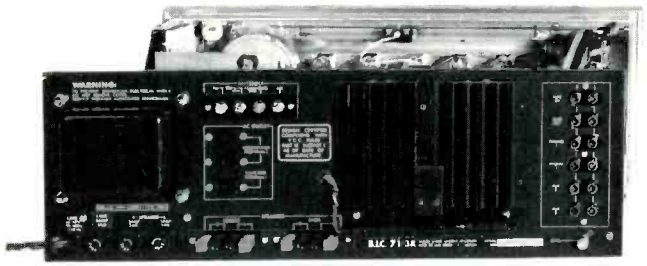


Fig. 1—Showing the back panel.

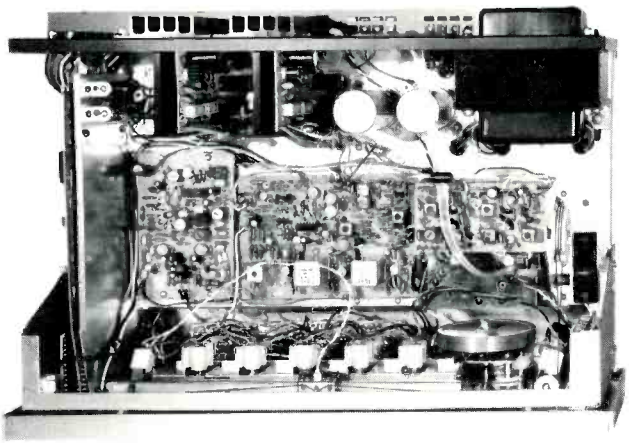


Fig. 2—View from above.

The power amplifier modules (seen mounted perpendicular to the chassis surface in Fig. 2) are fully d.c. coupled circuits, requiring no output coupling capacitor. Input stages are differential amplifiers and the output circuit is a complementary type. A schematic of this section (one channel) is shown in Fig. 4. Transistors Q758 and Q754, together with their associated diodes comprise a protective circuit and form a sort of bridge circuit in which the speaker load becomes one of the branches of the "bridge." Low values of load impedance, for example, cause Q759 and Q758 to turn ON and prevent the signal from being fed to the output stages when excessive current might otherwise flow. We can attest to the fact that the circuit is "short-proof" even when extended short circuits are maintained across the speaker output terminals. In fact, we wonder about the speaker line fuses—we could not cause them to "blow" under any conditions of short circuiting which we tried.

Performance Measurements

Figure 5 plots various characteristics of FM performance of the 71/3R. As can be seen, measured performance exceeded claims, in that IHF sensitivity measured 1.7 μV. (IHF measure-

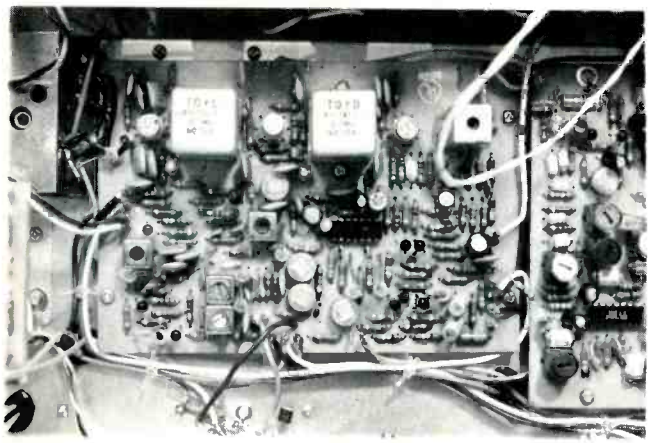


Fig. 3—FM i.f. and COMPUTER circuit board.

ments are taken at 98 MHz. At 88 MHz least usable sensitivity was actually a bit better, measuring 1.6 μV, while at the high end of the band we measured 1.9 μV, again better than published claims). Ultimate S/N was a respectable 68 dB, but more importantly, S/N at a mere 5 μV already measured 57 dB! To us, this figure is more meaningful than the IHF sensitivity, for it means that signals received with a signal strength of only 5 μV are noise-free and listenable. Interestingly, while the CENTER-TUNE circuits were set to about 1.5 μV in the DISTANT position, in the LOCAL position triggering took place for all signals having strengths above 5 μV. Thus, if you're interested in listening to stations that are both perfectly tuned and devoid of audible noise you merely have to set the switch to the LOCAL position and you are then assured that any station that "turns on" the computer circuits is arriving with a signal-to-noise ratio of *at least* 57 dB. Listeners who wish to DX have the option of the DISTANT position of the switch—at which setting they can receive signals down to 1.5 μV, which is about the practical and theoretical limit for FM.

THD in MONO measured 0.2%, better than claimed, while in stereo we measured 0.4%. We could not pin-point the exact signal strength required for full limiting in Fig. 5, since it takes 1.5 μV of signal to "turn on" the audio, and by that time, full limiting was already in evidence!

Stereo separation characteristics are plotted in Fig. 6 and, mid-frequencies the figure obtained was 42 dB (and was ictly the same in the opposite channel, not shown). At 50 Hz, separation was still in excess of 30 dB, while at 10 kHz we read a separation of 28 dB.

When we started to measure the power amplifier performance of the Model 71/3R, we thought that perhaps we had gotten hold of a higher powered model (B.I.C. has announced a second receiver model which will feature higher power than the 71/3R while most other features will be similar.) Talk about conservatism! (Is it synonymous with the "British" in British Industries?) This amplifier section was not even near ready to quit at 50 watts per channel, both channels driven.

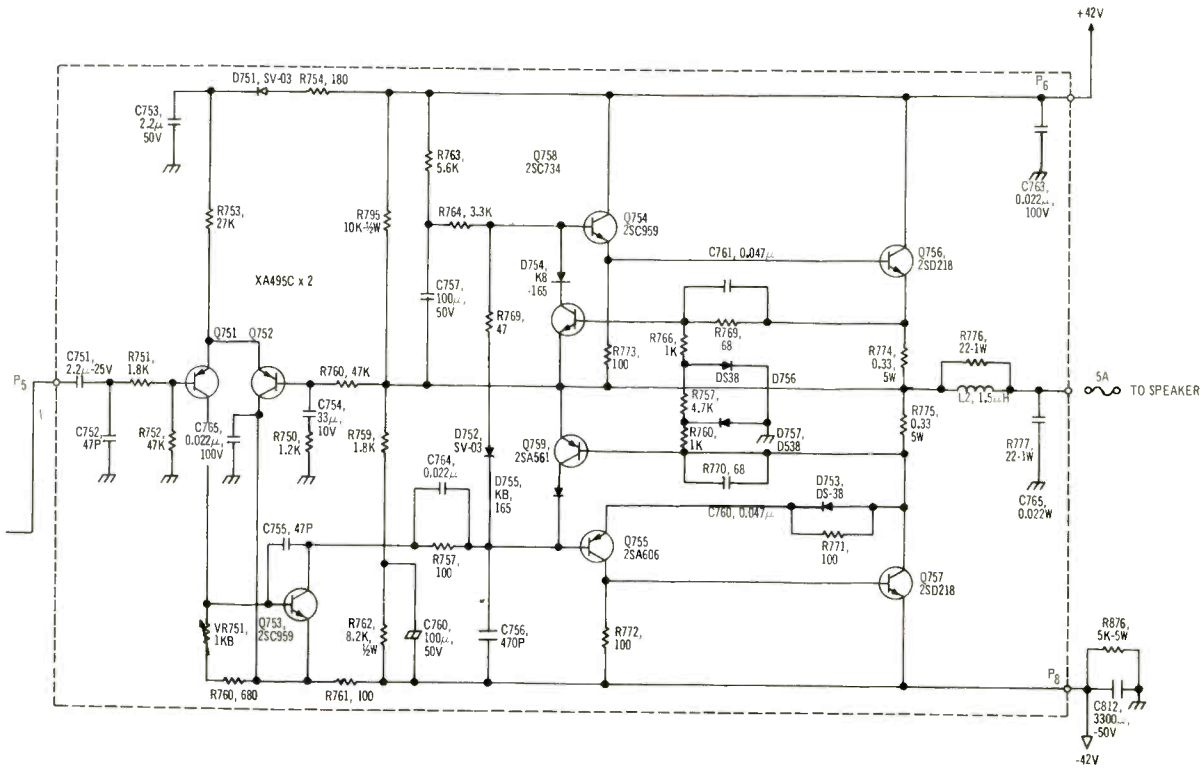


Fig. 4—Schematic of power amplifier module (one channel).

In fact, we reached rated THD at 63 watts per channel, with 8 ohm loads. Intrigued by this "under-rating," we measured the output using 4-ohm loads and read 82 watts per channel before reaching rated THD (0.3%). At *rated* power output THD was a miniscule 0.07%. At no power level below rated did the THD exceed 0.1%, as can be seen in the curve of Fig. 7.

Power bandwidth was equally incredible. Only when we realized that BIC was quoting power bandwidth in terms of −1 dB from rated power (IHF standards dictate a −3 dB or "half power" reading), were we able to explain the discrepancy. Using the −3 dB reading, the power bandwidth we obtained extended from 8 Hz to 35 kHz. More important, when we confined our measurements to the 20 to 20 kHz range, we were able to obtain 50 watts per channel at *every* frequency at less than rated THD. This is illustrated graphically in Fig. 9, along with THD readings at other, lower power levels. Figure 8 is a plot of power bandwidth, using the conventional IHF references.

The action of the various bass and treble crossover settings is graphed in Fig. 10 and helps to further explain the advan-

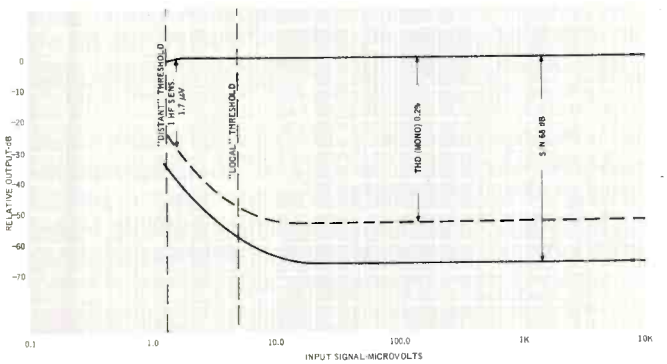


Fig. 5—FM (mono) characteristics.

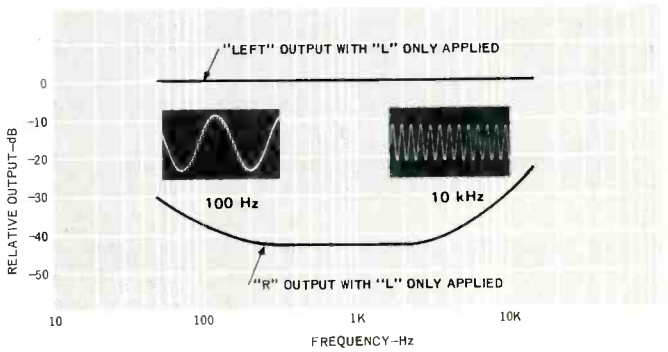


Fig. 6—Stereo FM separation characteristics.

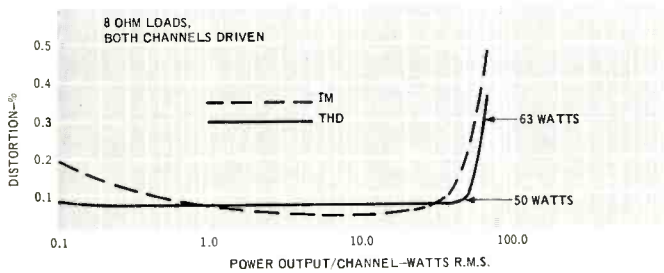


Fig. 7—Distortion vs. power output.

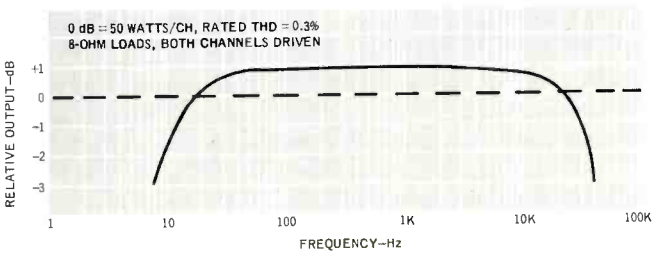


Fig. 8—Power Bandwidth.

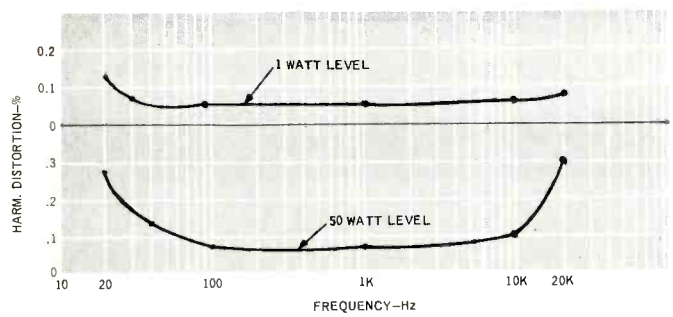


Fig. 9—THD vs. frequency at 1 watt and 50 watts per channel.

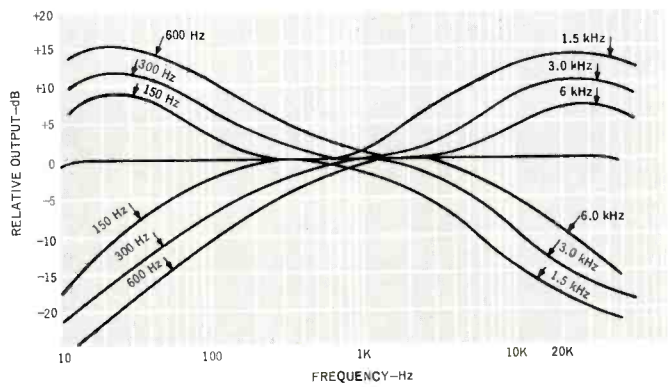


Fig. 10—Tone control range at the various crossover selections.

tage of this feature. The HIGH and LOW frequency filter action is plotted in Fig. 11 and is seen to have slopes of only 6 dB per octave. Normally, we like to see 12 dB slopes in these filters but, frankly, with the extra flexibility inherent in the tone control variable crossover features, you're not likely to depend upon these filters for much anyway.

British Industries makes a point in their literature about the ability of this receiver to reproduce square waves accurately

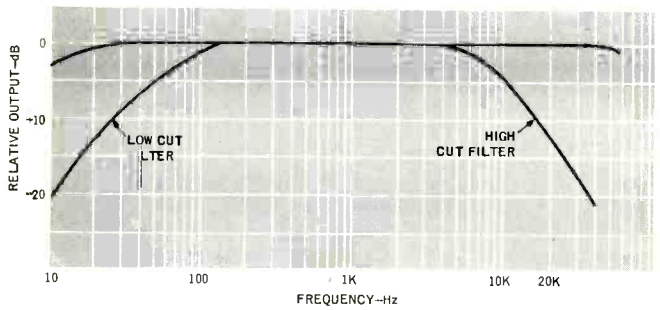
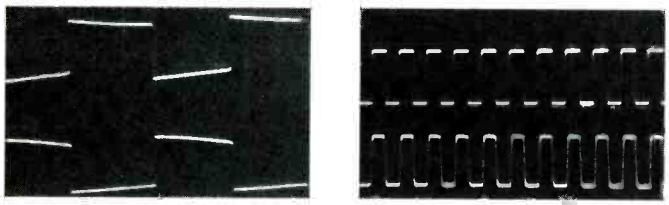


Fig. 11—Filter characteristics.



A **B**

Fig. 12—Square-wave response at **A** 20 Hz and **B** 20 kHz. Upper trace is input.

throughout the audible spectrum, so we thought we'd check this out as well. Rather than photograph square-waves at 100 Hz and 10,000 Hz, as is our normal practice, we decided to make things a little bit more difficult and used 20 Hz and 20 kHz. The results speak for themselves in Fig. 12. The only comparable square-wave performance we have ever run across was in an amplifier-preamplifier combination of somewhat higher power which sells for $700.00. The upper trace in each case is the input square wave as produced by our square wave generator. This is shown because it is not perfectly square at 20 Hz and we would not want to fault the 71/3R which is, in fact, reproducing just about what is fed to it.

Listening Tests

Station logging with the BIC/LUX 71/3R we were able to receive 52 *listenable* stations when the receiver was set in the DISTANT setting. In the LOCAL position, this figure was reduced to 46, which means that six stations were previously received with signal strengths of between 1.5 and 5 μV and were considered quite listenable. The gain of the FM section is such that it is possible to attain quite high listening levels at about 1 o'clock on the dual volume controls and it was therefore early in our listening tests that we began to realize that this amplifier was *not* the typical amplifier portion of a receiver. No matter what listening level we used this amplifier just refused to quit and exhibited a transparency and crispness which belies description. Fortunately, we do have a *few* carefully transmitted FM signals in our area (all too few, I must confess) and it is to these few that we listened extensively. One thing about a piece of equipment such as this is that it must be fed with good, clean program sources if its reproduction capability is to be fully appreciated. A new Columbia release of Santana served as our audition record in the PHONO input department and it is replete with those percussive and dynamic sounds that separate the superior amplifiers from their lesser cousins. The BIC/LUX 71/3R is definitely in the former category. In fact, this receiver should be auditioned by anyone interested in finding out what state-of-the art solid state design has been able to achieve after only a decade of popular use. The tuner section is fine, the center-tune feature is great to use, but that amplifier has got to be heard to be believed. *Leonard Feldman*

Check No. 54 on Reader Service Card

Sony 1130 Integrated Amplifier

MANUFACTURER'S SPECIFICATIONS

Power Output: 65 + 65 watts at 8 ohms, 70 + 70 watts at 4 ohms, for 0.1% THD. **Power Bandwidth (IHF)**: 7 to 30,000 Hz. **Sensitivity**: Phono, 1.2 mV; AUX, Tuner, Tape, 130 mV. **Signal/Noise**: Phono, 70 dB; Others, 90 dB (weighted). **Frequency Response**: 10 to 100,000 Hz +0, –2 dB. **Filters**: Low, 6 dB/octave below 100 Hz; High, 6 dB/octave above 7,000 Hz. **Tone Controls**: Bass, 100 Hz ± 10 dB; Treble, 10,000 Hz ± 10 dB; in ten 2 dB steps. **Dimensions**: 15¾ in. W. by 12⅞ in. D. by 5⅞ in. H. **Price**: $371.50 (plus applicable surcharge), wooden case: $24.50.

The Sony 1130 is an excellent example of the progress made in amplifier design over the past few years. It is quite small in size and not *that* expensive either, but the specifications were barely approached by top quality, highly expensive units only a short while ago. It has ample power for most purposes, distortion is almost immeasurable below its rated output, and just take a look at the facilities: Switched LOW and HIGH filters, two PHONO inputs (useful for comparisons), provision for using the main amplifier or the preamplifier independently, auxiliary input sockets on the front panel, speaker switch, stereo mode selector, tape monitor level switch, and so on. Step-type tone controls are used—these are a little expensive, but many people prefer the positive, *repeatable* action to the smoother control of the continuously variable kind. Certainly they stand up to hard use better—as a rule! The power switch is a separate lever type, and there are three outlet sockets on the rear panel, two of which are switched. Also at the rear are slide switches to disconnect the preamplifier from the power amp—nice for wiring in an equalizer or quadraphonic

matrixer. Figure 1 shows the view inside—note the large power transformer and the big capacitors.

Circuit Details

The preamp section uses eight transistors per channel, four being FETs. Three of these are used for the feedback tone control stages, and one is at the input. Three silicon types are used in a muting circuit which effectively shorts the preamplifier output to ground for a short period after switching on. Thus any switching transients are prevented from reaching the loudspeaker. The main amplifier uses a differential input stage, an NPN-PNP complementary driver arrangement feeding the NPN output transistors. A dual positive-negative power supply is employed, thus the loudspeaker is directly connected without a capacitor. A total of 11 transistors are used for each channel, plus a number of diodes which are employed in protection circuits. Six more transistors are used in the regulated power supply and a protection circuit. There are actually two kinds of protection—one for the power transistors and the other for the loudspeakers. A short circuit at the speaker terminals will limit the input signal applied to the output transistors by means of a fairly conventional type of trigger circuit. The speaker protection circuit is similar to the one used on the larger TA-3200F (reviewed November, 1970) and is shown in Fig. 3. The output signal is take from the output terminal through a low-pass filter (R140 or R240, C313 and C314) and fed to a bridge rectifier (D307 through D310). Because of this filter, the only voltage applied to the bridge rectifier is the very low-frequency or d.c. component that might be caused by transistor faults. When this d.c. rectified voltage becomes large enough, it starts the Hartley oscillator (Q303 and Tosc). The oscillator output is rectified by D311 and thus provides trigger voltage for the SCR-D-317 when trigger voltage is applied to the gate of the SCR, the SCR turns on and shorts the base voltage to ground through D312, the SCR, and D315. The base voltage of the other driver transistor is also shorted to ground through D313, the SCR, and D314, stopping any current flow in the output stage and thus protecting the speaker system. Quite a complex arrangement—unusual in a unit in this price range!

Performance Measurements

Power bandwidth curves are shown in Fig. 4, and it will be seen that half-power points are 17 Hz and just over 50,000 Hz—very creditable. Figure 5 shows the THD and IM charac-

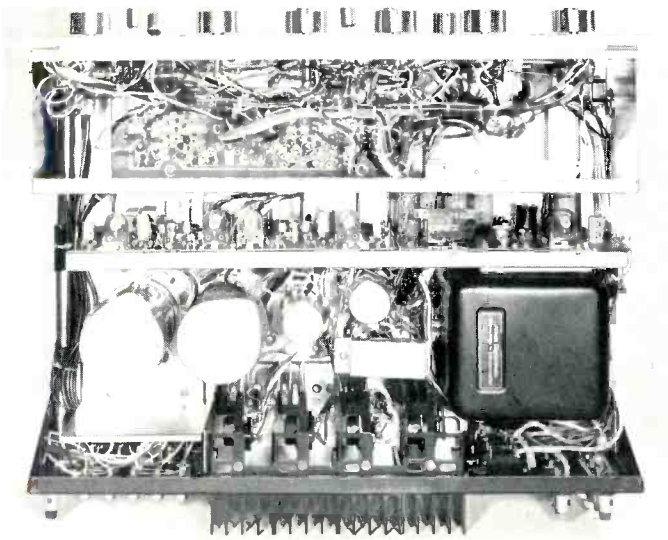


Fig. 1—Inside view.

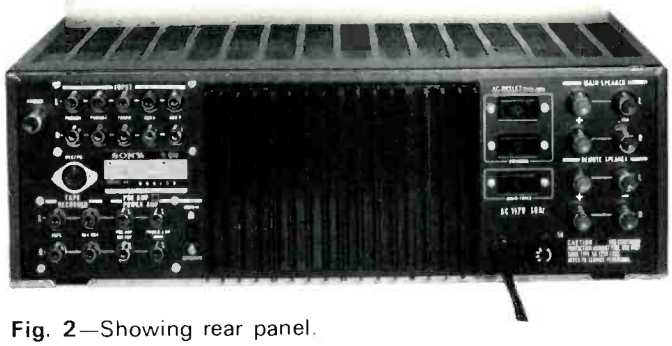


Fig. 2—Showing rear panel.

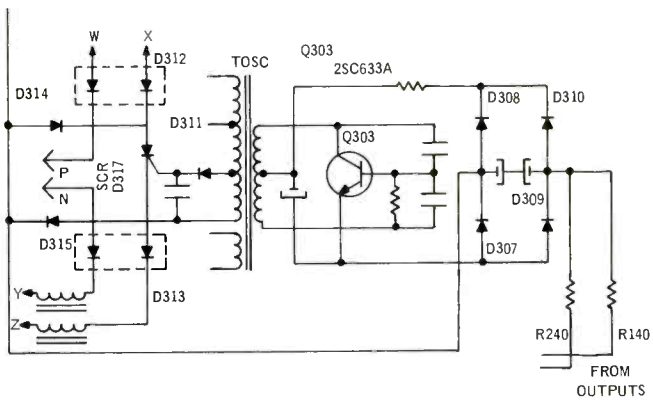


Fig. 3—Partial schematic of speaker protection system. W, X, Y, and Z go to the driver transistor bases, P and N are connected to a power limited or clamping circuit.

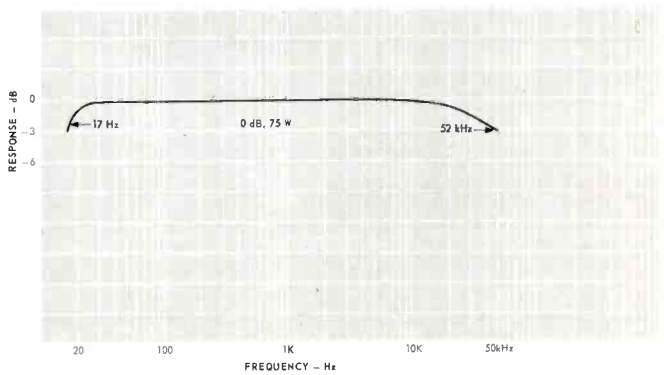


Fig. 4—Power bandwidth.

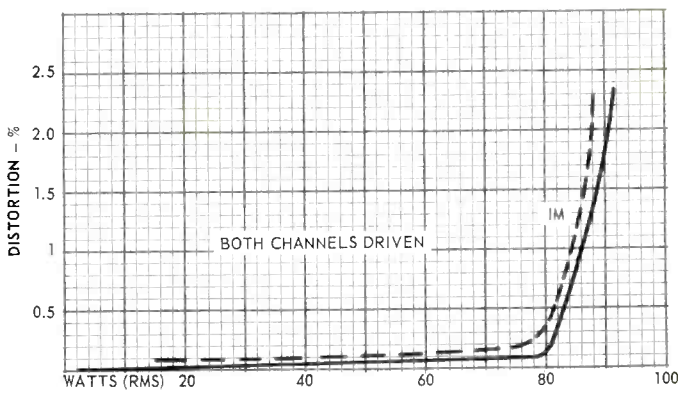


Fig. 5—THD and IM distortion.

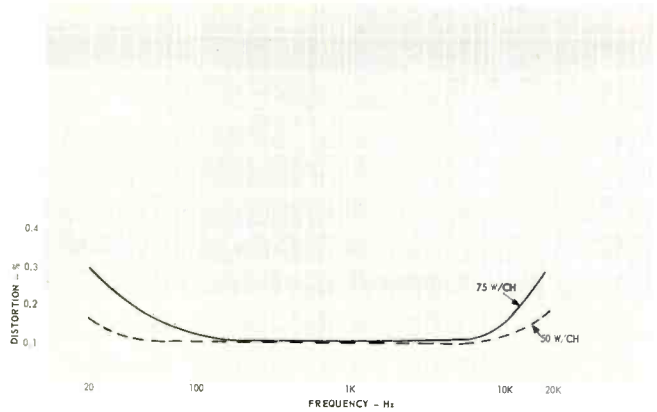


Fig. 6—Harmonic distortion versus frequency.

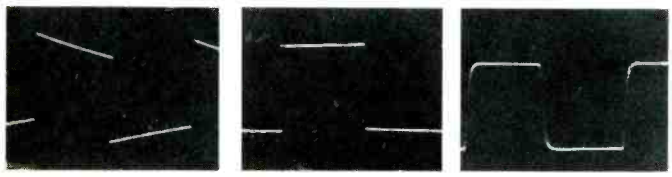


Fig. 7—Square wave response at **A**, 40 Hz; **B**, 1000 Hz, and **C**, 20,000 Hz.

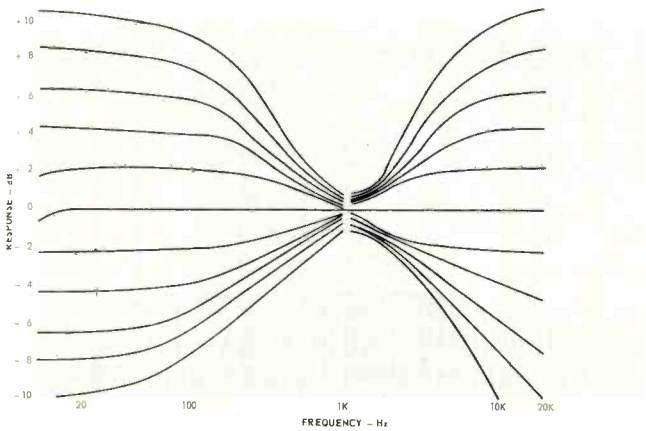


Fig. 8—Tone control curves.

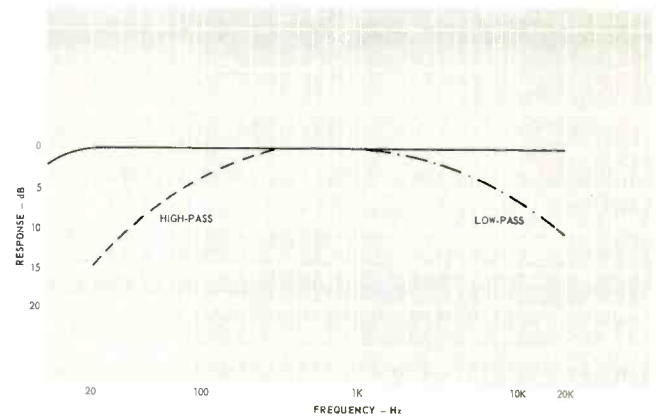


Fig. 9—Filter characteristics.

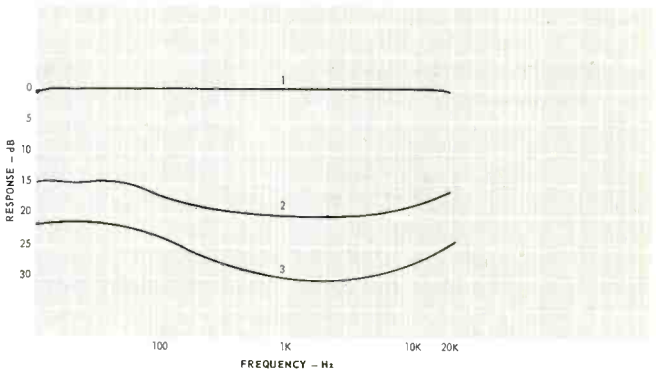


Fig. 10—Loudness control curves.

teristics. Rated output is given as 65 watts per channel into 8 ohms, but this was found to be a conservative figure. With both channels driven, we measured more than 80 watts per channel at the rated THD and over 90 healthy watts at the clip point. Perhaps more importantly, power was well maintained throughout the band, as can be seen from Fig. 6. In theory, the absence of a coupling capacitor improves the damping factor and this was found to be about 120 from 10 to 5,000 Hz, falling to 85 at 10,000 Hz. Phono sensitivity came out at 1.1 mV for full output and overload point was 86 mV. Input signal for the TUNER and AUX inputs was 160 mV. Signal/noise (unweighted, inputs terminated) was 66 dB for PHONO inputs and 86 dB for the others (referred to 80 watts). Residual noise, i.e. with the volume control at minimum, measured –87 dB. Crosstalk was –52 dB at 1000 Hz and –43 dB at 10,000 Hz. Frequency response, measured from the TUNER input, was 1 dB down at 10 Hz and 100,000 Hz. Figure 7 shows the excellent square-wave response at 40, 1000, and 20,000 Hz. Stability was checked with an electrostatic speaker load and was found to be completely satisfactory. Tone control response is shown in Fig. 8, high and low filters in Fig. 9, and loudness control in Fig. 10.

Listening Tests

How did the 1130 perform? Well, of course power output was ample for low efficiency speakers like the AR-3a or B&W 70, and in a fairly large room, there was no danger of amplifier overloading. Bass was clean and well defined, with smooth, effortless treble. The tone controls were effective and the step indents gave a certain professional feel. (Incidently, I particularly liked the spring-loaded speaker terminals, which are far better than the fiddling screw-connectors used on too many receivers and amplifiers these days. Not only are they a nuisance to use but they are placed too close together for safety! So, full marks to Sony on this feature.) One other thing—the protection circuits really *DO* work, as I found out when I accidently shorted the output leads at the 'scope! No smoke, no fuss. The waveform (a square-wave at 50 watts!) just disappeared and came slowly back. Very comforting.

Summing up: the Sony 1130 can be recommended as a relatively inexpensive top-quality amplifier with solid performance and many refinements. *T.A.*

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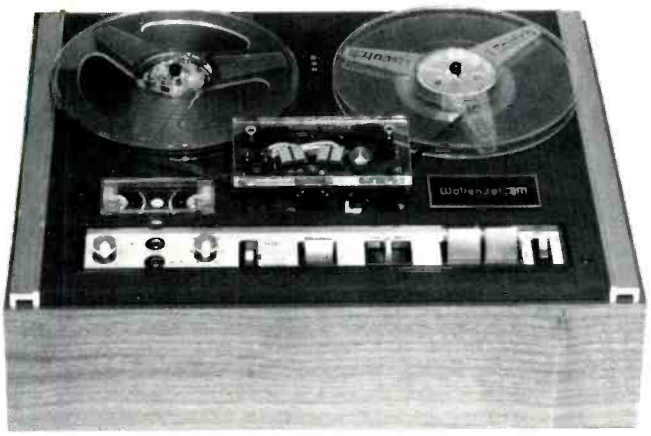


Wollensak Model 6364 Two/Four Channel Tape Recorder

MANUFACTURER'S SPECIFICATIONS

Recorder. Frequency Response: 35-20,000 Hz ±2dB at 7½ ips; 35-14,000 Hz ±2 dB at 3¾ ips; 35-10,000 Hz ± 3 dB at 1⅞ ips.
Wow and Flutter: 0.12% at 7½ ips; 0.20% at 3¾ ips; 0.30% at 1⅞ ips.
Signal-to-Noise Ratio: 54 dB at 7½ ips. **Speeds:** 7½, 3¾, and 1⅞ ips.
Crosstalk: Greater than 50 dB. **Fixed Preamp Output:** 1.0 V, each channel.
Controlled Preamp Output: 0 to 1.3 V, each front channel.
Inputs: Microphone, Tuner, AUX, and Magnetic cartridge.
Amplifier. Frequency Response: 20-20,000 Hz ±1 dB through microphone, tuner, and AUX inputs.
Power Bandwidth: 18 to 22,000 Hz. **Tone Control Range:** ±12 dB at 100 Hz; +7, -11 dB at 10,000 Hz.
Dimensions: 19⅝ in. W. x 13¾ in. D. x 6½ in. H. **Weight:** 24 lbs. **Price:** $399.95.

The rapidly growing interest in four-channel tapes makes this recorder especially valuable to those who are planning for the system-of-the-future. Providing complete stereo recording and playback facilities for conventional use together with four-channel playback, the Wollensak 6364 is convenient to use and includes features which set it apart from the general run of tape recorders.

Electrically a three-head machine, the erase and record heads are of four-track, two-channel configuration and are combined in one unit physically. The play head is a four-channel structure and feeds four separate preamps for quadraphonic operation.

The pressure pads and the pinch roller swing forward and down to permit easy threading, and they provide excellent access to the head faces for cleaning. The head structure is covered by a 5/16-in. thick clear plastic plate, allowing a view of the assembly even while operating. Two key-like controls toward the right of the front panel control the play and stop functions. A pause control integral with the play key holds the mechanism down until released to start the tape motion. Fast movement of the tape is controlled by a lever which moves to the right or left to produce fast forward or rewind motion respectively. Next to the left is the "Tape-Source" rocker switch which selects the feed to the monitor circuits. At the left end of the control panel are the two record-level controls, with microphone input jacks—standard phone type—between them. At the far right end of the control panel is the power switch, also a rocker type.

Along the left side of the top panel are the amplifier operating controls. Starting with the top, the first control adjusts the treble response of the "controlled preamp output" and the output from the built-in power amplifiers. The next control adjusts the bass to the same outputs. The balance control comes next, followed by the volume control. The input selector switch at the bottom of the panel selects between inputs from MICROPHONE, MAGNETIC PHONO CARTRIDGE, TUNER, and the ubiquitous AUX. The two VU meters are just above the input-level controls, and the three-position speed switch is located just above the head assembly. The four-digit counter is mounted between the two reel hubs. The reel spindles are of an unusual and interesting as well as effective design—each has a single spline to locate the reel, and a detent ball keeps the reel in place.

Along the left end of the walnut finished case is a panel which accommodates all the input connections except the microphone and headphone jacks, which are on the front panel. A pair of phono jacks for external speakers, also located on this left hand panel, provide sufficient power output for any conventional speaker system. Next is a pair of phono jacks labelled "controlled preamp output." This pair provides an output following the tone, volume, and balance controls and is useful when a higher level is desired than is available from the usual preamp outputs, which provide no- tone or level-control facility. The controlled preamp output is actually taken from the speaker output circuit, scaled down by about 20 dB from the speaker terminals.

Next come the preamp outputs for tracks 1 and 3, the usual stereo configuration, followed by a bias switch which provides for normal or high bias, the latter being required for certain types of tape. The preamp outputs for tracks 2 and 4 are next on the panel, and then two jacks are labelled "mixing inputs." These jacks permit a variety of different recording techniques, such as recording a microphone with an already-recorded track in the usual sound-on-sound and sound-with-sound methods, or a pseudo-stereo mono recording, or a reverberant stereo, or a reverberant enhanced mono recording, as well as multiple mixing, using an external mixer to balance the several sources. Exceptionally clear instructions are given for the patching between the various inputs and outputs for these techniques.

The transport drive employs a heavy-duty induction-type motor for the capstan, with the usual three-step mechanism between the idler wheel and the heavy flywheel on the capstan shaft. Spooling employs a separate motor, a d.c. device enclosed in a shielded housing at the upper center of the unit, which drives the reel spindles through belts and also provides dynamic braking, thus eliminating the need for mechanical braking on the two spindles. The tape handling of the machine is smooth and was without any noticeable problem during the hours we operated it.

Circuit Description

Each of the four preamps employs two transistors in a feedback-pair configuration, with equalization being switched from the 7½-ips speed to that required for the two lower speeds. The preamp outputs are tapped off at this point on tracks 1 and 3 (tracks 2 and 4 have no further amplification) and also fed to the volume control and thence to the tone-control circuit, a Baxendall type. It is then further amplified by a two-transistor pair and fed to the three-stage power amplifier which terminates in a complementary-symmetry stage. The balance control is just ahead of the power amplifiers.

Each record amplifier employs a two-stage preamplifier which is flat for all but the magnetic phono input, and in that input it has the prescribed RIAA equalization, within ±2 dB. The record-level control is next, with the mixing input fed to the arm of this control, and this is followed by a two-stage amplifier equalized for the record characteristics of the three speeds. Its output is then fed direct to the VU

meter network and to the recording head through the constant-current resistor. The two levels of bias are selected by a switch which parallels a capacitor across the usual capacitor in series from the bias feed to the erase heads. All the circuitry is simple and straightforward. The bias/erase oscillator employs two transistors in a balanced circuit and provides a bias frequency of 98.7 kHz.

The power supply is conventional, with a bridge rectifier and adequate filtering to supply 50 volts for the output stages of the amplifier. The d.c. spooling motor gets the same in the fast mode and about 28 volts in the play mode. Progressively lower voltages are supplied to the earlier amplifier stages to provide better filtering of the low-level stages. A filament-type pilot light indicates when power is on by illuminating the VU meters, and the record indicator light is fed from the d.c. supply to the bias oscillator.

A pair of dynamic microphones and a supply of audio cables are supplied with the unit.

PERFORMANCE

We noted the speed to be exact at 120 volts, 1 per cent slow at 100 volts, and 4.6 per cent slow at 90 volts; similarly it was 1.5 per cent fast at 135 volts. The frequency response curves for playback from a standard tape are shown in Fig. 5. Running the tape backward, we were able to measure responses from tracks 2 and 4, which are within 0.5 dB except at the top end where the difference rose to about 1.5 dB. Responses measured in the record/play mode are shown in Fig.6, and are reasonable for all three speeds. The effect of the tone controls is shown in Fig.7 for full and halfway positions of the controls. Hum-and-noise measured -43 dB in the playback mode, using a 15-kHz low-pass filter in the output circuit and a reference of an indicated +2 on the VU meters, at which point the distortion measured 3 per cent. At zero indicated level, the distortion measured 2.5 per cent from 50 to 10,000 Hz. Fast-wind times measured 70 seconds for 1200 feet of tape, relatively fast for a "consumer"machine.

At maximum settings of the record-level controls, a signal of 0.4 mV was sufficient to provide a zero-dB indicated level, while 43 mV was required to reach the same level at the tuner and AUX inputs, all of which are within specifications.

From the amplifier alone, we measured an output of 11 watts per channel into 8 ohms at a distortion of 1.0 per cent from a signal which would indicate 0 level on the VU meters. Wow and flutter (rms) measured 0.06 per cent at 7½ ips in the band from 0.5 to 6 Hz; 0.12 per cent in the band from 6 to 250 Hz, and 0.16 in the overall 0.5 to 250-Hz band. Similar measurements for 3¾ ips gave figures of 0.15, 0.16, and 0.25 per cent, and at 1⅞ ips we measured 0.18, 0.20, and 0.25 per cent, respectively.

Operation on Quadraphonics

In order to get the subjective feel of the 6364 with four-channel tapes, we hooked up a pair of speakers to the speaker outputs for the normal stereo channels (tracks 1 and 3), and fed the rear-channel outputs (tracks 2 and 4) through our normal listening system. Thus our regular speaker systems became the rear speakers and the two additional units became the normal "left front" and "right front" speakers, so we

Fig. 1—Close-up of the head assembly as seen by the user.

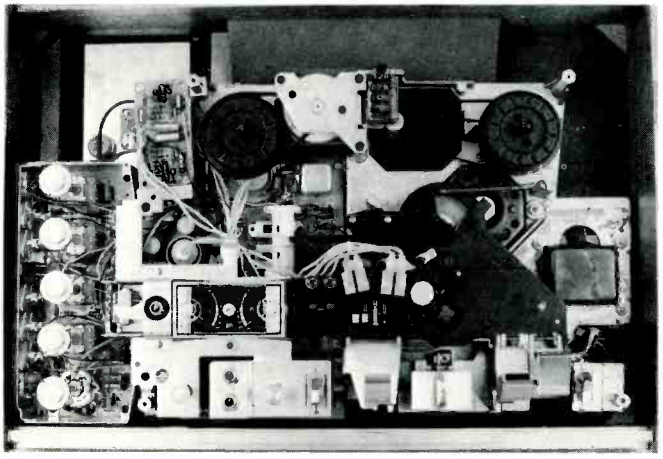


Fig. 2—View of the 6364 with the top plate removed. The amplifier controls are shown in line at the left.

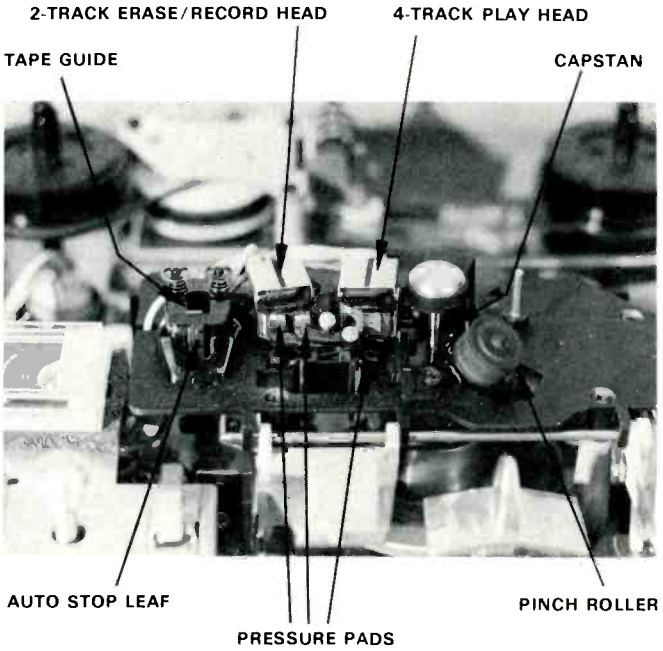


Fig. 3—Front view of the head assembly with the pinch roller and the pressure pads partially closed. The roller retracts to the horizontal position, as do the pressure pads, for easy threading.

simply had to turn around in the room to make everything come out right again. The two auxiliary speakers were not identical to the regular ones (who has four identical speakers this early in the quadraphonic game?) but they were of excellent quality—one was a Tannoy Orbitus, and the other a Fisher model of a few years ago, but still an excellent performer.

With the Vanguard test tape which accompanies the 6364, we finally got all four speakers carrying the program material they were supposed to according to the spoken announcements on the test tape and all equal in sound level as the announcer tells us. Then we went through the six selections on the demo tape—Handel's *Jephtha*, the inevitable Berlioz *Requiem*, two selections from Mahler's *Symphony No. 3*, two vocals from female pop singers, and a short bit of *The Amazing Electronic Pop Sound of Jean Jacques Perry*. Then we did it several more times, listening continually to the instrument and vocal placements and the overall effect. This was our first listening experience in our own familiar surroundings, and we must confess that "Surround Sound" is impressive and certainly a far cry from a system suggested 10 or 15 years ago by an enthusiast during one of the Los Angeles hi-fi shows. This individual suggested four speakers, one in each corner of the room, with the (mono) sound being commutated from speaker to speaker continuously. (If you try to face the sound with this system, you either wind up with a twisted neck or sitting on a piano stool.) None of that, however, is real four-channel sound. Impressive it is, though not all rooms will easily accomodate four speakers.

Most persons will like quadraphonic sound immensely of course, but some will not; this is up to the individual to decide. Whatever your decision, you can be assured that the 6364 will give you a good performance of your four-channel recorded tapes and will still be a comfortable and effective machine to use for conventional two-channel stereo listening.

C. G. McProud

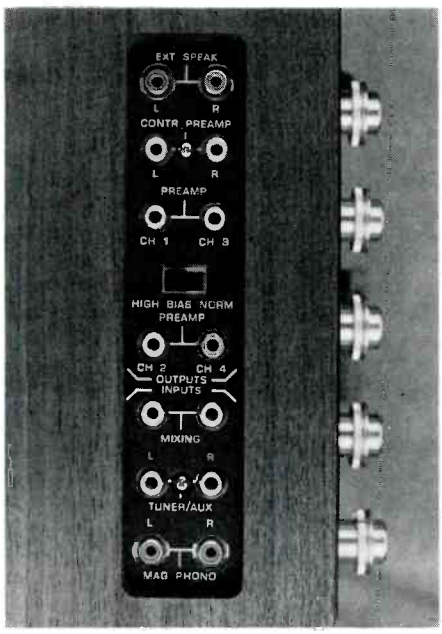


Fig. 4—The input-output connector panel on the left end of the cabinet. Bias level switch is seen at the center of the panel.

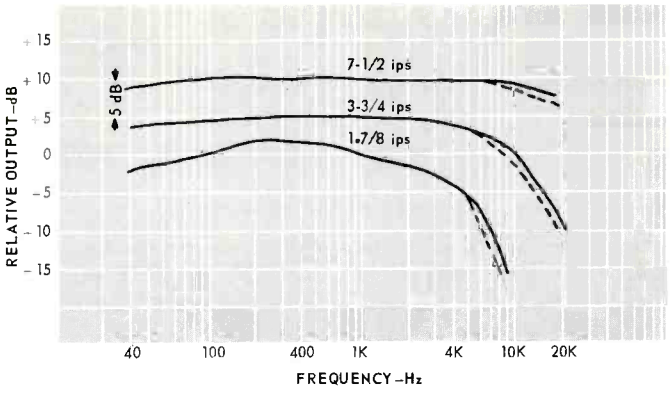


Fig. 5—Response from standard test tapes at the three indicated speeds.

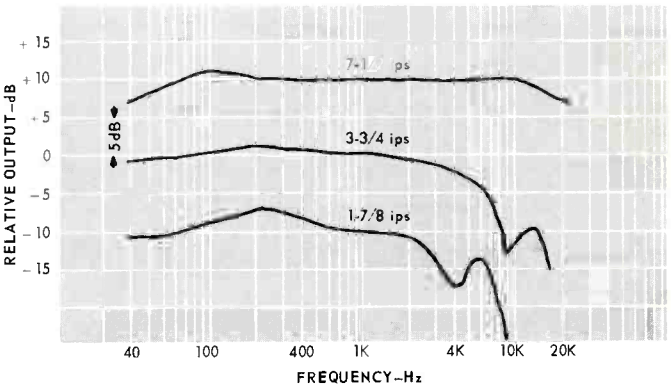


Fig. 6—Record and playback response at the three indicated speeds.

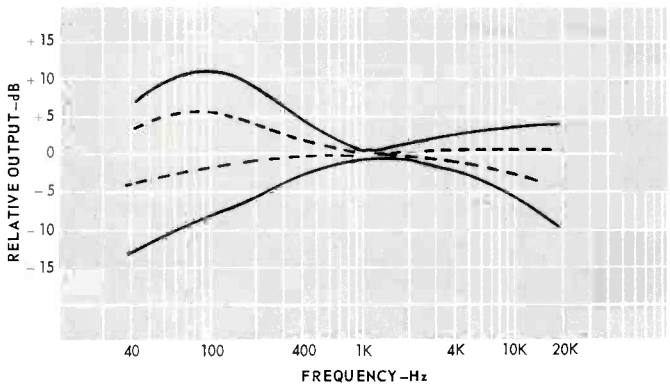


Fig. 7—Tone-control curves taken at 7½ ips. Solid lines indicate response with controls at FULL positions; dashed lines show response with controls at HALF positions.

Bundles From London

Greg Morrow

As VIRTUALLY ALL musically concerned readers of this magazine are aware, the classical music industry in the United States is going through a period of difficulty that may be described as the "classical blues." This malady infects all facets of the classical scene, but none, it seems, so deeply as the classical recording industry. This has resulted in many unhappy classical record collectors. I challenge anyone to show me a really contented classical record man. Indeed, who has been fortunate enough not to have returned discs to a dealer for quality defects? Theoretically, a contended classical record collector could live in Pierre, South Dakota, or New York City and have no trouble finding any classical record listed in the Schwann catalog. The satisfied collector would have access to well-stocked shops staffed with knowledgeable sales persons.

Unfortunately, outside of the largest cities, there seems to be no habitat where the few remaining contented classical record collectors (if they do exist in the United States) might thrive. In fact, if events in the classical record industry keep moving as they have been in the past few years, this nation may find itself without any classical record collectors at all, satisfied or no.

But I believe that there is an alternative to this—importing one's recordings from Great Britain.

At first glance, this solution may seem rather farfetched, but it is not as complicated as it might seem. In Great Britain profit ordinarily is not the prime motive for releasing classical recordings, and therefore more care is given to the manufacture and overall quality of recordings. This is not to say that every British disc is flawless and perfect, but in most cases, quality is of a generally higher caliber than in the U.S. item. Thus, it can be to one's advantage to import one's classical recordings from Britain.

If the harried American classical record enthusiast wonders how his British counterpart fares, a copy of a current British record-hi fi periodical should be obtained. The two most popular ones, to my knowledge, are the *Grammophone* and *Records and Recording.*

In leafing through either of the above mentioned magazines, those who regularly read similar American publications will probably express amazement at the advertising by the various record companies. For example, in a recent issue of *Records and Recording,* CBS, the affiliate of American Columbia, had four pages of ads; Decca, six pages; Philips, four pages. These are fairly typical examples, and they all advertise *classical* discs! Each page contains fine art work and is tastefully laid out. Compare these pages with the paltry offerings in the popular American record publications. Most domestic record magazines are lucky to have four *total* pages of classical record ads.

Also, notice the large number of record shops which advertise in the British record magazines. Stores of all types and descriptions offer their wares to the prospective purchaser. A number of these shops handle classical or serious music recordings as their main lines, not secondary to popular recordings, as is the case with too many shops in the U.S.

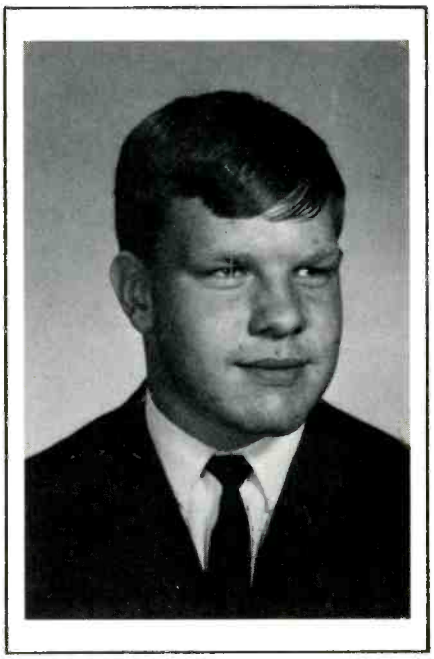
The "purchasing guide" compiled here hopefully will be of help to the dismayed American discophile, though it does not pretend to be complete. For example, I do not fully discuss tapes. The following only lists the record shops and manufacturers which do a major trade in the British classical record market.

The Record Companies

The Decca Gramophone Co., Ltd. Decca House, 9 Albert Embankment, London SE1, England

This large firm (no relation to the American company of the same name) markets its products under the *London* label in the United States. Always an innovator, Decca became famous for its "full frequency range recordings" *(ffrr)* in the late forties. Their old 78 rpm discs were almost as quiet and frequency response was almost as great as on the first microgroove discs which superseded them. In the summer of 1950, Decca became the first to introduce long-playing microgroove records to the British public. Although Decca was not the first to introduce stereo records, the British public did not really take to stereo until Decca released its first discs recorded with the new technique.

Decca's present catalog is vast, including such ambitious undertakings as the Wagner *Ring* and Mahler's Symphonies under Solti. There are several labels under the Decca leadership which produce classical discs:



Decca is a full-price line and features a large repertorie of all types of classical music. Most releases are in stereo.

Ace of Diamonds is a mid-price reissue line consisting of an orchestral/instrumental series and Grand Opera series. Most recordings are available in both stereo and mono. Flagstad's Wagner and Kleiber's *Rosenkavalier* and *Nozze de Figaro* are features of this label, together with conductors Ernest Ansermet, Jean Martinon, and others of equal renown.

Ace of Clubs is another mid-price reissue series, but most offerings are in mono only. Many of Kathleen Ferrier's recording are to be found on this label.

Eclipse is Decca's budget series and a veritable treasure trove. Ansermet's still dazzling 1950 *Petrouchka,* which was the first microgroove release in Britain, is one of the highlights to be found on this label. The Kleiber/Concertgebouw Beethoven Fifth, now unavailable in the United States, is another high point. Dame Edith Sitwell reading *Facade* and Munchinger's *Brandenburg Concertos* are also to be found on this label. Most releases are fake stereo, and a few are in mono only.

Phase Four, Decca's "sonic spectacular" series, offers light classical and classical warhorses recorded with a

rather exaggerated stereo effect.

EMI Records,
Manchester Square,
London W1, England

Electrical and Mechanical Industries, which is the parent company of Capitol, Angel, and Seraphim in the United States, bills itself as the "Greatest Recording Organisation in the World." EMI advanced the state of recording in the 1930's with its famous "Society Sets" of works by Beethoven, Sibelius, Delius, and others.

Today EMI's catalog befits an organization of its size and complexity. They release classical discs on several labels at present.

HMV, "His Master's Voice," uses the same famous "dog" trademark as RCA of the United States did until recently. The HMV line is a full-price series, recorded, with few exceptions, in stereo. Beecham, Barbirolli, and Klemperer conduct, while Callas, Fisher-Dieskau, and Schwartzkopf sing, among others. A special note for Beethoven lovers and bargain hunters: The Nine Symphonies conducted by Klemperer are available at a permanent bargain price of $23.76 (9 pounds, 90 pence). This set retails in the United States, on the Angel label, at $47.84. The HMV set was recently remastered and repackaged, so the sound is improved.

Columbia, which is unrelated to American Columbia, offers a mainly symphonic repertorie, with most discs recorded in stereo. Klemperer is one of the prominently featured artists.

HMV Concert Classics is a mid-price reissue series, featuring such artists as Sir Malcom Sargent, Dinu Lipatti, and Colin Davis, along with much of Furtwängler's recorded output.

Studio Two Promenade Series is EMI's answer to Decca's Phase Four stereo label. Light classics conducted by Silvestri, Boult, and Clarles Groves are features on this label.

RCA Limited, Record Division,
RCA House, Curzon St.,
London W1, England

The British affiliate of this American giant is well established in Britain. Most recordings are identical with those released in the United States. Classical recordings are issued on several labels.

RCA Red Seal is the top line series and allows Britons to hear the Boston and Chicago Symphonies, along with the Philadelphia Orchestra and other American groups. The London Symphony, under the baton of André Previn, is also prominently featured on British *Red Seal.*

RCA Victrola, as in the United States, is a budget reissue line, with emphasis on Toscanini, Munch, and other well-known figures who have recorded for RCA in the past.

RCA Victrola Sovereign is an exclusive British label, available at the regular Victrola price. Koussevitzky fans take note: Several of his recordings with the Boston Symphony are available on this label. These recordings include the Beethoven *Eroica,* Sibelius' Fifth Symphony, and Roy Harris' Third Symphony, along with *La Mer, Pictures at an Exhibition, Bolero, Ma Mere L' Oye, and El Salon Mexico.*

CBS Records,
28-30 Theobalds Rd.,
London WC1, England

British CBS, the branch of American Columbia, maintains an extensive catalog on several labels.

CBS is a full-price series, with most releases issued in tandem with American Columbia Masterworks. As expected, Bernstein, Ormandy, Boulez, and other prominent American soloists comprise the bulk of the recordings on this label.

CBS Classics, a mid-price label established several years ago, is a bargain hunter's delight. Bernstein, Ormandy, Szell, and Walter figure prominently in this series, along with E. Power Biggs, Charles Rosen, and the Juilliard String Quartet.

Philips Records, Ltd.
Stanhope House, Stanhope Place,
London W2, England

The British subsidiary of the Netherlands-based Philips electronics firm offers many handsome items. Recently Philips has released such sets as the Covent Garden *Les Troyens,* a five-record compendium of music composed by the Bach family, and an eleborate 11-record set of Wagner opera.

Many of the British discs are released by Mercury/Philips here in the United States under those two labels (domestically pressed), but the "Philips Imports" series is directly imported from Europe.

There are in Britain, as in the United States, many smaller companies which produce classical records. Listed below are some of the better-known small firms.

Unicorn Records,
27-29 York Road, Waterloo,
London SE1, England
Pye Records (Sales), Ltd.
A.T.V. House,
Great Cumberland Place,
London W1, England
Abbey Recording Co., Ltd.
All Saints Passage,
Cambridge, England
World Record Club,
P. O. Box 11, Richmond,
Surrey, England
BBC Radio Enterprises,
Villiers House,
Haven Green, Ealing,
London W5, England
Oryx Recordings,
167 Burwood Road,
London W10, England
Saga Records, Ltd.,
326 Kensal Road,
London W10, England

Information on the preceding labels may be obtained by writing to the addresses shown. Many of them also advertise in the larger British record publications.

The Record Shops

The shops listed are all reputable, and all advertise regularly in the record magazines.

Alfred Imhof, Ltd.,
112-116 New Oxford St.,
London WC1, England

Founded in 1845, this shop boasts one of Europe's largest stocks of recordings, both on disc and tape. Imhof's carries virtually all British, Continental, and world-wide labels. All orders have the personal attention of experienced assistants. Orders of over $36.00 (15 pounds) are shipped overseas post free. A monthly credit account service may be opened at this shop.

Henry Stave and Co., Ltd.
8 Dean St.,
London SW1, England

Stave's, the home of "Incomparable, Unplayed, Stave-Sealed, Virgin Gramophone Records," is another institution well-known to London record buyers. A unique service of this shop is the "Consensus and Review," a privately printed publication which is described as "an invaluable and utterly reliable guide to the latest releases."

All overseas orders are packed in wooden crates, and orders over $36.00 (15 pounds) are shipped post free. A one-year subscription to the "Consensus and Review" is $3.60 (1 pound, 50 pence).

James Asman, Ltd.
Mail Order Dept.
38 Camomile St.,
London EC3, England

James Asman offers records at tax-free prices to overseas customers. This shop carries an extensive stock of all records and labels, with many bargains offered nowhere else. When writing them, ask for their "bargain lists." Again, orders over $36.00 (15 pounds) are sent postage free.

Long Playing Record Library, Ltd.
Squires Gate Station Approach,
Blackpool FY 82 SPU, England

The LP Library offers a try-before-you-buy service, somewhat like that of a lending library for books, for both

discs and, introduced last year, cassettes. The difference is that you can buy the item if you choose, which cancels the borrowing fee. There is a low membership fee, the amount of which depends on which of the four services you desire and qualify for. Yes, *qualify*. But let me quote from a recent LP Library advertisement.

"In order to qualify for membership (in the Professional area of the Library) you must have genuine high fidelity equipment, with a playing deck physically separated from the loudspeakers, a transcription motor, and a cartridge arm of comparable standard."

To what does such membership entitle one? Discs in "immaculate condition" with "a good proportion of brand-new records." In addition, a regular list of the cream of the new issues is sent with your package of discs.

Crotchet & Co.,
Church Station,
Shropshire SY6 5DR
England

Crotchet offers a similar lending library service, with purchase as an option. Discounts are offered with the percentage varying with the amount of the total order. Library members receive special discounts.

Wilson Stereo Library, Ltd.,
104-106 Norwood High St.,
London SE 27, England

Wilson's publishes the Stereo Index, which is one of the better guides of quality discs. Covered are orchestral, choral, operatic, chamber, and instrumental works as well as lighter records, including folk and bands. While the two libraries above devote most of their attention to classical works, Wilson's includes jazz, blues, shows, and popular. And like the LP Library, they offer a cassette library, but in addition, open reel tapes are offered.

A good way to keep up on current British releases is to subscribe to a British record magazine. Listed are three popular, high quality record/hi-fi periodicals:

Records and Recording,
Hanson Books,
Artillery Mansions, 75 Victoria St.,
London SW1, England
$6.75 @ year (12 issues)

E.M.G. Monthly Letter
E.M.G. Handmade Gramophones Ltd.
26 Soho Square,
London WIV 6BB, England

The Gramophone
177-9 Kenton Road,
Harrow,
Middlesex HA3 OHA, England
$6.80 @ year (12 issues)

The Gramophone also issues the *Classical Record Catalogue*, a quarterly publication which lists in detail all British classical LP's. A year's subscription is $4.50 and may be obtained by writing to the above address. This catalog is a masterpiece of organization and detail—an artist's index is even included with every issue.

A publication called *The New Records* is put out monthly by Francis Antony, Ltd., Circulation Dept., 20 East Hill, St. Austell, Cornwall, England. A year's subscription is $4.50, air mail included.

Well, that is my run-down on English record labels, stores, and publications. True, purchasing discs from England is a bit more complicated and time consuming than a trip to Discount Discs at the shopping center, but when was the last time you were able to choose among the various recordings of a work rather than settling for the one which was in the record bin? And judging from what I've received, I think you'll be pleased with your bundles from Britain. Æ

EDITOR'S NOTE: *This article was written before the dollar devaluation, the effects of which were unknown as we went to press.*

Stockhausen's Stimmung: First New York City Performance

William N. Agosto

ON A SUNDAY NIGHT last November, six vocalists from the *Collegium Vocale* of Cologne ranged themselves on the floor around a lighted circle on the Alice Tully Hall stage at Lincoln Center and began to intone *Stimmung* by Karlheinz Stockhausen. It was the first New York City performance of the work by the aging *enfant terrible* of German new music, and the young musical avant garde made a good showing. They listened intently for 75 minutes, without interruption, while the performers sang what sounded like every overtone their voices could produce on the lowest vocal B. The harmonic spectrum grew from the keynote to a thin web of the most prominent partials. Gradually the overtone content increased. With exceptional control, the vocalists dispersed pitch transitions among themselves from a few Hz up through more conventional intervals, enriching the harmonic structure at a deliberate and continuous pace.

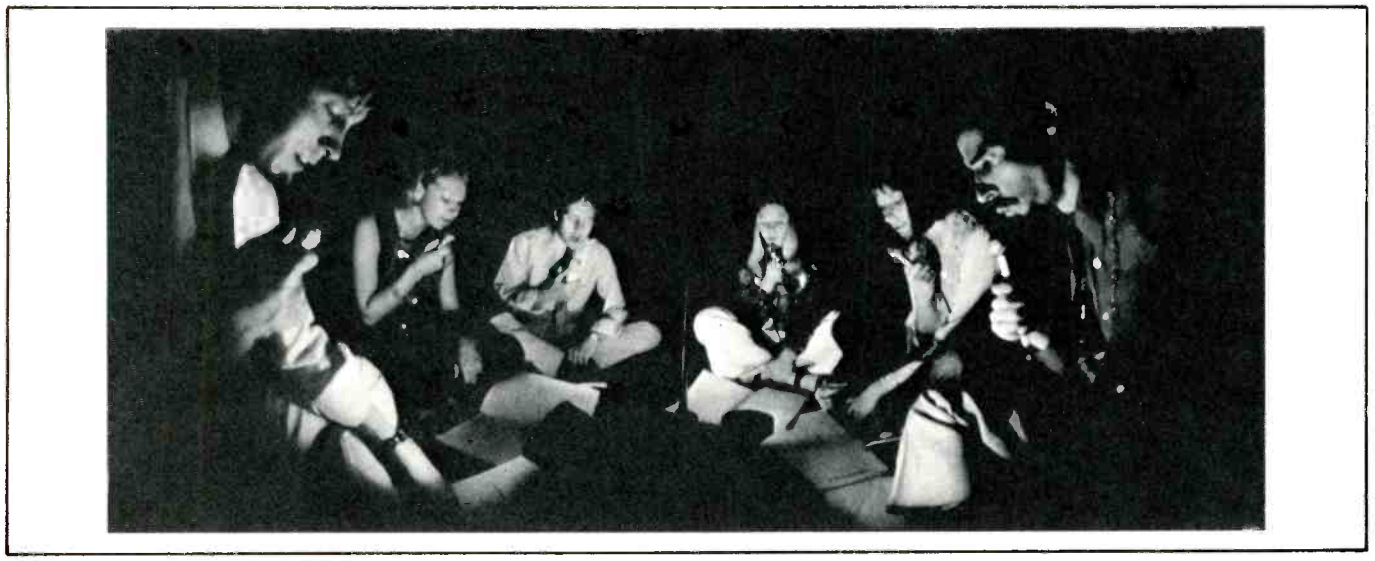
There was no instrumental accompaniment except for taped reference pitches which the audience couldn't hear, and it was hard to believe the overtone separation achieved could be obtained with the human voice alone. Each performer used a microphone for amplification, without evident electronic alteration. All the intonation was in the head, a constant drone of changing vowel sounds, chants, hums and breathings. It was a simple conception, all the natural overtones of B, but executed with the precision of an acoustical prism.

Mr. Stockhausen composed the work on Long Island Sound in 1968, using texts he wrote in 1967 while amorously involved in the San Francisco Bay area. It was commissioned by the *Collegium Vocale* at the Rhineland School of Music in Cologne and the first performances were given in Paris late in 1968. It has been performed many times since, especially at the Expo 70 German Pavilion in Osaka.

The title, *Stimmung*, (*tuning or mood* in German) suggests the vocal exchange among the performers. Each singer has 11 "magic names" which he may use to begin eight or nine "models" or musical phrase patterns. Every performer shares in conducting the work. When one begins a model he motions the others to take it up and develop it. They do so within the prescribed overtone series, reciprocating harmonically, rhythmically, dynamically and textually. The magic names are like bridge posts supporting the musical continuum. They include the days of the week in German and English, as well as Indian and Oriental words, *Vishnu* and *Kai* among them. Fragments of German, English and Japanese poetry are used and phrases like "come on," "the male is basically an animal," and even "Barber shop" which falls in with the tuning and detuning blend very well.

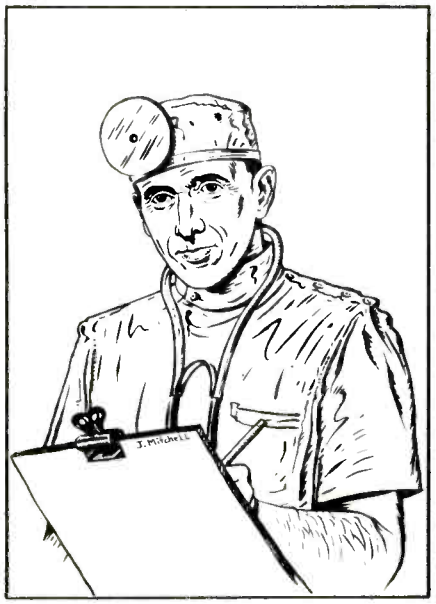
The work has the rare quality of being both hypnotic and intellectually satisfying. The interior development of the harmony is very absorbing, the tissue of sound sensual and the texts diverting. There is a strong Eastern strain, but the composer's European heritage is equally well in evidence. The drone recalls the orchestral pedal of Wagner and Debussy, and Schoenberg-like *Sprechstimme* erupts from time to time. *Stimme* (the voice) is common to *Stimmung* and *Sprechstimme* and all three are omnipresent in the work. It is music which the listeners felt strongly about—with an almost religious experience on the one hand or leaving the hall on the other, as some did. Nobody was indifferent.

The composer was there, gracious, affable, obliging young questioners with a feast of answers—and celebrities with a buffet. It was a pioneering evening. We felt we were charting a new course and filling out a consciousness, and Mr. Stockhausen was very much at the helm. AE



Audio ETC Doctoring the Signal

Edward Tatnall Canby



THIS MAGAZINE is Philadelphia-based, whereas I am New York-based, and this is often a great convenience. True, we have a busy telephone tie line from one city to the other, which makes talking with the office a bit like talking to my neighbor down the road on my Connecticut party line during weekends. But the Editor is unable to attend NYC meetings and press conferences via tie line. So either he trudges resignedly down to the RR or bus station and makes a long day of it, or he gets hold of one of us up in the Big City. Fun and games. I've got a pile of press stuff a foot high in front of me now, and my insides have been pleased by more snazzy eats and drinks than you can imagine in these last months.

And there's the AES Convention, too, almost next door to me, relatively speaking. I hung out there for days at a time last fall. (The Editor had to take a hotel room.) Practically had my brains frying—there was so much to be learned, by anybody interested in what is new and/or controversial in this *very* controversial period of audio history. The AES Conventions are for me like going to college again.

Bits of all this accumulation and more will be spilling out here, as space allows. I will *not* ask for an entire issue—which might be necessary to cover it all. That would be impractical. Because as we become a bigger magazine, space becomes more valuable, *ergo,* harder to get, this being a curious application of the old law of diminishing returns! The mature Canby, in any case, is less longwinded than the youthful version of 24 plus years ago, when we started. So—to business.

Big Bang

For my ear, the most totally sensational demonstration at last autumn's AES meetings occurred in a hotel room upstairs from the main activities, and nobody was around except the inventor and his helpful wife. I walked in curious; I left aurally shaken. Yet I heard nothing more than a couple of drum beats, recorded on tape. Just what the Burwen Noise Eliminator will do for the larger audio world is not yet clear. But its impact on the immediate ear is incredible. Merely to read about it (AUDIO, June, 1971) in the author's measured words isn't the same at all, through no fault of his, needless to say.

Just "picture" it audibly in your mind. Walk in and sit down before a more or less standard-looking stereo hi-fi living room set up, with a tape machine attached. Not a pro monster, just one of those that habitually play at 7½ or slower in plenty of homes. Off to the side is the "works" in question, a flat, thin module designed for very minimum rack mounting, a couple of inches high. The tape is turned on, with the familiar modest *clonk,* and the reels turn, I wait.

But is the power on? Are the electronics functioning? Not a sound. Not even a *trace* of *any* sound. Just like my old Ampex when the electronics fuse blew, but the mechanical-drive fuse didn't. All machinery working. No sound. Dead. Just as I was about to open my mouth to ask—**BAM!!!** The most horrendously loud kettle drum (or was it bass drum?) explosion I've ever heard. Then, silence. And then again, **BAM!!!**

There was more, but this was all I needed. Here was an audio phenomenon that in at least a half century I am sure nobody had ever heard before. Not in *that* ratio between silence and sound, S/N if you wish. And not with such extraordinary *cleanliness.* Takes me awhile to write all this out, but the entire impact of this device, intellectually as well as sonically, hit me in a half second, and no two ways about it.

We all know the problems that have plagued the difficult art of compression and/or expansion of the audio signal over these many long years. We remember the early crudities and we still know the sounds of the various overshoots and undershoots and so on that happen, even when they shouldn't, when the pure audio signal is tampered with as to its natural volume levels. We recall (we older fans) the excitement in the 1940s over the H.H. Scott Dynamic Noise Suppressor circuit, designed to take hiss and scratch and rumble out of 78 disc reproduction. (It did, if you got all the gates and thresholds and levels just right.) And then there was the later Fairchild Compander, home-intended (which, alas, I could never make work for my own home listening). In the pro area there are vast quantities of C/E equipment and always have been. We are all too familiar with, shall I say, the compansion, that goes on the air today to produce a maximum signal and, hopefully, so much more moola. (Cash, to you.) I am shocked, regularly, to hear the incredible distortions perpetrated by some of our pop AM stations, whose names I will not mention. Singing (or speaking) voice over music—and the music wobbles in and out, up and down, as though somebody had loaded the musicians into a brace of jeeps with oval wheels bouncing over a corduroy road in the jungle and said, "Now, P-P-PLAY, boys. . . ."

And, finally, we are very much aware of Dolby. Dolby did it right, a few years back, as far as combined compression/expansion is concerned, and the Dolby people have since developed their basic idea into a world-wide integrated system, now semi-standard and tied into innumerable audio operations. Does Burwen challenge Dolby?

In some ways, yes. Dolby's background silence reflects S/N gains of 10 dB and more, without audible signal change, in the areas where the A and B circuits operate. Burwen's flatware, inserted in your audio, will give you 35 dB, and that's a lot. Even more impressive, though, is that cleanliness of sound. As far as my ear could tell, it was absolute. Drum transients! A very tough test, and I heard no dif-

ference between the treated and untreated drum explosions. Burwen, like Dolby a few years ago, just seems impossible. But these are the things we do today with solid state technology. The Burwen "poop" cites a test, channel 1 into channel 2, that shows an "instantaneous error" of not more than +0.5 dB for steady signals and +1 dB for transients. A "Precision Rectifier" does it, and the individual component modules in the system run accurate to a tenth of a dB, with harmonic distortion in the 0.01 dB range. Far be it from me to quote further specs. But my ear, unequivocally, says *good.*

Also I leave it to you to delve into the technical differences between Dolby and Burwen (they are very different, as a matter of fact). I merely suggest that the two systems are by no means mutually exclusive and may very well work together, most likely in tandem. (How else?) Burwen might be used for basic noiseless recording, allowing a 110 dB dynamic range on your master tape, then Dolby for the usual transfers on down the chain to the ultimate audio destination, with minimum S/N losses en route and maximum interchangeability. It would seem unlikely, at this point, that Burwen could directly challenge Dolby as a new over-all standard. Dolby already has such a solid position of usefulness and practicality, in a thousand interchangeable areas, that the system is not going to be tossed out overnight under any circumstances at all. Besides, as I say, the two systems are innately different in technique and not directly competitive in practical terms. Room for both.

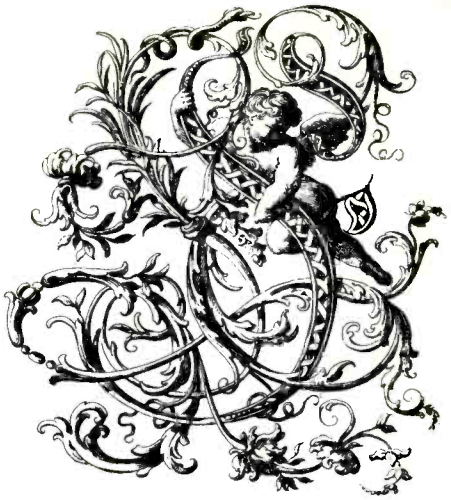
Burwen has a Dynamic Noise Filter too, a one-shot affair (not the dual mirror-image system characteristic of the Noise Eliminator and of the two Dolby circuits) which seems to be the latter-day successor to the H.H. Scott circuit. Also comes built into an amplifier. If the Eliminator weren't so sensational, I surely would be spending time on these; but somehow, I can't get my mind off that big **BAM!!!** Really hit me.

Note, you hi-fi bugs, that these Burwen products aren't exactly intended for your Aunt Sarah's portable Sony, or something. If you have an extra thou on hand, you can buy yourself a channel of Burwen; two cost more. If you are a crazy four-channel fiend, it'll be $5,700, please. (But I'll bet they come out with a Consumer Eliminator one day soon. If you see what I mean.) **AE**

Erratum
New Receiver Directory

The correct price of the Panasonic SA-4000 receiver, listed on page 39 in January, is $990.00.

Classical Record Reviews



EDWARD TATNALL CANBY

Leedy: Entropical Paradise. Six Sonic Environments Created on the Moog Synthesizer and Buchla Modular Electronic Music System. Seraphim SIC 6060 (3 discs), stereo $8.94.

These new big electronic pieces have one thing in common—they are invariably acclaimed, especially by their own publicity people. But they aren't really all alike. This one is good. Even the "argument," by the composer, is simple and well written, and will convince you if I don't. *That's* plenty rare! (Most composers write turgid technical polysyllablic jargon. They'd do better to stick to music.)

Sonic environments—exactly. The big point of these six sides is that they do not "go" anywhere, though they constantly change, within a rigid set of parameters, a computer-style program of sounds for each, very limited and yet infinitely varied. It takes awhile for most of us to get out of the old feeling that works of art in time must GROW, must have shape, beginning, end and middle, all somehow inevitably right. That is Germanic dogma, superb for a large area of classical music. But not universal. It took me a good 30 years to find *this* out for myself!

Each side is programmed out of a very few basic sound-variables. These are somehow organized with the intent of infinite *randomness*, within a pattern. Now any mathematically inclined reader will know that here is one of the toughest of practicalities! Nothing is harder to generate than true *randomness*. Nature tends towards entropy. See? So I find the genuinely random aspects of the patterned sounds in these works quite fascinating in themselves. Unity and Diversity, that is the old game, newly set forth. The nearest natural equivalent, I'd say, is the sound of water dripping into a bathtub. That is exactly what we have here, in conceptual terms. No beginning, no end, a rigidly circumscribed set of sound parameters—and a superbly fascinating degree of randomness! Only, this might be 50 dripping faucets all at once.

Each side has a type of sound set-up. Wood-blocky, xylophone sounds in a watery reverb. Popping, twanging sounds, guttural, or like a finger popped out of a mouth, stuttery. Sighing wind sounds, a rising hurricane blast that blows up and dies away, again and again, gales blowing through loose weather stripping, or steam locomotive whistles, mournfully never-ending, like ghosts of an era. Some of it is ugly, demanding. Yet interesting.

You don't have to call it music if you don't want to. The composer says so. That's helpful. It's like Varèse's "organized sound"—but very differently organized, an altogether different world. I suggest you'll be able to use it nicely to make your own sonic environments. Just play, like sonic wallpaper. Pretty good wallpaper.

Performance: Ain't none. Sound: A-

Village Music of Yugoslavia. (Zagreb Folklore Festival). **Nonesuch H-72042,** stereo, $2.98.

The African Mbira. Music of the Shona People of Rhodesia. Dumisani Abraham Maraire and others. **Nonesuch H-72043,** stereo, $2.98.

Javanese Court Gamelan. Pura Paku Alaman, Jogyakarta, K.R.T. Wasitodipuro. **Nonesuch H-2044,** stereo, $2.98.

Always keep an eye and an ear on the Nonesuch Explorer releases. They seldom lack interest and the stereo fi, regardless of the locale, is invariably hi. (That's partly because a lot of them are recorded in the U.S.A. by traveling "natives.")

Of these three, oddly, the most Westernized is "The African Mbira." The three Shona people who perform are two students and a professor at, of all places, the University of Washington in Seattle; but this, surely, has little to do with the Western influence so clearly marked in their home music. Its sound is strikingly like that of the West Indies steel band made out of old oil drums; the instruments clank away, marimba style, with frequent expressive buzzings, accompanied by shaking rattles; the singing too is not too far from the more primitive West Indies sort, but with more repetition of shorter bits. The Western aspect is in the clear harmonies, which at times have an almost "gospel" quality, simple chords and keys like F major. Nice music and a nice jabber of meaningless (to us) Africanese, the whole not a bit the worse for whatever "contamination" it may have suffered. I'd call it, rather, assimilation.

In contrast, the Javenese music is 100 percent Eastern, with not the slightest trace of Western influence. As always, it is a highly shopisticated, extremely elaborate and formal music, played at length on traditional gamelan instruments—gongs, bells, assorted metal sound producers, these produced in the 17th century for a local prince, whose successor was honored by the music here recorded on the occasion of a birthday broadcast. (Seems the Prince's birthday is celebrated every 35 days.) The instruments in this case are accompanied by numerous voices, solo and women's group, an unusual gamelan facet for those of us who have heard only the instrumental music.

The Javanese music is dutifully and interestingly explained on the jacket, with many references to the various traditional modes and tunings, but all of this will go right over your musical head, of course. Our ears simply are untrained for these complex and ancient ways of hearing. The scales used are clear enough, except that most of the notes will sound "out of tune"; they do not correspond exactly to our Western tones, which seem so "right" to us. Interesting modalities, such as a long work based on the notes (approximately) F-sharp, G, B, C, D, with the unlikely B—most inappropriate in Western thinking—as the clear tonic, the ending note. Nope, you won't be able to say you get the sense of this music. But you will nevertheless find it interesting and pleasing. Imagine (as you listen) how the Beethoven Fifth might sound to one of these performers!

As for the Yugoslavs, they preserve a remarkable amount of their ancient village musical traditions which

antedate our Western art music by millenia. Some of this recording, of course, is village polka music, more or less, charmingly crude and unsophisticated. But more of it is exotic and Eastern sounding, the voices wailing in that loud, piercing fashion that seems to go with true folk singing everywhere, full of tricky ornamentation and rhythm. One pair of instrumental works (there are primitive oboes, clarinets, guitars, out of the Middle Ages) is carefully played in dissonant parallel seconds and sevenths, a style that is almost too odd to believe.

The promoters here have fallen a bit back into a dishonorable recording tradition: excerpts that are too short and too many. These vary from less than a minute to a bit over three. The music would be better for longer slices, as in most of the other Nonesuch Explorer recordings.

Performances: ?? Sound: B+

Beethoven: Sonatas for Piano and Violin, complete. (1944). Joseph Szigeti, Claudio Arrau. Library of Congress concerts. **Vanguard Everyman SRV 300/3** (4 discs), $11.92.

Is it true what they've been saying about Arrau? More than a quarter century later, Arrau has entered the category of famed pianistic elder statesmen, revered far and wide in the music world. Musicians bow down, as have concert audiences. And PR people, too, right and left (following, not leading, as PR always does). Yet, to my own disquiet, I have consistently found the late Arrau's pianism unmusical, cold, hard; I wish I hadn't. Much easier just to worship, along with others!

1944 and a revelation. Marvelous! Now I begin to understand. Arrau was a born pianistic genius, playing big Beethoven at 4 or something. In 1944, here, his Beethoven is absolutely alive, full of bounce and vigor, so much so that, indeed, the wise Szigeti, one of the top fiddlers of the day, quietly gives him first place without batting a fiddler's eyelid. True, there are a few intense passages, in the "Kreuzer," where the later and harder Arrau is perceptible. But mostly he sounds like another Rudolph Serkin, all tremendous bounce, personality, projection. Somehow, this is the way the young Beethoven must have played. With this sort of keyboard charisma.

In comparison, Bartók's "Kreutzer" Sonata of only four years earlier, in the same hall, with the same violinist, is not really a performing success. It is a composers' performance, as composers go in this modern age. I know—Bartók was a celebrated pianist. But for my ear, in the telltale Library of Congress Beethoven, he plays like a 20th century *composer*. That is, he plays with brilliance (he had the fingers) and immense conviction, but with that curious inner drama that says, somehow—*If only this durned instrument would say what I want it to say*! It never quite does. Bartók was too big for his own fingers, at least in his conception of Beethoven. The fingers were plenty quick, but the mind was still quicker, and fell over itself trying to convert ideas to physical sound. Only on paper did Bartók really

get down everything he felt. And, of course, in playing his own music.

Don't ask me why Arrau is not now, for my ears, what he was in these 1944 recordings. Don't ask anybody, because you'll get nowhere. His fame is set and that is that.

Performance: A- Sound: C

Songs of Debussy. Anna Moffo; Jean Casadesus, pf. **RCA LSC 3225,** stereo, $5.98

All these musical eggs in one basket —and not a crack to be found in any of them, for my ear. That is because the two artists involved here are both of them sensitive, understanding, and musical. That's what you need. Also, of course, you need *very* careful engineering, to balance the big piano against a voice that must range from very loud to very soft, all over the place. RCA's people have done this job nobly.

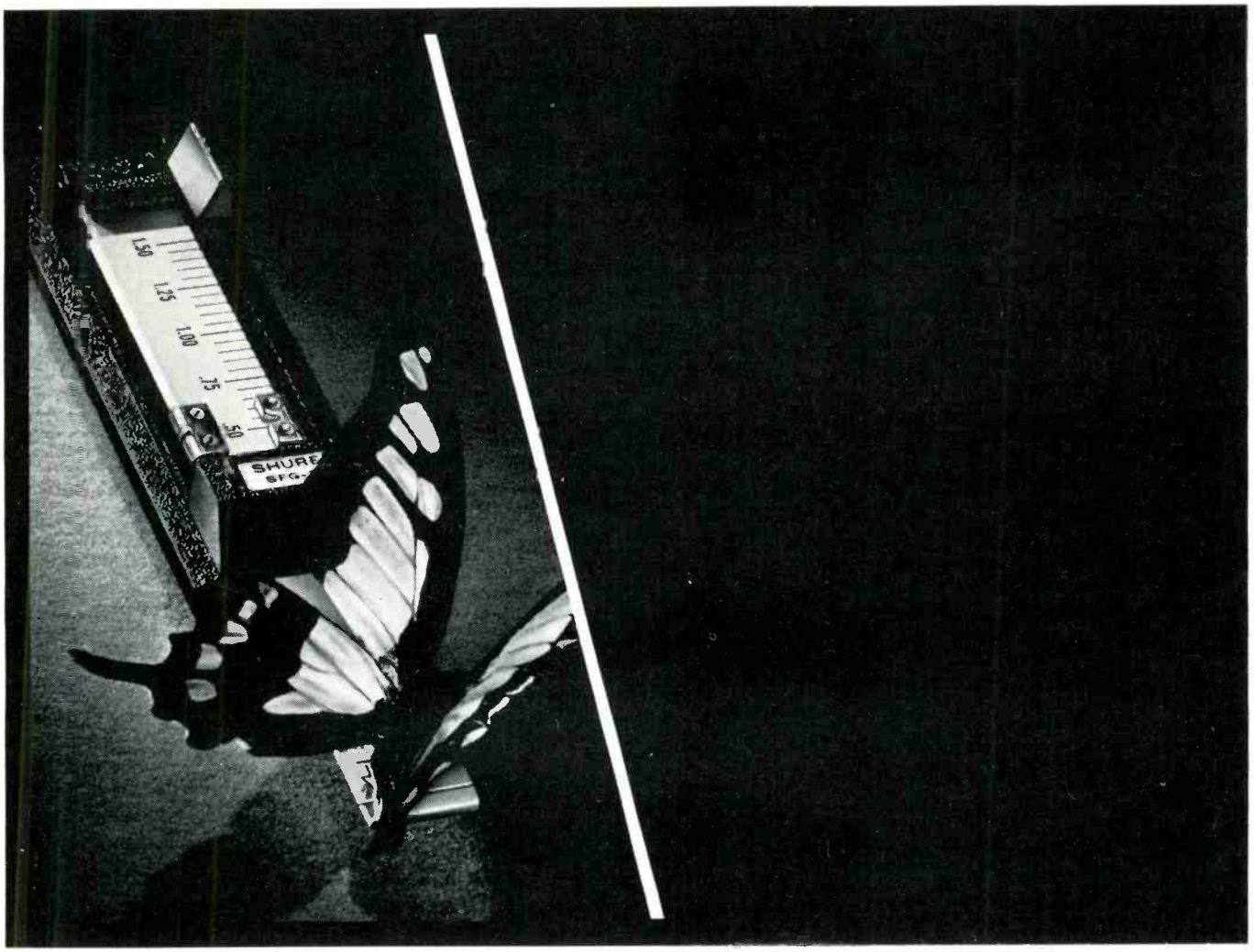
Moffo's voice is a trace heavy for Debussy but the French styling of her delivery is remarkably good and her ear for exact pitch is absolutely superb, as is her control of the often-difficult high passages and the large leaps. She gives you a fine feeling of confidence, that nothing is going to go wrong, or be embarrassing, or grossly loud, or fuzzy and diffuse. And Jean Casadesus plays as though born to Debussy, which in a way he was. Last, but *not* least (Angel, please take note), there is a big booklet with all the texts, in French and English.

Oh yes, one little fault in the production. Alan Rich's good comments on the various groups of songs are useless, for many listeners, because there is no identification, on the jacket or the disc, except by individual title! Silly oversight. You can always get out your big music dictionary and look them up, one by one.

Performance: A— Sound: A—

Peter Rabbit and Tales of Beatrix Potter. Original soundtrack music from the Royal Ballet Film. Orchestra of the Royal Opera House, Covent Garden, Lanchbery. **Angel S-36789,** stereo, $5.98.

The film from which this music comes is by now very well known, what with frequent showings and massive attendant publicity in the big mags —pictures in color of those human-sized ultra-realistic animals, pigs, mice, frogs, squirrels and, of course



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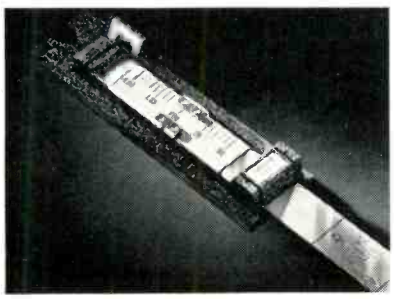

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Canby's Capsules

Pre-War Victor, Columbia, RCA, ETS.

Leopold Stokowsky and the Philadelphia Orch. (1927). Beethoven: Symphony #7. Schubert: Unfinished Symph. Parnassus 5 (Box 281, Phoenicia, N.Y. 12464).

Wow! All collectors over 50 remember Victor's first 78 albums with the "Philly"—virtually the first *albums* in U.S. front parlors. These were M-16 and M-17 and do *I* remember them. But—WOW!—what a strange sound now. Old-fashioned playing, with slithey violins where none now dare slide; Yet plenty potent, and the LP transfer is a labor of love. Exhaustive, incredibly detailed discographic notes on all these Parnassus items, for the specialists.

Walter Gieseking, Hans Rosbaud. Mozart: Pf. Concerto in E Flat, K. 271. Beethoven: Pf. Concerto #1 in C. Berlin State Opera Orch. **Parnassus 7.**

U.S. Columbia's albums began to count by the middle 30s. Here are M-291 and M-308, as imported and reissued on domestic 78. This is vintage middle-Gieseking, tho I disagree with Parnassus' dislike of the later G. discs. His German music, as here, is always technically superb, but dry and formal; whereas, somehow, his French Debussy gets to the soul of that composer. For me anyhow. The old Berlin State Opera Orch. (ca. 1936) is pretty sad here, even allowing for no-edit takes on 78 disc. A comment on those times, maybe?

Reiner/Chicago Symphony Play Bartók. Music for Strings, Percussion & Celesta; Hungarian Sketches. RCA Victrola VICS 1620, stereo, $2.98.

The early-stereo Chi/Reiner tape recordings were a later notable series, since reappearing on LP, now via low-cost Victrola. Reiner's Bartók and R. Strauss simply cannot be beat, ever (though matched in different-style performances)—tautly disciplined, crystal-clear, explosively potent, with cat-like tension—what else? Plus fine early-type distant stereo. (This is orch. string version of "Music." Alternative uses solo string players only.)

A Sonata Recital (1940) by Joseph Szigeti and Bela Bartók. (Lib. of Congress concert.) **Vanguard Everyman SRV 304/5** (2 discs), mono, $5.96.

Here's more history for you: Bartók himself—playing Beethoven and Debussy, plus Bartók. Odd! The great man now sounds *very* old fashioned (and why not? he'd be 90 this year). In the Beethoven ("Kreutzer"), much heavy rubato, all the chords played left-hand-first, turn-of-the-century style. But the B. power is there—an electric performance. Szigeti (before his later wide vibrato) is excellent, especially in Bartók; just right dynamic coarseness of fiddle tone. (He had played with Bartók for years.) Fair "electrical transcription" type sound (16" 33s?). Music a bit under-rehearsed—B. had just landed from Europe.

Charles Ives Chamber Music (first recordings). Paul Zukovsky, vl, New York Str. Quartet. **Columbia M 30230,** stereo, $5.98.

Copland: Quartet Piano and Strings (1950); Sextet Clarinet, Piano, Strings (arr. Short Symphony, 1932); Str. Trio "Vitebsk" (1929). Aaron Copland, pf, H. Wright, clan., Memb. Juilliard Str. Quartet. **Columbia M 30375,** stereo, $5.98.

Somebody threw these at me for a sonic guessing game—predictably, I floundered all over with the Ives, until a sassy American tune gave the show away. Hindemith, Schoenberg, what-have-you! Yet it's all 1908 and back. Copland I spotted in moments—he always sounds himself, whether pop-smooth or classic-dissonant, as here. If you like modern solo strings with piano, plus clarinet, these make excellent document discs, rounding out two important Americans.

Adolf Scherbaum, Trompete. (Torelli Concerti, Sonatas; A. Scarlatti: Cantata Su le sponde del Tebro; 2 arias, Endimione e Cintia. Trompete Barock-Ensemble Scherbaum, Barbara Schlick, Sopr. **Deutsche Gramm. 2530 023,** stereo, $6.98.

Expensive, but worth it. Scherbaum's trumpet has modern valves but his styling is perfect, the sound wonderfully clean and accurate, his surrounding ensemble impeccable. On side 1, a brace of Torelli (no—*not* Corelli), one with two trumpets; on side 2, a Scarlatti Cantata and two arias, pitting trumpet against soprano—lovely, slightly archaic Baroque with some strange harmonies. Schlick is excellent German-type soprano (you'd never know all this was Italian), sincere and accurately musical.

Medieval Roots. New York Pro Musica, Greenberg, White. **Decca DL 79438,** stereo, $5.98.

A fine "best of" reissue disc, easy-listening suite of well-matched early works, voices and instruments, from assorted earlier Pro Musica tapings. The instruments are best; the vocal pieces have some of the hard, hurried early-Pro-Musica sound. But the whole flows—a good job.

Peter Rabbit himself, all going through their graceful dance routines. Probably half suffocated inside those masks. But of the music, not having seen/heard the film, I knew not a thing. Nobody was talking. Whose music? What sort?

Well, it says here that it was "composed and scored" by John Lanchbery, who is the conductor. So it must be, but what it adds up to in the listening is a kind of parallel to all the typical ballet music of the mid-19th century you ever heard, and pleasantly so. All very pre-Tchaikovsky, more out of Gounod or a mild Delibes, *very* mild. Just how much of it is pure imitation by John Lanchbery, whether any of the music is transcribed from works of that period (scored, as the ascription has it), is not too clear. I recognized the style, but not the tunes, though I admit I got a bit absentminded, here and there, and might have missed a familiar old clinker. In any case, none of the numbers are identified except by the dance title.

All of which means that you may buy this disc (a) as a bit of harmless old-fashioned-style background music, or (b) if you have seen the film, to remind you of same. Either way it's quite OK.

Performance: B Sound: B

Brahms: Hungarian Dances, Waltzes Op. 39. Schubert: Marche Militaire; Fantasia in F Minor. Richard and John Contiguglia, duo-pianists. **Connoisseur Soc. CS 2037,** stereo, $5.98.

This is the finest disc of two-piano Brahms and Schubert since Stereo! In my memory, only the team of Demus and Badura-Skoda, on old mono Westminsters, could possibly compare in the truthfulness and beauty of this Schubert, as here put forth. And I *never* remember hearing Brahms like this! Not on discs, anyhow. I played the whole damn thing three times through.

These two young men, out of Yale University, are that rare phenomenon, a two-piano team that plays *music,* not just brilliantly coordinated pianism. They are indeed superbly coordinated, almost beyond belief. But what comes out makes one forget the pianos. And think of the composer himself. They have such a beautiful sense for phrasing, for rhythm, for the exactly perfect tempo. And they play, truly, as one.

Though I haven't liked Connoisseur's one-piano recording, a too-reverberant church sound, I find no fault whatsover with this larger sound of two grand pianos together. It suits both the music and the performers.

Performance: A Sound: B+

Jazz & Blues

Martha Sanders Gilmore

Roy Ayers: Ubiquity.
Musicians: Roy Ayers, vibes, vocals; Edwin Birdsong, organ, vocals; Harry Whitaker, electric piano; Bill Henderson, electric piano; Richie Resnicoff, guitar; John Williams, electric bass; Alphonso Mouzon, drums, and Jumma Santos, conga.
Songs: Pretty Brown Skin; Raindrops Keep Fallin' On My Head; I can't Help Myself; Love; The Fuzz; Hummin'; Can You Dig It?, and Painted Desert.
Polydor 24-4049, stereo, $4.98.

Roy Ayers has bypassed his newly adapted aura of "ubiquity" in this LP in which omnipresence unfortunately does not bespeak the high quality often concomitant to commitment. The talent is assuredly here, but this mixture is a mishmash of popular musical merchandise which, in the final analysis, does not lead anywhere and leaves the listener unresolved and dissatisfied.

Vibist Ayers, who struck out on his own in February of 1970, has coupled his vibes with the fuzz device, a tone variator normally associated with the guitar which projects a roundness and mellowness of tone akin to the soft padding of cotton gauze, setting one adrift on billowing clouds. Overtones and reverberations are somewhat muffled and, in the words of Leonard Feather, "the fuzz-tone sounds like a set of chromatically arranged doorbell buzzers." Ayers employs the fuzz half 'n half on this eight-track disc in which he vocalizes as well with organist Edwin Birdsong.

Instrumentalist, vocalist, composer, arranger, Ayers emits his multi-talented vibrations here in material ranging from blues to rock to soul to bossa nova and combinations thereof. His group of seven, septet if you will, bows energetically to the sometime histrionics of rock and its accompanying amperage but does so with taste and finesse. Electric pianos are played interchangeably by Bill Henderson, no longer with Ayers' group, and Harry Whitaker. Henderson launches some most provocative musical ideas in "Painted Desert" by Joe Zawinul, one of the more interesting tracks on the album which bears repeated listenings. The composition is imbued with the vast pageant of tones of the desert and summons forth the mystique and Eastern character of a desert caravan. Mouzon's drum work is worthy of comment here and is perhaps his high spot in the entire LP.

"Pretty Brown Skin," Ayers' own composition, is given a soul treatment with Ayers and Birdsong on vocals. Richie Resnicoff plays an excessively electric guitar and gets off one of his few solos here, inscribing his statement with a drone effect much as one might expect from the dentist's drill. Resnicoff's guitar suffers sadly from a lack of amplification and his tone lacks resonance and is annoyingly abrasive and scratchy. Otherwise, the sound reproduction on this LP is an aural pleasure and deserves a galaxy of stars!

In "Raindrops Keep Fallin' On My Head" by Bacharach and David, Ayers' mallets fall fluently, liquidly, softly as raindrops on rose petals. An impressionistic boss nova, it hops, skips, and jumps to a fare-thee-well, truly "ubiquitous," ebullient, totally titillating. Santos on conga makes a significant rhythmic contribution to a mellifluous rendition of this pop tune.

There is no doubt in my mind that "Hummin" by Nat Adderley and Gene McDaniels has all the ingredients of a lucrative single, as do several other tunes on this album. Ayers and Birdsong do a fine job of arranging and singing it here, a harmonic success with a gospel flavor. Ayers' voice resembles his vibes—soft, velvety, plush, with no sharp edges, creating an ample spectrum of sound.

Birdsong's organ solo in "Love" is suggestive of a Fellini film, surrealistic, in which he uses his organ as a rhythm instrument, striking march-like chords. The musicians are permitted to explore in "The Fuzz" and "Can You Dig It?", both up-tempo numbers.

This album is a showcase for Birdsong and Ayers whose colorful, chromatic, scalar approach to vibes with a propensity for rapidly repeated notes has won for him acclaim and recognition in the past few years. However, his fellow musicians take few solos and the entire LP seems to have been contrived to appease a commercial market rather than a deeply musical one. A disappointment because the talent and potential are indeed present.

As stated earlier, the engineering is excellent with judicious mixing, my only reservation being the guitar reproduction and a proclivity to the fadeout.

This is a hybrid in fine dress; well-rehearsed, pleasantly arranged vignettes of a variety of musical forms. But, the craft only skims along the surface of the art.

Sound: A Performance: B–

Los Pinguinos Del Norte: Topical Songs from the Rio Grande Valley, Music of La Raza, Vol. 1
Musicians: Ruben Juarez, accordion, vocals; Hilario Gaytan, guitar, vocals; Ricardo Escalante, bass, vocals, and Rumel Fuentes, bajo sexto, vocals.
Songs: El Contrabando Del Paso; Jacinto Trevino; El Gallito; Dos Hermanos; Mexico Americano; El Desesperado; Gregorio Cortez; Benjamin Argumedo, and Carga Blanca.
Arhoolie 3002, $5.98.

Here is the music of the Texas-American border, an area smitten with

historical significance, a once bitterly fought over territory where a code of violence still prevails in song, where a man's a man and a woman's a woman.

This collection contains six traditional corridos—ballads or sagas told in the anecdotal tradition of the Old West—and is music of the brown-skinned Latin Americans known as La Raza, a people of the lower economic stratum of society. The corrido, which dates all the way back to the Mexican Revolution, thrived from 1836 to the 1930's and may still be heard today in cantinas such as the El Patio in Piedras Negras, Mexico where this LP was recorded.

The music lives as a personal statement in simple, uncomplicated, and repetitive song forms, often executed in ¾ time, and which run for an average of eight to ten stanzas in length. One senses that musicianship here actually plays second fiddle to the moral and message as in "Carga Blanca," delivered with a touch of ironic humour and which warns us to

Stay away from crooked business;
You just saw what happened.

Communication as release is a more important ingredient in the folk music of an exploited people along our southern Texas border.

The accordion is the instrument which embellishes the sentiments of these field workers and laborers, and here played cheerfully by Ruben Juarez who also sings in a high pitched, rather nasal voice. The bajo sexto, a 12-stringed guitar employed as a rhythm instrument, is strummed and occasionally picked by Rumel Fuentes, while Hilario Gaytan plays guitar and sings along with Juarez in a lower range, achieving a quavering vibrato. The string bassist is Ricardo Escalante.

This is the music of a fiercely proud people to whom death at one time came easily and fearlessly and for whom bravery was king. The corridos are brimming with the adventures of heroes, contraband heroes, killings, weapons with which to kill, and the dreaded fate of the penitentiary. Significantly, however, "Mexico Americano," written for the occasion by Rumel Fuentes (a student who is not actually one of Los Pinguinos but who sings here), depicts the plight of the Mexican-American as we know it today.

Place names run rife throughout the lyrics as in "El Desperado," Los Pinguinos' own composition which berates the tired mobility of the orange picker who complains, "I think I'm turning orange." The only instrumental is "El Gallito," a rollicking dance form known as the *huapango.*

Although bereft of musical complexity and at times admittedly uninteresting, the corrido is a melodic form which should certainly be recorded and preserved. One must view it in its proper context as a glimpse back into history and into this particular culture.

As always, the notes by Chris Strachwitz are infinitely informative and carefully researched.

Recorded on portable equipment, the sound is fair for the most part but in "Carga Blanca" very good, for some mysterious reason. The musicians connote authenticity to the point of rolled R's, are charming in their tongue-in-cheek brand of story telling, and the liner notes will provide the beginning student a more than palatable lesson in Spanish. This is a record for the ardent folklorist and for one who has had contact with the border society.

Sound: C+ Performance: B

Return of the Native

The Link Wray Experience

Martha Sanders Gilmore

Photo by Robert Brenner through the courtesy of Polydor.

MEETING LINK WRAY is like bumping into a burst of sunshine, a dazzling, refreshing white-on-white-on-white experience. Talking to him is akin to popping the cork of a bottle of rose Seltzer water which fizzles and bubbles, overflowing the glass' rim as does Wray's watermelon smile that seems to start behind his ears.

Scarcely anyone ever says "Hey!" anymore, but Wray does—in warm Southern tones. A fierce shock of black hair contrasts with a picket fence of straight white teeth, flanked by high cheek bones—the outward dressing of a totally unassuming person. Soft, gentle, kind, unaffected, but with an exciting toughness and fiber generated by a cushionless existence, Wray's a sunshine superman all fitted out in buckskin. It's hard to believe he is 42 years old—he admits he stokes his furnace with vitamin E.

Yet in spite of this apparent *joie de vivre,* the part-Indian rock star has humble origins and had endured suffering. Wray was born in Dunn, North Carolina, "just off the main highway," where his mother, one of 23 children, was a holiness preacher woman, sermonizing and holding meetings right off their porch. As a small boy, Wray accompanied her rhythmic vocal cadences with hymns on his 1910 Gibson guitar, having learned blues chords and changes from an old Negro gentleman called Hambone who would sit on the porch and pick an afternoon off back in 1910.

Wray's great-grandmother was a full-blooded Shawnee Indian, his 79-year-old father a German who played cards with Charles De Gaulle before he became *De Gaulle.* When Wray was a child, his parents moved to Portsmouth, Virginia, where his father took a job as a shipfitter. In 1942, when Wray was only 14, he drove a cab without a hack license to support a small band which he fronted at the White Rabbit on weekends, playing old standards such as "Deep Purple" and "Stardust."

Wray did a tour of duty in the Army during the Korean War, playing on the Armed Forces network, later returning to Norfolk, Virginia, where he played

at a little place called The Ratskeller. A physical examination disclosed TB which Wray had probably contracted overseas; an operation resulted in the removal of one lung. The doctors said he would never be able to sing again. While in the hospital, he read the Bible from cover to cover and, although he doesn't believe in organized religion or churches, has continued to live his religion ever since. Wray neither smokes nor drinks and will no longer play in clubs where people go for motives other than music. Wray comments unpiously in his disarmingly sincere and candid manner: "People go to clubs to pick up girls." From now on, he will just do concerts.

Link Wray made his first million seller hit "Rumble" on Archie Blyer's Cadence label in 1954. He composed the tune at a record hop in Fredericksburg when he was called upon to play a stroll and describes it as a "happening—it had a use!" (Wray unselfconsciously demonstrated the stroll, a slow, sinuous camel-walk of a step.) In 1955, Wray became attracted to the music of Bill Haley and moved north to Washington, D.C., for more opportunity and exposure, playing next door to the Ford Theater in a club which subsequently burned.

But becoming disillusioned because people tried to make a puppet of him, Wray disappeared for a few years, reemerging with another smash, "Rawhide," in January, 1959. The tune, which was written on the way back from a trip to Nashville, was plugged by Dick Clark.

Wray is a true original, ahead of his time in many ways. Influenced by Duane Eddy in the fifties, deeply admiring Johnny Smith, and idolizing Elvis as his "favorite," yet preceeding him, Wray was one of the first to open his instrument to distortion, paving the way for such rock greats as Jimi Hendrix, The Rolling Stones, George Harrison, The Who, and Frank Zappa. They all picked up techniques from Link Wray, who fashioned some of the original electronic gadgets.

But again a distaste for the whims and fancies of record producers drove Wray away to seek his own way. Of studio recording he says, "This can't be done with true musicians. I couldn't have an outsider produce my sessions. It's not my bag." As he admits, he "doesn't travel with the rest of the rats."

Link Wray fled to his Family place in southwestern Prince George's County, Maryland, a five-acre farm in Accokeek, away from the city's whistles and horns. There Wray settled with his "Family" before communes became fashionable, a family of fellow musicians, brothers and sisters, and friends, sharing, laughing together, working, recording together. Wray gigged around at nearby spots, such as the Ozark, Stardust, and Wigwam.

The Wray Family took it in their minds to convert a tired old chicken coop into a recording shack, using an old, beat-up three-track recorder and everything from crickets and nails for sound. They named it Wray's Shack Three-Track. Room was scarce so the speakers for Wray's guitar were plopped outside in the yard, the mike stuck in the window. A bass drum was simulated by stomping on the wooden floor, while a small attached room housed the controls.

Wray and Family recorded some 125 tunes in the shack over a six or seven year period. Thus was born the rawboned Polydor LP 24-4064, titled simply *Link Wray*, his first in 12 years. Here, Wray has taken music from the studio and brought it out to the people. Some musicians own their own record companies, others make their own recording studios!

The handsomely bound package contains 11 tracks of authentic, unhindered music that conveys Wray's experience and disdain for artifice as simply unorthodox, nonconformist, and artistic. It is a fascinating album—totally honest, harsh, unrelenting, and rough, unsophisticated in ways, futuristic in others. It is communication. "Wray's music has its clothes off," one writer puts it.

Five of the cuts are by Wray, five by Wray's producer Steve Verrocca, a Milanese whom fans may remember from his hit "Volare." The remaining tune, "Tail Dragger," is by bluesman Willie Dixon. The music is primitive and of the earth, the lyrics pessimistic, and the sound thoroughly unique and full of texture and pervasive excitement. The Family includes Billy Hodges, piano and organ; Bobby Howard, mandolin and piano; Doug Wray and Steve Verroca, drums and percussion, and they all team up for vocals.

Wray sings on all cuts, believing that instrumentals don't last and can't communicate the way lyrics do. His voice is raspy and scratchy but no matter, his guitar playing is staggering! In spite of his feelings, we wish Wray would play more.

It is obvious that Verocca has the feeling for what makes a hit, as in the rousing "La-De-Da" and the gospel-flavored, softly swinging "Take Me Home, Jesus" in which Wray plays a dobro, making the tune sound like sunny Italy. The percussion surrounds the melodic line like a river and is most effective as it swirls about, tucking the melody into its wake. "Juke Box Mama" bumps and grinds raunchily—recalling Clyde McPhatter and Jerry Lee Lewis—like a train rattling behind Hodge's chugging-locomotive piano.

Wray thinks much of John Hammond, musing that "music will always come back to the blues." It is not surprising therefore to find a plaintive boogie motif underlying the heart of "The Rise and Fall of Jimmy Stokes." Wray's tunes might be said to be more lyrical than Verroca's, though perhaps not so sophisticated, as with "Fallin' Rain," an interpretive comment on war which is ethereal and Donovan-ish, with a creaking rocking chair percussive movement.

Wray's inspiration for "Fire and Brimstone" was a nightmare he had, while "Ice People," one of the most interesting tracks, is a smooth, calm, philosophical statement. Wray sings:

"They'll crucify you if you aren't part of the establishment. . . .

"If you don't go to war, you're not living by the Golden Rule."

Wray's most extensive solo is on Verroca's "God Out West," a funky, quivering, wavering guitar riff that speaks volumes.

"Crowbar" smacks of tadpoles and bullfrogs, a surrealistic, murky, blues-based effort. Wray lived near "Black River Swamp," which he portrays musically against Howard's mandolin.

Engineered by Link's brother, Vernon, the sound varies from track to track, but I found it skillfully blended and a general pleasure.

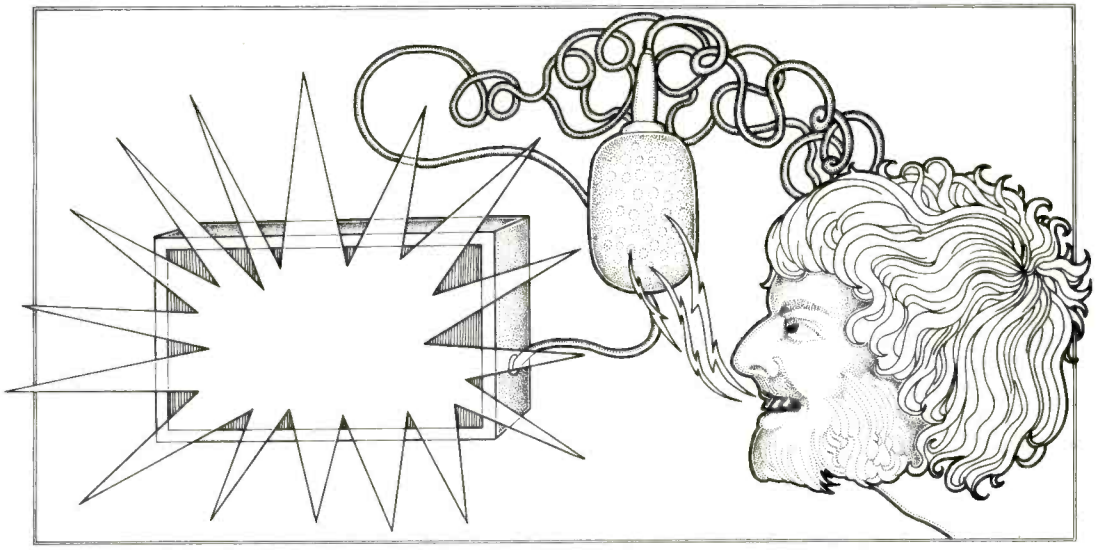
* * *

The family has moved to Tucson, Arizona, now, a development is moving in on their Accokeek acreage. Wray wants to breathe clean air and will continue his music out west. The family plans to transport their studio/shack by van and each will record an album for Polydor. In fact, Bobby Howard, alias Mordicai Jones, already has, Polydor PD-5010.

Wray and his wife Sharon, whom he describes as "beautiful people," eventually hope to move out of their trailer, buy a ranch, and raise horses. He also wants to help Indians and the poor of all colors. Wray comments earnestly, "I've been poor; I know what it is to be poor. But this is a blessed country—no bombs."

The Link Wray album is not merely an excursion into rock; it is that plus Black blues, country, folk, gospel, and poetry, all in a delightful and rustic combination. You'll never hear another quite like it. May Link Wray sail his aboriginal craft unemcumbered to still calmer waters. AE

Weingarten Looks At



Spoken Word Discs

Propaganda. In a sense, that's what modern recordings have become.

Underground music, of course, is doctrine-in-residence, and FM thus is continually blasting forth messages (albeit over the ear-shattering strains of rock) that the Establishment evils must be destroyed. But even AM, the bastion of the over-30 set (*and*, via Top 40 radio, the teenyboppers who haven't yet donned the facade of hating everything un-new), has succumbed to ditties that are peddling one dogma or another, wrapped, naturally, in bubble-gum papers or spiced with tasteless sugary substitutes.

The most blatant propaganda, however, comes to the audiophile in the form of spoken word discs, most of which are so slanted that even those who agree with the principles expounded are uneasy with the hammer-like approach of Recorded Truth.

Case in point: **BILL COSBY TALKS TO KIDS ABOUT DRUGS** (Uni, 73101), a disc aimed at instilling in youngsters a horror of non-prescribed pain-killers. None, certainly, would argue with the premise, but many will disagree with the overkill flavor of the LP, despite the stamp of approval from the National Coordinating Council on Drug Education, Washington, D.C.

Education just can't be sold like detergents, and almost everyone rebels at having it pounded into their skulls.

Cosby, for instance, never really differentiates between so-called soft drugs and the harder stuff. All are equally horrendous, he indicates, whether they be pills or pot or heroin. And, somehow, the evils of alcholism are barely touched on.

The main problem with the recording is that it is simplistic, totally black-and-white, with facts and myths intermingled so that only a fear-factor stands out. "Scare the hell out of the kids and maybe they won't touch the stuff." Maybe. But there must be a cleaner way.

"Downers and uppers," for instance, finds Cosby exaggerating, via electronic gimmickry, the slowness and fastness, respectively, of reactions to pills. This is accompanied by an approach that simply says no one needs a high. Try telling that to the millions who daily use artificial stimulants of one sort or another, however.

And to cover some of the other cuts: "Questions and Answers" teaches that *all* drugs are bad when given by someone you don't know; "Dope Pusher" includes a non-song that chants "I don't need no bad drugs" and tells that the pusher sells a "bag of death and agony and pain;" "People Make Mistakes" asks why people start taking drugs when they spend so much time trying to stop later, and "I Know I Can Handle It" is a piece that suggests just the opposite.

Cosby, who, throughout, is talking to a vocal group of children, a few of which are obviously confused by his sometimes *in* terminology, climaxes his opus with another non-song, "Dope Is for the Dopies."

The musical interludes, performed by Cosby with an unnamed band in the background, are, in actually, slogans pushed off a clef. The impact would most likely be greater if each proposed listener be told to write "I will not become a junkie" five-hundred times on a screechy blackboard.

Whether the youngsters on the disc (members of International Children's School and the Jimmy Joyce Children) retained anything is moot; my own children (ages eight and six) seemed to, despite the fact that they squirmed uncomfortably—and fearfully—through the entire playing time. The Weingarten duo, however, indicated that they previously had heard most of "that stuff" on video's anti-commercials. And they did respond well to a family question-and-answer session afterward.

Probably most of those who need to hear the record, which despite the criticism should be heard, never will. The ghetto kids' families would never spend the money; the middle-class kids' families would say it could never happen to them.

If it stops only a handful of tots from experimenting with drugs, though, the disc will have served an invaluable purpose.

For adult listeners, those who want their anti-drug messages wrapped in ribbons of great literary achievement, highly recommended, in contrast, is **LONG DAY'S JOURNEY INTO NIGHT** (Caedmon, TRS 350).

The four-disc package of Eugene O'Neill's autobiographical play deals primarily with guilt, the guilt of a

family collectively dying because one member (a fictionalized version of O'Neill's mother) is a morphine addict withdrawing into the safe, painless fantasy of the past.

The set, the potent drama of which is *not* lost because there is no visual stage, stars Robert Ryan, Geraldine Fitzgerald, and Stacy Keach. Sound quality is excellent; excitement is constant; quality, overall, inundates the listener.

And the message gets through.

Straight political propaganda, although not as prevalent on vinyl as in other communications media, also is becoming a factor with which to be reckoned. Witness **ANGELA DAVIS SPEAKS** (Folkways, FD 5401S) and **BERRIGAN RAPS** (Caedmon, TC 1402), a couple of entries that tell it like the main characters see it.

In a free society, which, not incidentally, both the self-styled Black Communist symbol and the imprisoned priest claim America is *not,* there should be an opportunity for everyone to speak. Perhaps this pair of discs is their chance—although, truthfully, the agitation and exaggeration seem as unfair as they contend the Establishment press and airwave coverage is.

The Davis disc, to be a traditionalist and let women go first, is fascinating if only for its bitterness, its vitriol. Why is she a Communist? Responding to one of 13 queris posed by Harlem readers of *Muhammad Speaks,* the largest black newspaper in the U.S., she says:

"If we are going to rise out of our oppression, our poverty, if we are going to cease being the targets of . . . the lynch mob mentality of racist policemen, we will have to destroy the American capitalist system."

Angela Yvonne Davis, who was born in Birmingham, Ala., on Jan. 26, 1944, is one of the new rebels, militant of militants who quotes not Jefferson or Paine but Malcolm X and Huey Newton. Her political biography says she "grew up among a whole generation of Black people who had seen

their men risk their lives overseas in a fight against foreign fascism only to return home and find the same mentality still directed against themselves" via racism and segregation.

"She saw the symbols of law and order represented by the likes of George Wallace and Bull Connor, the burning cross of the old South, the electric cattle prods of the new. Yet she also saw . . . the first glimmering of a renewed resistance, and she joined. . . ."

The disc, the text of which (except for some brief on-the-street inteviews) is included, is broken into three main segments. The first is an introduction of principles, a taped recording of one of Miss Davis' speeches. The sound quality is poor, although the intensity of her words seems to make up for that. The second is her responses to the 13 questions, asked by one of her lawyers, Margaret Burnham, while the militant was incarcerated in New York City's Women's House of Detention awaiting extradition to California, where she faced trial on charges stemming from the bizarre Soledad courtroom slaying that made national headlines. The third is a panel discussion between Charlene Mitchell, a member of one of the many committees to free Miss Davis; Gil Noble, from the WABC-TV staff that produced "Like It Is," a video program on which the disc is based, and Miss Burnham.

These are followed by a brief segment in which the public, via the street interviews, is asked if it thought Miss Davis could have a fair trial: the answers, for the most part, were in the negative.

The Berrigan recording, in contrast, despite also being a militant outburst, is slightly softer—perhaps only because it contains one full side of poetry readings.

But Father Daniel Berrigan, S.J., admitted felon (for burning draft board papers at Catonsville), obviously isn't content with the status quo. His methods are less violent, though no less revolutionary.

He is quoted, on the liner notes, for instance, extracted from George Reimer's book, "The New Jesuits," as saying:

"I submit that the laws are the last resort of the desperate. If everything else fails in human communication, enact the law and lock the bastards up. Whether they are war resisters or Vietnamese or blacks or priests. Lock them up."

Thus, Berrigan, whose brother Philip, also a radical priest, has swallowed an equal dose of disenchantment pills, in introducing his anti-Establishment poetry on this recording, dedicates his works, expectedly, to "all peace people, to good freaks everywhere, to poets and musicians, to all resisters of war. . . ."

Side One contains "A Sermon From the Underground," a taped recording made by the priest when in hiding, and "An Interview with Marc N. Weiss at Cornell, April 1, 1970."

The sermon, the sound quality of which is uneven at best, frequently muddled, calls present U.S. policies "the death game of a nation." Berrigan insists that life is the most important thing, and he injects Jesus often in his anti-death argument against the state. Somehow, though, the rebel makes the listener feel Berrigan *enjoys* his martyrdom as he elevates his criminality to Christ-like behavior.

"It is better to burn papers than children," he states at one point in joint reference to Catonsville and Vietnam, but the impact of that statement is mired in what appears to be an ego trip.

In the Weiss inteview, Berrigan is stronger in his attack on American society, coming across as an alarmist who can find virtually nothing salvageable about current history.

In the same line, **THE TRIAL OF THE CATONSVILLE NINE** (Caedmon, TRS 353) is one of the best examples of agit-prop (agitation-propaganda) theater. The two-disc package is Berrigan's own play based on the raid on the draft board, naturally one-sided, naturally emotion-packed, naturally interesting.

For those who prefer a lighter approach to propaganda, however, there is at least one attempt worth noting, **ALL IN THE FAMILY** (Atlantic, SD 7210).

The 13 cuts, extracts from video's top-rated show, are sure to evoke some laughter even if you've seen the originals. The main character, most of you already know, is a bigot. From Archie's lips slide slurs on every ethnic group extant and everone left of Herbert Hoover. Somehow, though, it still is funny, probably because it is a caricature.

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Classified

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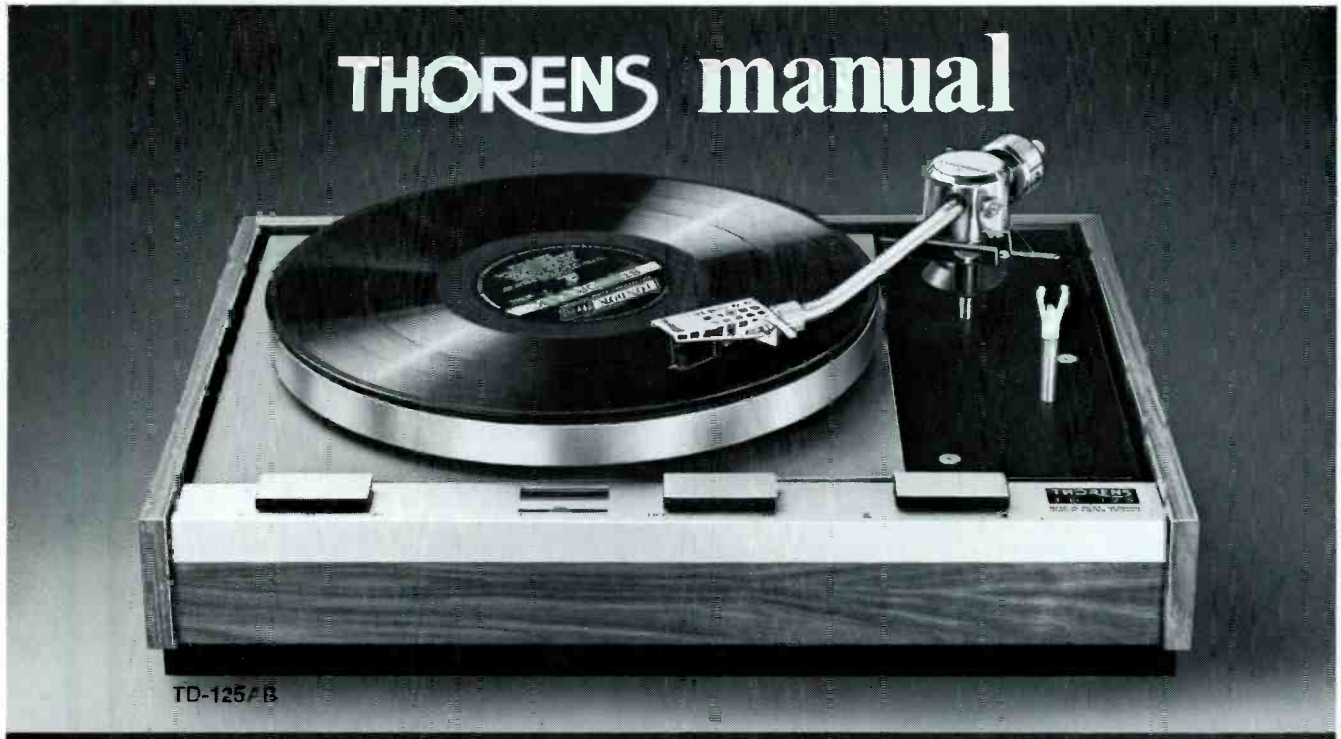

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