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Audio

THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • FEBRUARY 1975 75¢ ®

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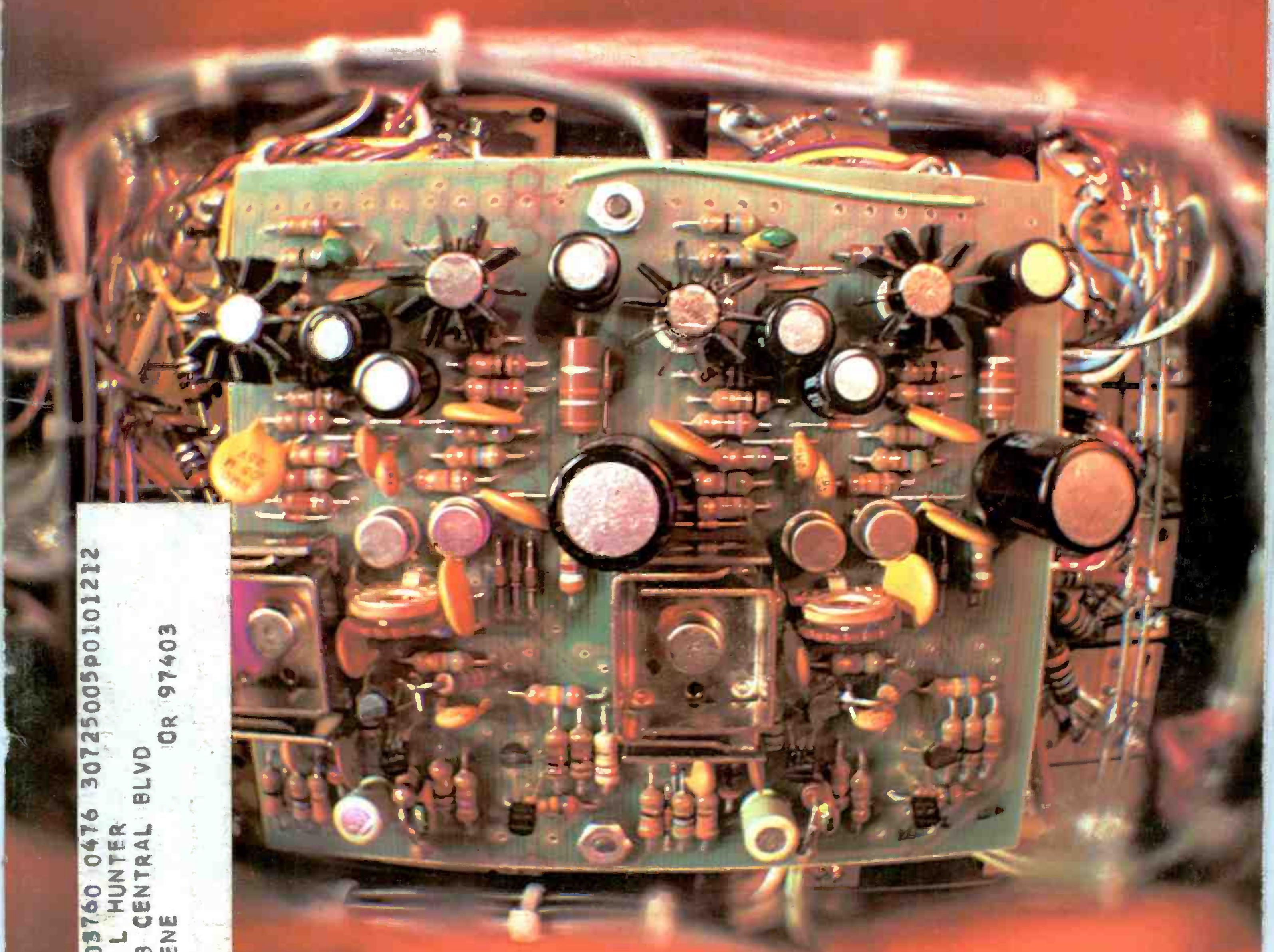

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speed while a record is playing. Both of these sophisticated units are even equipped with a strobe light directed at the strobe marks for easy viewing. Pioneer's engineers really think of everything.


Electronic speed adjustment for each speed

Automatic features without automatic drawbacks

If you prefer to let your tonearm and turntable do all the work, consider Pioneer's all new PL-A45D. With it you can play your records without ever touching the tonearm. Unlike other single play automatics which depend upon complicated mechanical linkages to provide the necessary tonearm cycling motion, the PL-A45D uses a separate precision gear motor just to move the tonearm in accordance with your instructions. Its other 4-pole synchronous motor is free to drive only the 12-inch aluminum alloy die-cast platter without interruption or change of torque and speed.


Automatic operation—manual precision

Superb S-Shaped tonearms for better tracking

The tonearm of every Pioneer turntable system is the "S-shaped" design, for optimum groove tracking. All are statically balanced and all use adjustable counterweights with direct read-out of tracking force. All have adjustable anti-skate control and oil-damped cueing for the gentlest application of stylus tip to record groove. Lightweight plug-in cartridge shells insure positive electrical contact and optimum stylus position and angle for lower distortion and reduced record wear.


S-shaped tonearm for ideal tracking

The tradition of unexcelled performance

Still, all of these features and refinements alone do not guarantee the performance specifications of Pioneer's new turntables. Each tonearm and turntable platter combination is shock mounted in its specially designed natural grain cabinet (with hinged dust cover). Precision machining of all rotational parts of each unit, plus a program of continuous quality control insure that each Pioneer turntable will meet or exceed its published specifications — a time honored tradition with all Pioneer components.

Manual turntables— choice of the professionals

Engineers, experts and enthusiasts agree: to get the best performance, you need a manual turntable. And to get the best manual turntable, you need a Pioneer. Every Pioneer manual turntable offers a level of precision and performance unparalleled in its price range. And every one is a total system — complete with dust cover and base — and designed for years of professional trouble-free sound reproduction.

turntable that's right for you.

D	PL-A45D	PL-51A	PL-71
	Belt	Direct	Direct
nch.	4-pole synch.	DC Servo	DC Servo
	—	±2%	±2%
47dB	More than 47dB	More than 55dB	More than 60dB
MS)	0.1% (WRMS)	0.06% (WRMS)	0.05% (WRMS)
"S"	Static Bal. "S"	Static Bal. "S"	Static Bal. "S"
	8 11/16"	8 11/16"	8¾"
	12"	12¼"	12¼"
oz.	2 lbs. 3 oz.	3 lbs. 1 oz.	3 lbs. 8 oz.
5	$169.95	$249.95	$299.95

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For the best manual turntabl[e] get a Pioneer.

The manual turntable is rapidly becoming the first choice of hi-fi enthusiasts everywhere. The reason why is quite simple. Today's enthusiasts are more knowledgeable, more sophisticated and more involved with their music. And only the manual turntable can provide the involvement and performance they demand.

At Pioneer, this trend comes as no surprise. We have long recognized the superiority of the manual turntable. And long recognized a simple fact: a record changer in no way improves performance. It can detract from it.

As a result, we now offer the finest and most complete line of manual turntables available. Manual turntables that are designed with the needs of today's hi-fi enthusiast in mind. Turntables that are engineered for precision response.

When you get right down to it, good record playing equipment really has only two requirements: uniform rotation of a turntable, and accurate tracing of a record groove by a tonearm and its cartridge.

Pioneer's engineers have long recognized that these requirements are best met by single-play turntables and precision engineered tonearms. Our five new belt-drive and direct-drive turntable systems mean you needn't settle for the higher wow and flutter and the poorer signal-to-noise ratios (rumble) of record changers. Whether you've budgeted $100 or $300 for this vital element of your high fidelity system, there's a Pioneer turntable that outperforms any record changer in its price class.

Consider the performance advantages

Belt-drive, featured in Pioneer's PL-10, PL-12D and PL-A45D, means smoother, more uniform platter rotation than can be achieved with typical idler-wheel/pulley arrangements normally found in record changers. Even changers equipped with synchronous motors transmit vibration to the turntable platter. This is picked up as low-frequency rumble by the tonearm and cartridge. By driving the platter with a precision-finished belt, vibration is effectively absorbed before it can be translated to audible rumble.

Belt-drive for rumble-free rotation

Direct-drive motor reduces friction

Pioneer's direct-drive models, PL-51. and PL-71 go even a step further in achi[e]ing noise-free, precision platter rotation. The DC electronically controlled servo-motors used in these models rotate at exactly the required 33⅓ or 45 rpm plat[ter] speed. Their shafts are directly connecte[d] to the center of the turntable, with no in[ter]mediate pulleys or other speed reductio[n] devices. This means no extra friction-producing bearing surfaces.

Because of the unique technology embodied in these new, direct-drive mot[ors] it's possible to control their speed electr[on]ically. This is more precise than any mechanical drive system. Both our PL-51 and PL-71 offer individual pitch control f[or] both 33⅓ and 45 rpm speeds. Their turntable platters are edge-fitted with stroboscopic marks, so you can adjust precise

Choose the Pioneer

Model	PL-10	PL-1[2]
Drive system	Belt	Belt
Drive motor	4-pole synch.	4-pole sy[nch.]
Speed control	—	—
S/N (Rumble)	More than 47dB	More than
Wow & Flutter	0.1% (WRMS)	0.1% (WR[MS])
Tonearm Type	Static Bal. "S"	Static Bal
Tonearm Length	8¹¹⁄₁₆"	8¹¹⁄₁₆"
Turntable Diameter	12"	12"
Turntable Weight	2 lbs. 3 oz.	2 lbs. 3
Price:	$99.95	$119.9[5]

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That's because we carefully developed **dII** as a fully integrated system. Only **dII** fluid solubilizes ordinary dirt and debris as well as other contaminants. Then fluid, problems, and particulate matter are removed through capillary action onto our uni-directional brush fiber. The **dII** system is available from your audio specialist for $12.95. **dII** fluid is $2.25. (We also have a special formula for old 78's for $2.00.)

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Audio

February, 1975 *"Succesor to RADIO Est. 1917"* **Vol. 59, No. 2**

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Equipment Profiles

Record Reviews

Audio in General

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AUDIO (title registerd U.S. Pat. Off.) is published monthly by North American Publishing Co., Irvin J. Borowsky, President; Frank Nemeyer, and Jay L. Butler, Vice Presidents; R. Kenneth Baxter, Vice President/Production: Nate Rosenblatt, Promotion Director; Mary Claffey, Circulation Director.
RATES—United States only: 1 year for $7.00, 2 years for $12.00, 3 years for $17.00; outside the U.S.: 1 year for $9.00, 2 years for $16.00, and 3 years for $23.00. Printed in U.S.A. at Columbus, Ohio. All rights reserved. Entire contents copyrighted 1975 by North American Publishing Co. Second class postage paid at Philadelphia, Pa. and additional mailing office. Back issues, $2.00 each.
REGIONAL SALES OFFICES: Jay L. Butler, Publisher and Sanford L. Cahn, Marketing Director, 41 East 42nd St., New York, N.Y. 10017, telephone (212) 687-8924.
Jay Martin, 15010 Ventura Blvd., Sherman Oaks, California. 91403, telephone (213) 981-7852.
REPRESENTATIVES: Continental Europe: John Ashcraft, 12 Bear St., Leicester-Square, London W.C.2, telephone 930-0525. For Benelux and Germany. W.J.M. Saunders, Mgr., Herengracht 365. Amsterdam, Holland, telephone 24.09.08.
Japan: Japan Printing News Co., Ltd., No. 13.2 Chome Ginza Higasi, Chuo-ku, Tokyo, telephone 541-5795.

AUDIO Editorial and Publishing Offices, 134 N. 13th St., Philadelphia, Penna. 19107
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BELT DRIVE ISN'T NEW. MULTIPLE PLAY ISN'T NEW. A TURNTABLE THAT COMBINES BOTH *IS* NEW. READ ALL ABOUT IT.

Back in monophonic times, turntable motors drove platters through a series of wheels called "idlers".

Many automatics and changers still use this system.

In those days, records and playback systems were still relatively unsophisticated, so the distortions an idler drive system created didn't matter much.

Today, however, distortion is a critical problem. With recordings of increased dynamic range, wow, flutter and rumble must be reduced to inconsequential levels.

A belt-drive system is light years ahead of idler drive in that department.

And here the belt is driven by a unique motor found only in B·I·C turntables. It is a 300 RPM, 24-pole motor and it is inherently freer from noise and vibration than the 1800 RPM units with from 2 to 16 poles, which are standard in even the best of the conventional automatics.

The advantage of Programmed Multiple Play

The 980 and 960 are not record changers.

They are belt-drive Programmed Turntables which are engineered to play as many as 6 records at a time.

They have a 2-point record support system which is far less complicated and far more reliable than any umbrella spindle we've ever seen.

But an even more important advantage is this.

An automatic record handling system like the one on a B·I·C turntable can handle a single record, or 6 at a time, perfectly. No false drops. No bouncing and skating a diamond stylus across the grooves. It eliminates human error, and human error is what damages the sidewalls of your record grooves forever.

The simplicity factor

The 980 and 960 have the visibly lower profile of single-play manual instruments. They've been engineered to be simple machines, so they have fewer parts and fewer potential problems.

They abound in innovations. In the tone arm, the cartridge shell, the program panel, the entire system.

We can send you more detailed information if you write to Dept. 2A, British Industries Co., Westbury, L.I. 11590; or better yet, see them at your local audio specialist.

B·I·C™

This is the 980 with solid state speed control and strobe. About $200.* The 960 is identical except for these two features. About $150.*

* Less base and cartridge.

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Why not get all the music you paid for?

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You're entitled to pure unadulterated music . . . the original. Nothing more, nothing less.

And this is the whole idea of the Crown DC-300 A.

"Like lifting a curtain" was how one Crown owner described his experience.

Why not get an amplifier that gives you all the music in your collection, but no more than that!

Make this simple comparison:
(1) Listen with a critical ear to your favorite recording at home; then
(2) Listen to that same recording with a DC-300 A at your Crown dealer.

We rest our case on your ears!

Power output: 155 watts/channel min. RMS into 8 ohms stereo. 300 watts min. RMS into 16 ohms mono, over a bandwidth of 1-20,000 Hz, at a rated distortion of 0.05%. Intermodulation distortion less than 0.05%, 0.01 watt to rated output, into 8 ohms stereo, 16 ohms mono.

Is Crown crazy?

To guarantee **parts** and **labor**, and pay for **round-trip shipping** for three full years. (We'll even send you a shipping carton if you didn't save yours.) That takes nerve . . . and faith in your product!

At **Crown,** reliability is a way of life. Long life . . . with you.

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WHEN LISTENING BECOMES AN ART.

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Audioclinic

Joseph Giovanelli

Mixing Tube and Solid State Equipment

Q. I know that one can do almost anything with a high-fidelity system—but is it wise to mix tube and solid state components in such a system?—Name withheld.

A. There is nothing wrong with mixing tube and solid-state gear. One thing to watch out for with transistor amplifiers is to be sure that the speaker (output) terminals have one side returned to chassis ground, to which all input signal grounds are made (some solid-state amplifiers have "floating" outputs).

The input impedance of solid-state equipment is usually much lower than that of tube equipment. And the output impedance of tube tuners and preamplifiers is generally so much higher than the input impedance of transistor units that the signal output from the tube unit is inadequate to drive the transistor component. However, there's generally little problem driving tube amplifiers from transistor units.

Bi- and Tri-Amplification

Q. I am seriously considering the purchase of an electronic crossover system so I can bi-amp or tri-amp my speakers. Must my power amplifiers all have the same power output, or can I use smaller amps for the tweeters and mid-range than for the woofers? Can I get as good sound using standard loudspeakers with one heavy-duty power amplifier (only) for each channel?—Name Withheld.

A. The bass frequencies account for the greatest proportion of acoustic energy in a music system. Therefore your most powerful amplifiers should drive the woofers, the next largest amplifiers connect to the midrange (if you're tri-amping), and the tweeters can be driven with the smallest amplifiers.

There are a number of different input-output phase relationships possible between the three (or two) control centers (preamps), the crossovers, and the power amplifiers in each channel. This means that speaker phasing must be worked out by careful, aural testing, not just by the normal connection of the *high* (+ or 8 ohm) speaker terminals to the *high* amplifier output terminals, and the common (– or ground) terminals to the commons. Listening tests may even dictate reversing some of the connections.

Because an electronic crossover divides the signals into two (or three) frequency bands before they're fed to the power amplifiers, the amount of intermodulation distortion will be reduced. This will improve the sound. In addition, some high level (conventional) crossovers, such as are found in most normal speaker systems, tend to ring at or near the crossover frequencies. This is distortion also, and is obviously undesirable.

Properly designed electronic crossovers do not ring. Just how much improvement can be gained from bi- or tri-amplifying (using two, or three power amplifiers from each channel, plus the electronic crossovers) depends on how much IM and ringing is in your present system before you upgrade it in this way. Sometimes the improvement can be quite dramatic.

15 Degree Tracking Angle

Q. I know that a phono cartridge must track at a 15 degree angle. I am not sure that mine is doing so. Is there a way that I can check this parameter?—Ronald L. Ambrogi, Brooklyn, N.Y.

A. If a cartridge is properly installed in its tonearm, it is almost always automatically tracking at the proper angle, as this is generally a function of the stylus and how the jewel is set into the shank. Be sure that the cartridge is mounted correctly. Check the instructions which are included with both the cartridge and with your tonearm. Follow them carefully, and that should be all you need to do.

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

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Tape Guide

Herman Burstein

Sound On Sound

Q. Just what is sound on sound? I have a tape deck with this function. I've heard that you can keep adding different sound tracks on one channel, yet with my deck you can have only two tracks recorded on each other, unless you go through a confusing process and record the two tracks over to the other channel and add another sound track (making three) via speaker and a microphone. I use the tape monitor switch on my receiver for this purpose. Would buying a microphone mixer solve my problem? In buying a mixer, I notice that a mixer usually ranges from either $5 to $20 or $80 to $250. What is the difference?—Alexander Stewart, Tallapososa, Ga.

A. A tape recorder which truly incorporates a sound-on-sound provision does the following. Record Signal 1 on Track 1. Play Signal 1 and record this simultaneously with Signal 2 on Track 3 (no speaker is involved in this step or any of the following steps). Play Track 3 (containing Signals 1 and 2) and record this simultaneously with Signal 3 on Track 1. Play Track 1 (Signals 1, 2, and 3) and record this simultaneously with Signal 4 on Track 3, etc. All this, of course, is on a mono basis. If you want stereo sound-on-sound, you will need 4-track heads and suitable mixing and switching facilities; alternatively, you will need an extra 2-track playback head mounted before the erase head, plus the necessary mixing and switching facilities.

The more expensive mixers provide better quality and more flexibility, and usually provide gain. The cheaper mixers may be passive devices without gain.

Square Wave Reproduction

Q. In "Equipment Profiles" one sees from time to time reproductions of square waves used as a criteria of the quality of a given piece of equipment. Yet over many years of reading Audio I have never seen a reproduction of the playback of a square wave recorded on a tape recorder. Why? I tried it on my unit and got back something that barely resembles a square wave. When making a bias adjustment, would adjusting to reproduce and record the best square wave be a useful way of making such an adjustment? —Charles L. Thomas, Tempe, Arizona.

A. A square wave, as can be shown mathematically or with electronic apparatus, consists of a fundamental frequency and an infinite number of odd harmonics. For example, a 1,000 Hz square wave would consist of a 1,000 Hz sine wave plus sine waves of 3,000 Hz, 5,000 Hz, etc. As a practical matter, a good square wave can be reproduced by a piece of electronic equipment if it is capable of handling the first ten odd harmonics. Because a tape recorder has limited high frequency response, it cannot adequately reproduce a square wave for the higher frequencies; it can only do so for the middle and lower ones—say from about 1,000 Hz down. To illustrate, reproduction of a 1,000 Hz square wave requires that the tape recorder have virtually flat response to about 21,000 Hz. This can be done by the better machines today, but not all that easily. By comparison, a good audio preamp or power amp can get out to 100,000 Hz, making it possible to reproduce square waves to about 10,000 Hz. I don't see any basis for adjusting bias by using a square wave.

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

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Behind The Scenes

Bert Whyte

LATE LAST SUMMER, the great Philips company of Eindhoven, Holland, and the AKG company in Vienna invited members of the hi-fi press corps to inspect their audio manufacturing facilities in their respective countries . . . and needless to say, do some sightseeing and "live it up a bit."

Understandably, these press junkets are very popular (even if you do have to do some fast "hustling around," and in this respect our Dutch and Viennese friends are as expert as their Japanese counterparts), so in addition to yours truly there were such well-known hi-fi personalities as . . . Larry Zide, Julian Hirsch, Norman Eisenberg, Martin Clifford, Harry Maynard, and Ivan Berger. A number of wives were along to "keep the boys in line" (and to spend their money), and we were accompanied by George Garnes, Advertising Director of North American Philips Co., and the grey-haired, grey-bearded, distinguished national sales manager of Norelco, Robert Miller. We were to be joined in Eindhoven by the genial general manager of Norelco, Andy Brakhan. It should be noted here that Norelco distributes AKG products in America, thus the Norelco people were acting as dual hosts until we reached Vienna.

We deplaned from our 747 in Amsterdam, and were then flown to Eindhoven in Philips' private prop jet. As you might expect, as headquarters for the Philips vast, globe-girdling industrial empire, Eindhoven is very much a "company city." There are many electronic and other types of manufacturing plants in Eindhoven, which employ some 45,000 people. Ensconced in our hotel and having recovered from "jet lag," we were given an elaborate "Welcome" dinner, (suitably lubricated with plenty of the famous Heineken and Amstel beer) and met many of the Philips executives who would be our hosts for the next several days.

Bright and early the next morning, we began our visit to the Philips electronics laboratory, which is indeed an extensive facility. Of course our main interest was in the audio lab and demonstration room, and our hosts were eager to give us an elaborate presentation of their new 22RH532 Motional Feedback (hereinafter known as the MFB) loudspeaker system. The demo room was roughly 20 by 40 ft. with about a 9 ft. ceiling. Along one wall they had arrayed six well-known U.S. and European loudspeakers. I won't name names, but the speakers represented both ends of the price scale in popular acoustic suspension models. I should note that all the speakers were in stereo pairs. Interspersed among these speakers, and in general dwarfed by them, were stereo pairs of the tiny 15 x 11¼ x 8¾ in. MFB speaker.

An elaborate A/B switching set-up was provided to check the MFB against the other speakers. Peter Gouw, the head of the audio labs and an engineer of immense talent who aided his presentations by his obviously sincere and enthusiastic love of music and audio, had provided every possible kind of source material, including open-reel tape with Dolby A. Records were played over their new 209S turntable (about which more later on), and since the MFB has its own internal amplifier, to allay any fear of underpowering the other speakers, those were driven by Bose's huge 1801 250-watt amplifiers.

Before we go on with the tests, here is a description of the MFB. In the approximately 15 liter enclosure is an 8-in. woofer, 5-in. mid-range, and 1-in. dome tweeter, all made by Philips. Two output amplifiers are also contained in each enclosure. The woofer amplifier is terminated with a 4-ohm speaker, and with one-volt input can deliver up to 40 watts. The other amplifier is similar, except that it delivers up to 20 watts. Connected to the output of this amplifier are a high-pass and a low-pass filter with a crossover at 3500 Hz. All frequencies above 3500 Hz are fed to the dome tweeter, while frequencies between 500 and 3500 Hz are fed to the mid-range driver. The woofer is crossed over at 500 Hz through an electronic crossover ahead of the two amplifiers. In other words we have a bi-amplified speaker system in this small enclosure with an output total of 60 watts.

The heart of the MFB is a piezoelectric crystal acceleration transducer attached to the cone of the woofer, just outward of the voice coil. This PXE sensing element, as Philips calls it, measures the acoustic acceleration (movement) of the cone and converts it into an electrical signal. This signal is proportional to the cone motion and is fed to a comparator which compares it with the original incoming signal supplied to the woofer amplifier. As differences are detected by the comparator, corrective signals are fed back to the speaker via the built-in amplifier. Thus, we have a motional feedback system. The objective of this system is the reduction of bass distortion and since the resonance of the woofer is treated by the MFB as an anomaly, it is "corrected" so that in essence the 8-in. woofer has a resonant frequency of 35 Hz.

Let's get back to the A/B tests. Peter Gouw started off with a superb recording of Oscar Peterson, in which Oscar's piano was accompanied by a string bass played arco (with a bow). The bass is playing a descending figure and the sound is very "open" and revealing. Switching between the various speakers and the MFB, it was apparent that all the speakers could reproduce the lowest note played, about 45-50 Hz. However, it was equally apparent that there were considerable differences in the quality of the sound among the conventional speakers as well as that of the MFB.

To be perfectly candid, we were as much interested in the quality of sound of the popular U.S. speakers under these finely controlled A/B conditions, as we were with the MFB. Most noticeable, once we had become acclimated to the acoustic qualities of the room, was the degree of coloration exhibited by these speakers, mostly in the form of an

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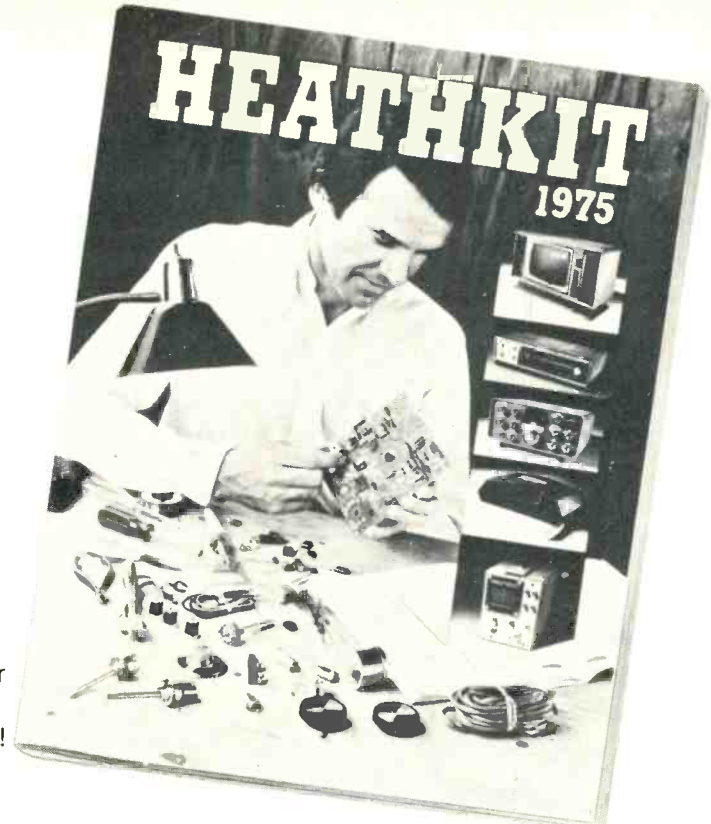

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Without a doubt, one of the world's finest receivers. The amplifier delivers 60 watts RMS per channel into 8 ohms at less than 0.25% total harmonic distortion from 20-20,000 Hz. And the AM and FM sections measure up to equally impressive levels of performance. An outstanding receiver, yet even a novice can build it.

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emphasis in the 100 to 200 Hz range which gave the bass a "voomy" over-resonant quality adversely affecting the timbre and cleanness of the sound. In contrast, the MFB was free of the coloration and was singularly clean in its bass reproduction. Most impressive was that this tiny enclosure could actually reproduce such low frequencies. Claimed response is to 35 Hz, and with source material which actually contains such frequencies, the MFB does a very creditable job, but in my opinion, I would say that at 35 Hz, it was down about 5 dB or so. While the reduction of bass distortion and the freedom from mid-bass coloration are among the most important features of the MFB, equally important are the advantages of its bi-amplification.

We auditioned the MFB with a wide variety of pop and classical music and were impressed with the general cleanness of the mid-range and highs, and with the extended high end response. In summing up the sound quality of the MFB, it impresses most with its exceptionally smooth overall response and neutral character. I should mention that these little MFB speakers can play at quite a high level, with a claimed SPL of 106 dB at 1 meter.

Among other advantages Philips claim for the MFB, is that if they are used with receivers or integrated amplifiers of less than 60 watts per channel, the output power of the receiver/amplifier will be upgraded to 60 watts per channel. There are input connections on the rear of the MFB enclosure, to accept the signal from a pre-amplifier, etc., and there is also an output jack which can be used to connect other MFB units in series for greater power output. Carried to the ultimate extension of this idea, as many as 15 MFB units could be connected to each channel of a pre-amplifier, and assuming a four-channel system, you could wind up with 3600 watts of power!

Peter Gouw and his cohorts showed us other audio items, including a prototype "big brother" of the MFB with a 15-in. woofer. Late in the afternoon, Peter asked us to take a break for refreshments, and to come back in half an hour, when he would have a special treat for us. When we returned to the sound room, a bar had been set up, and everything was very festive, with a 5-man jazz combo, of piano, bass, drums, saxophone, and trumpet, furnishing live music for our pleasure.

After a while, as we were watching and listening to the band, the drummer put down his sticks, casually lit a cigarette and walked over to the bar . . . but the sound of the drums was still neatly accompanying the rest of the players! Then the piano man left, and subsequently the trumpeter and the rest of the band headed for the bar, and the music played on! I had noted a few clues that tipped me off to what was happening, but we all agreed that we had heard the best "live versus loudspeaker" demonstration in our experience. The players and the Philips recording engineers had done an outstanding job of recording without introducing the obtrusive acoustical qualities of the room that usually betray these demonstrations. Everything was beautifully synchronized, and then the background drape opened, revealing two pairs of the little MFB speakers on each side of the orchestra. Truly impressive, and all of us gave the Philips people a well-deserved round of applause. There is no doubt in my mind that in the MFB loudspeaker, Philips has come up with a unique new product which should find a wide and appreciative audience.

While we were in Eindhoven, we visited the audio research labs, where after a general overview of their facilities and activities, we were given a look and a listen to what could be a very significant advance in magnetic tape. The Philips scientists have come up with a tape coated with *iron powder,* rather than *iron oxide.* One of the principal virtues of this new tape is said to be in the improvement of signal-to-noise ratio. We listened to a triple pianissimo section in the finale of Respighi's *Pines of Rome,* recorded on chromium dioxide and on the iron powder tape. An A/B comparison between them dramatically substantiated their claims of a 6-dB improvement in the S/N, as that amount of tape hiss became obtrusive on the CrO_2 tape. Because of its higher coercivity, thinner coatings with the same relative output as conventional tape are possible. Higher bias drive is necessary, somewhat more than for CrO_2.

After a evening of wining and dining, the next morning we were off for Hasselt, Belgium, where the Philips plant that manufactures the new 209S electronic turntable is located. Hundreds of girls are employed here on the assembly lines, where every part and then the subassemblies go through quality-control checkpoints located at various intervals on the lines. Finally, the completed units are tested in a glass-enclosed "clean room." The 209S turntable is one of the most automatic units yet devised. There are three motors in each; one for turntable drive, one for pick-up arm movement, and one for cueing. On the top right of the turntable base is a panel with controls for manual operation, if desired, plus a 33 1/3/45 rpm speed adjustment control and an anti-skating force adjustment control. When the sliding smoked-plexiglass panel is pulled over the control panel, the turntable is in AUTO mode.

Now dig this, fellas . . . you place a record on the turntable platter, and whether you have put on a 7-in. 45-rpm single, or a 10-in. (I suppose some people still have some of these) or 12-in. 33 1/3 LP, the turntable begins to revolve at the correct speed, the pick-up arm lifts up and contacts the lead-in groove at the correct diameter, the record is played to conclusion, then the arm lifts off the record and returns to the arm rest. If you wish you can interupt the playback at any point with a mere finger touch on a capacitor-type button which controls the arm lift. To return the arm to PLAY position, you touch another button. If you would like a *repeat* play of the entire recording, just leave the sliding panel in place and the unit will go through the whole cycle again. I should have mentioned that a muting circuit goes into operation before and after pick-up arm set down and lift off, so you never hear anything from this turntable except the program. The whole system operates electronically, with three sensors in the turntable to "recognize" record size and speed, and pass this information to a so-called mini-computer. The arm has an accurate built-in stylus-pressure gauge, and the arm lift has viscous damping. The 209S turntable drive motor is of the d.c. type with a tacho-generator. The generator produces a frequency signal which is fed to another mini-computer (probably the usual comparator/feedback correction scheme) to correct any speed variations. There is a sub-chassis under the turntable base which provides considerable damping for reduction of acoustic feedback. The 209S certainly must be regarded as one of the most sophisticated pieces of record playing equipment yet offered to the public.

After returning from Belgium, we all were treated to a most memorable and delicious farewell dinner at our hotel. I can't praise too highly the very efficient job the Philips people did in providing us with every possible and technical support in this presentation of their new products, and their open-handed, generous hospitaliity which made our visit so pleasant. Next month . . . . to Vienna and AKG.

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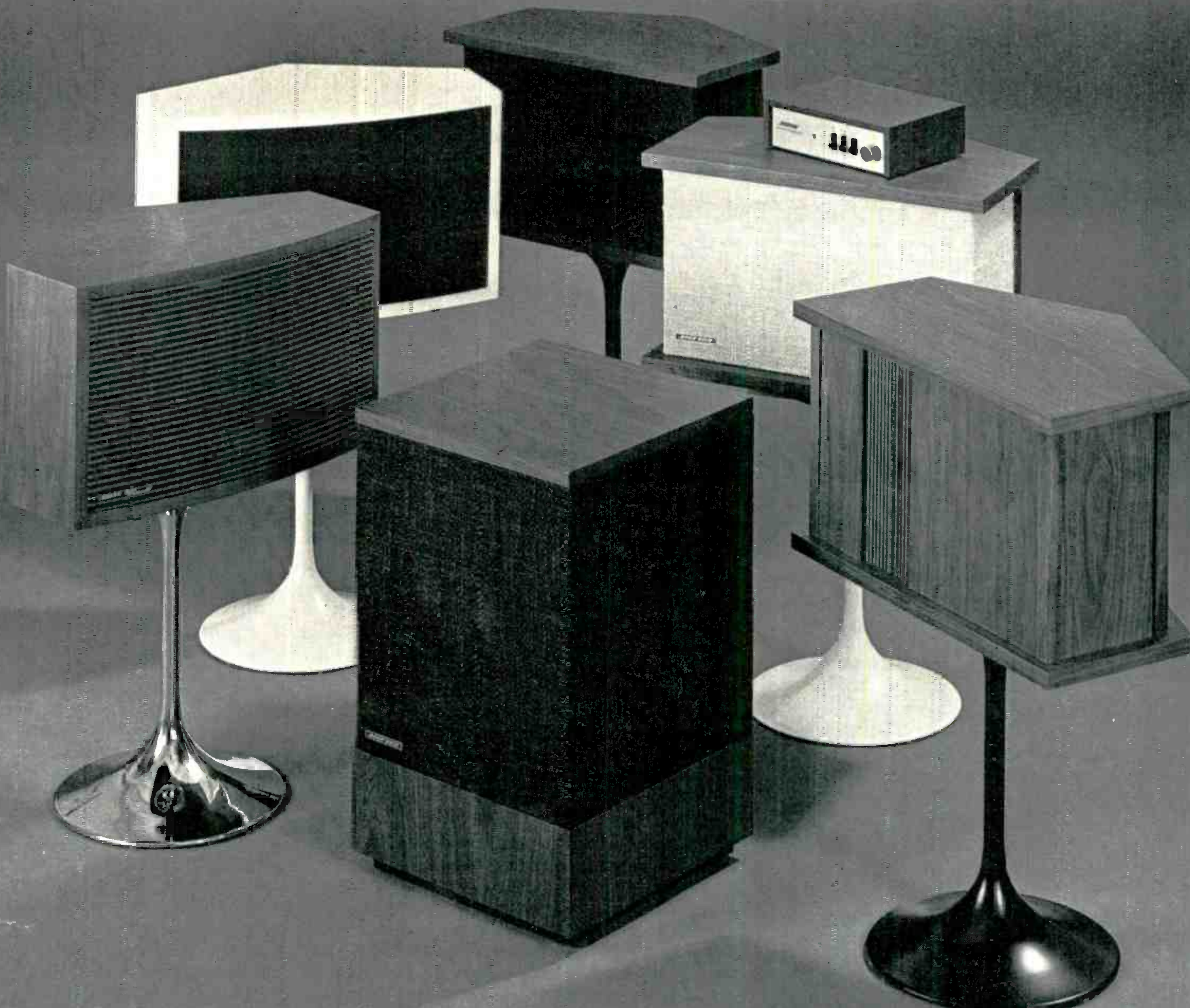

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*For a description of this research see the article "Sound Recording and Reproduction" published in Technology Review (M.I.T.) Vol. 75, No. 7, June '73. Reprints are available from BOSE for fifty cents.

†For your complimentary copy of these reviews plus information on our speakers write: BOSE, Dept. AF, The Mountain, Framingham, MA 01701.

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Shown above: (left to right) new walnut and white 901 Continentals; ebony, white, and walnut 901s; (center) 501. Pedestals optional.

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Audio ETC

Edward Tatnall Canby

Digital Is there any message these days which does not come to us Americans *digitally*—that is, in disjointed segments, sequential blocks and, even more important, simultaneously with other sequences of message? Darned few, I'd say. Which is interesting in view of our own coming electronic revolution, the digital transmission of the audio signal. So get out your pulses and listen (read) my story. (THE WHALE)

You see, we now get everything in plurals. It's the media, not the medium. In Latin, media is the neuter plural, and who ever uses the singular? Only those ungrammatical ladies who call themselves mediums. But then the spirits never were very good at Latin. (PUT JONAH)

Back in the 'teens we had already learned to listen to grand opera on discs through a barrage of multiple "messages" never before encountered in opera, commonly called record scratch. We managed. And soon thereafter we were deciphering code on the radio air, and then voices, through untold masses of sonic interference, this time a great deal of it all too easily intelligible. Those old radio sets weren't very selective. All this was unplanned and accidental. It couldn't be helped, and so we gritted our teeth and got used to it, which turned out to be of immense importance to our sonic future. We got the habit. We found we could absorb multiple messages very nicely, and tune out what we didn't want, or take in everything. Now, we are solidly grounded in plural transmission, deliberate and planned, and absolutely everywhere. We've spent a half century learning all about this, and we are *good*—especially our younger people. It has become a matter of choice. We like it this way. Everything in digital blocks, scrambled together. Even our meals. Soup, entree, and dessert all at once, neatly pulse-coded and quick packaged. Just like the airlines. (DOWN THE HATCH)

And this, I say to you, is what we mean by *media*, in the plural. Or, redundantly, the multi-media, as though one plural weren't enough. Make it two. (BUT COUGHED HIM UP)

So now we find a single message, linear style, no less than tedious. Who wants mono? Even our canned music comes to us in multiple channels. I suppose I should really call this boredom with things merely singular, not tedium, but tedia. (BECAUSE HE SCRATCHED)

Entity. You will note that I am conducting a literary experiment here, in line with my linear remarks. Practicing what I preach. Digital blocks of message bits intermixed. *Entity One.* See how many different ideas I can juggle into the air all at once, in print, the way an audio engineer goes about seeing how many pulsed channels of digital info he can put into his latest transmission. As a matter of fact, my normal printed message, a single and continuous "channel" of type written out in proper linear fashion, does not really reach you in analog form at all, but digitally for the eye. As you read, you are everywhere interrupted by those seductive ads on every side, which is why they are there. (BURMA-SHAVE)

And my type face is broken into blocks, down one side of a page, across the top of another, continued on page xx, and continued again. Quite normal, and few of you seem even to notice it. That is because this layout is typical of our present scattered and pulsed ways of information absorbing. Second nature to us. (HIS FACE WAS SMOOTH)

Entity One. Odd, then, that the more conservative publisher of our British contemporary, *Hi-Fi News & Record Review*, jams in each issue a first section that is all ads, a hundred pages, before you get to a single word of editorial content. Very logical and ever so civilized—we must keep those ads where they belong and allow our editorial content the complete freedom for your attention that it so richly deserves. Nevertheless, I find this format quite disturbing—wouldn't you? I hate to seem uncultivated, but I do find the American mix much easier to absorb. So would you, since you come from the same place as I do. That is a measure of the strength of our new ways of perception. (AND COOL AS ICE)

There is an old journalistic rule, probably invented by the New York Times, that says the whole of a news story must be summed up in the first paragraph; then, as the eye moves on downward, the same ground is covered again, and again, sequentially, in further elaboration, 'round and 'round. Or should I say oblong by oblong. Touching all bases. Isn't that extraordinarily like the digital/sequential techniques that we are now polishing up in electronics, hopefully with a view to applying them to audio circuitry? They do say that this will be our next revolution, and this is logical because, as you see, in the larger sense this way of thinking, this procedure, has long been with us and is in fact the very stuff of 20th century civilization. The more you explore, the more striking this is. (AND OH LOUISE!)

Hey, don't you see, plain old analog electronic amplification, the kind we've always had, is now a hopeless anachronism? From this viewpoint it is dismally out of date. This is a digital world. (HE SMELLED)

Yes, but the analog amp still works very nicely, you'll say. An amplified literal analog of the original signal. Well, yes, it still works. But only by default, because we have already cor-

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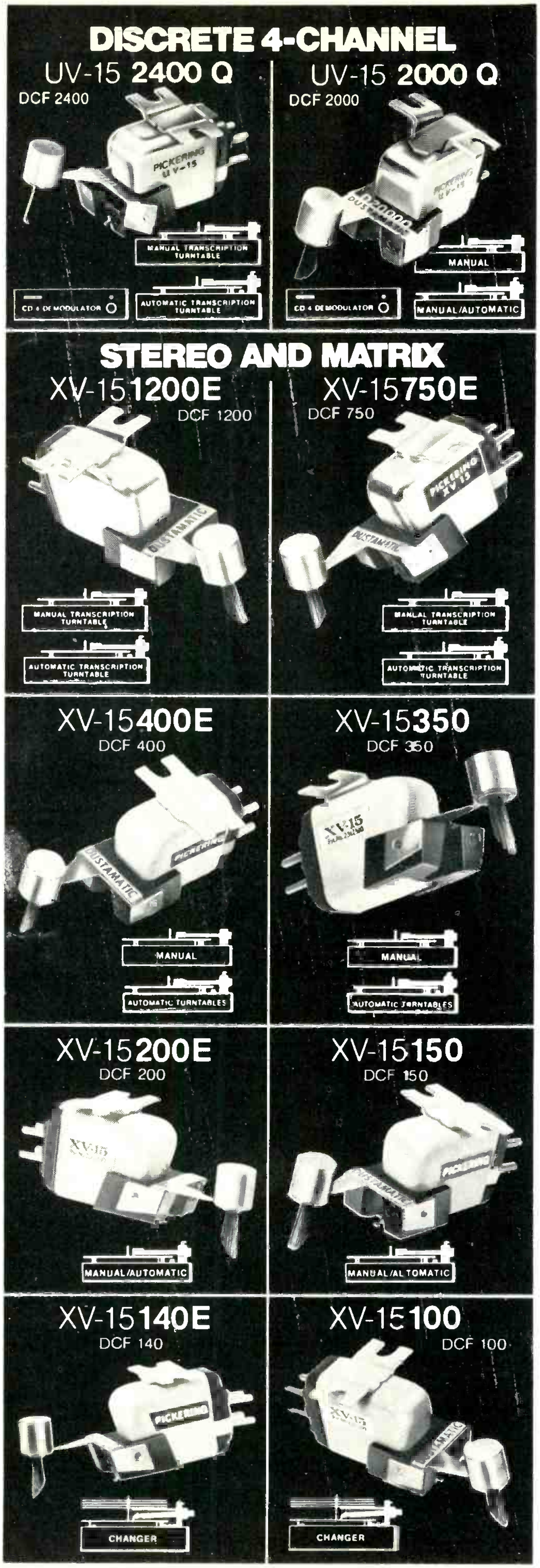

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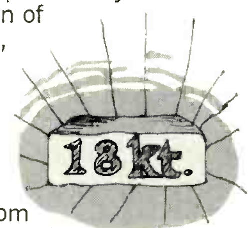
THE GOLD-PLATED RELIABILITY FACTOR.

In this age of planned obsolescence, unreliable performance and shoddy workmanship are almost taken for granted. But there are still a few exceptional products that are built to last and one of them is the Revox tape recorder.

Revox dependability is a combination of many factors, but perhaps the most important of them is advanced engineering.



Borrowing from space age technology, Revox gold-plates all of the electrical contacts on its plug-in circuit boards, relays and rotary switches. The result: every one of these movable contacts, the ones that usually cause most of the problems, can be depended upon to perform well for the life of the machine. Obviously, gold plating is considerably more expensive than conventional tinning, but Revox thinks it's worth it.

Because Revox engineers demand margins of performance and reliability that far exceed ordinary production standards, you can own a tape recorder that will work perfectly the first time you use it and for years to come. And that's why Revox is the only one to back its machines with a lifetime guarantee.

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The illustration contains optional extras.

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rupted it (if I may stretch that term) via dual stereo signals and quadruple quadraphonics, whether matrixed or discreted. We do have to be practical. And the linear word in lines of type is still useful, too. But don't think this can last. Digital circuits are inherently right for the audio messages we are going to have to deal with, and are dealing with already. Ask anybody. (SO NICE)

It's digital conglomeration all over. Look around you! What is a conglomerate? A conglomerate, I say, is a simultaneous digital mix of discrete enterprises, differing business "messages," brought together in a common, economic transmission. A multiplexed economy. (BURMA-SHAVE)

Entity One for 40 Channels. The big value in our coming digital electronics is that via this principle of multiple simultaneous/sequential pulsing we can cope with our audio software in far more flexible (and economical) ways, produce as many channels as we will ever need and with as few limitations on quality, bandwidth, and so on as we can ever hope to imagine. (That is, after we get the d--- thing working.) You'll be hearing plenty more about the micro-techniques of this approach, so I'm merely getting one leg in, on general macro-principles. Won't do any harm. I keep getting more fascinated by the large aspects of it. (PITY ALL)

You see, all our intelligence, our messages, our *things,* become more and more digital minded, module inclined, as we barge bravely onwards into the unknown. And less and less linear. It happens even when, technically, there is only a single channel of communication. Take those recent radio ads I keep hearing. A block of news, then a jumble of voices all talking at once. Out of the jumble come fragments of sense: . . .*I like . . . run straight down to the store . . . my husband says* . . . these in fact are the commercial message, strung out into digital increments. No problem—we take it in stride! But imagine explaining the idea, say, to Queen Victoria. Her imperial language was strictly of the old-fashioned linear sort and very logical. English teachers today notwithstanding, our own is more and more the fragmented type. Grammar notwithstanding, this is the sort of intelligence that we take in most easily. The ad people know what they are doing. *Entity One for 40 Channels and 20 Tape Recorders.*

I suppose the earliest example of large-scale digitality in music was in the days of the Baroque opera, the 17th and 18th centuries, which shows that a good idea often sprouts before its time. They liked to put on *two* operas at once, intermixed. First, an act of a high-minded tragedy, an *opera seria,* the grandest of the grand. Then Act I of a totally irrelevant but nicely contrasted *opera buffa,* a hilarious farce—then back for Act II of the tragedy, and so on through the evening. In England, Shakespeare did a better sequential integration; his plays combine the solemn and the hilarious, plots and subplots, all within a single transmission. Shakespeare in multiplex. (THE MIGHTY CEASARS)

Just like TV. There, the idea isn't so much dramatic contrast as, more directly, to make a maximum dual impact via both ads and "content." How? By digital intermix. Segment of cowboy film, cut off instantaneously, and straight into a block of four or five segmented ads (also intercut without breaks), then straight back to the cowboys at precisely the spot we left off. Things move so fast in this fashion that I tend to get mixed up, being of the older generation; I find myself riding that cowboy horse right into the nearest beauty parlor before I can rein myself in. But most people are totally acclimated. (THEY PULLED)

I have been injecting these little blocks of Burma-Shave into this text (EACH WHISKER OUT) because for years I have noted with growing awe, as time has progressed, that those little wonders, the tiny but very visible signboards by the sides of our old two-lane highways in the 1920s and on, were far ahead of the game in terms of our present ways of thought and even our biggest ad dollars. Back in 1925 this forward-looking ad device was almost a happenstance to begin with, but it flourished and spread, year after year, for almost 40 years. Wow! It wasn't only that the little ads, in sequence as you drove down the road, were always funny and perfectly chosen for their medium (not yet media). It was also because in plain fact here was the germ of our present rampantly digital approach, squarely in line with coming great events. No matter that they were corny—deliberately—and purely mechanical, for line-of-sight viewing. No electronic miracles. But the necessities of the new age, the 40-mph traveling family in its new car, the need to sell on the hoof, on four tires, dynamically, on the move, led directly to a format *laid out in time,* like every radio and TV ad since for a half century. And this in a day when radio was barely started and the radio commercial not yet even talked about. (WITH TWEEZERS)

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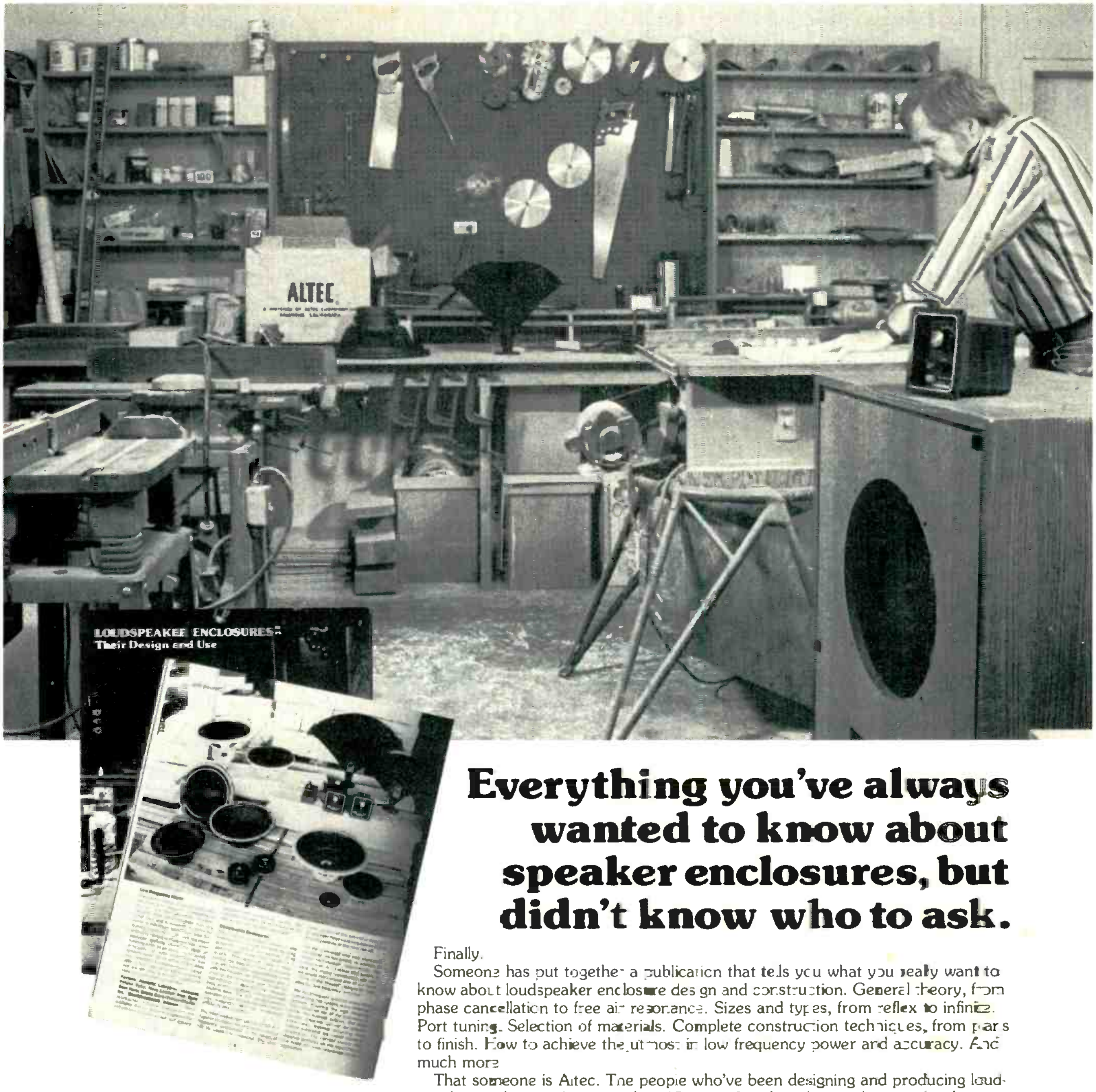

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In fact, I'm writing a belated review of a splendid little book that appeared some years ago, *The Verse by the Side of the Road* by Frank Rowsome, Jr. (Dutton Paperback, D191 1966), and I thank Mr. Rowsome for the quotes I have borrowed. Do try to find a copy for yourself, and learn all about Burma-Shave.

My own experience was strictly personal and long before this book. As a child I was delighted with the very idea of Burma-Shave, and for years I never missed a segment on those happy little red signs (some were orange), set at such tantalizing intervals against the roadside greenery. A Burma-Shave jingle on paper, out of its proper medium, loses all its punch, as indeed it should. Even when you spread it out.

THE CHICK HE WED
LET OUT A WHOOP
FELT HIS CHIN AND
FLEW THE COOP:

You must imagine those segments spaced a half mile or so (was it?) apart, each one saucily placed in the middle of nowhere, in some country pasture, making absolutely no sense on its own, just *there*. Nothing for it, but to hold the mental breath and wait, at an even 40, until after 75 trees, four houses, and a gas station, the next little red sign appeared 'way down the road and hove into reading distance. It was marvelous. We kids, in the back seat, would simply yell out each message, and then dissolve into giggles as the final punch line was delivered, followed always by the florid Burma-Shave logo. Gone—all gone (1963). We drive too fast. We don't look at the side of the road any more, lest we hit a concrete abutment. WHY DOES A CHICKEN / CROSS THE STREET? (New twist on an old adage.) Well, drive right on and you'll soon find out. But doesn't that chatty "Cross the street?" sign look cute, as though asking some polite question of the nearest driver! All by itself, in the middle of a landscape, and the next segment far down the highway.

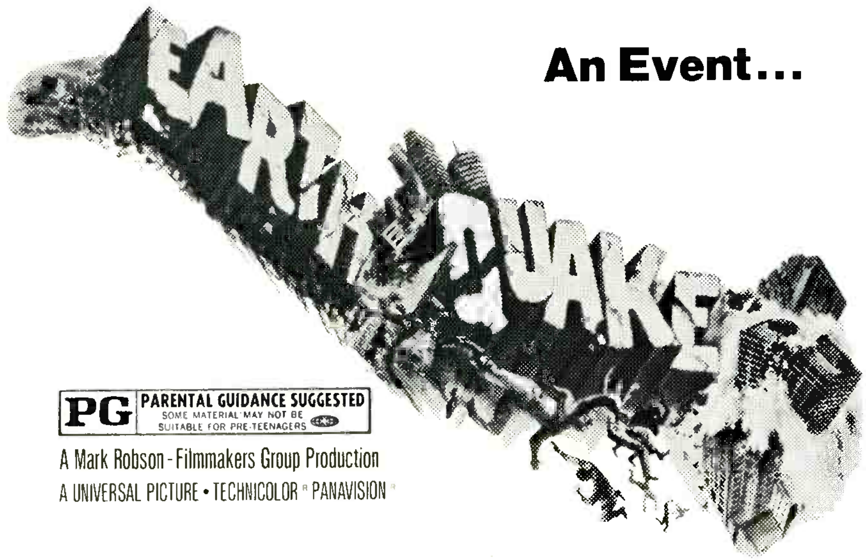
Our most sophisticated accomplishment, as we grew older, was to read the Burma-Shave digitals *on the left side of the road*, out the back window and in reverse order. Some mix! You had to memorize the sequence and then retrograde it. BURMA-SHAVE WILTER WHISKER TRY THE BRUSHLESS OUT OF KILTER WATER HEATER. So much for Burma-Shave.

Entity One for 40 Channels? I almost forgot. This magnum opus exists, but definitely, and it may come your way. It was composed, that is, assembled, by Morris Knight, the same who wrote me some good definitions of noise, back a few issues. I won't go into detail on Entity One but I assure you it must be something to experience. A traveling sonic show, evening long, that requires a spacious auditorium with good acoustics, 20 two-channel tape players, all going at once, and 40 loudspeakers (minimum) for the 40 simultaneous channels of information, set up in a handsome pattern so that people may sit, lie, or otherwise deposit themselves for varied listening, all over the place. Two big segments, and the organized sound gives way at an intermission to the pleasantly rambling noise of people relaxing. Good idea. Entity One travels in a station wagon, which seems to be a problem only to Prof. Knight and his muscles (with student aid—the show goes on mostly on college campuses). Twenty Ampexes, as I remember. Plus those speakers and the necessary 20 amps, amplifiers I mean, not amperes, plus the easily imagined miles of cable. After each show, the audience is asked to give its reaction in writing and the indefatigible Knight has sent me a vast book full of offbeat examples—far out! Sonically and philosophically, the college kids eat it up. It's their world.

Now admittedly there isn't much that can be done to simplify the dispersal of Morris Knight's 40 loudspeakers, unless to make them small-

(Continued on page 61)

An Event...



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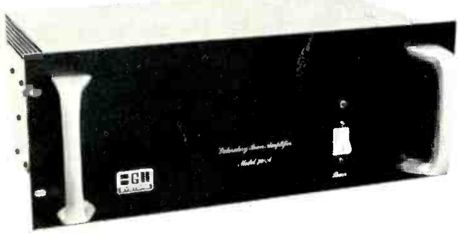

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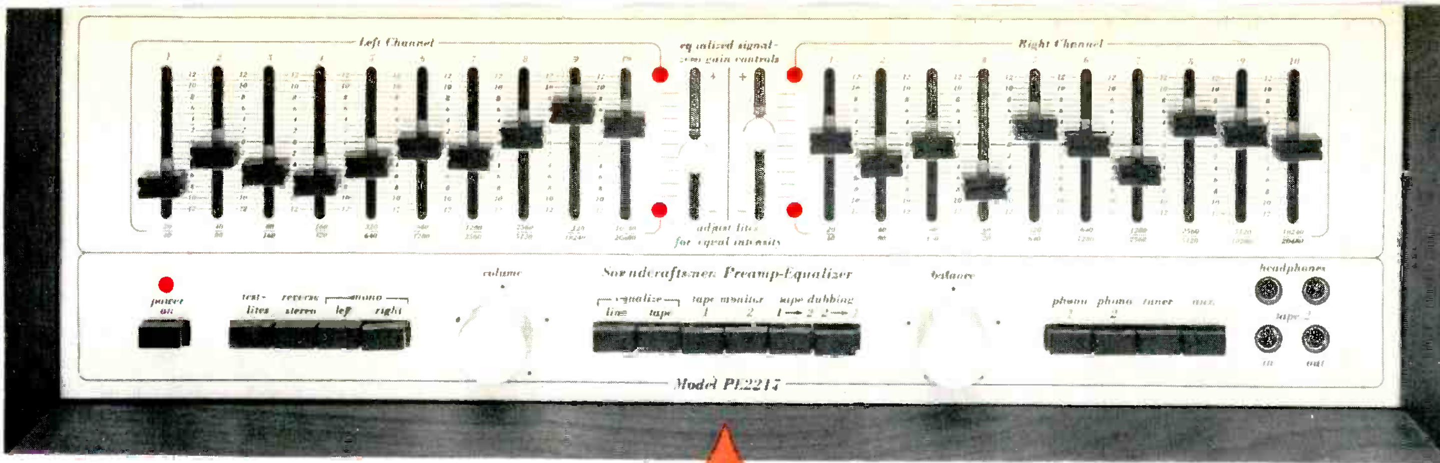

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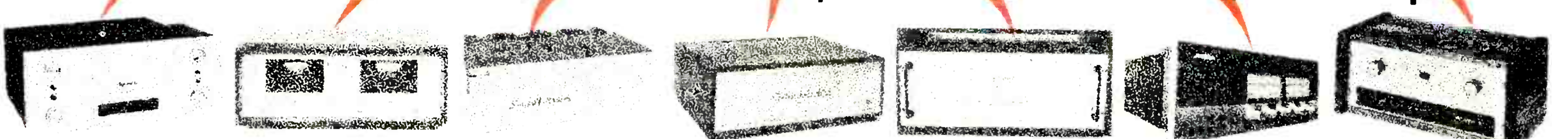

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SPECIFICATIONS

FREQ. RESPONSE — Hi-level: ±¼ db, 5 Hz to 100 KHz
FREQ. RESPONSE — Phono: ±½ db, 20 Hz to 20 KHz
THD: less than .05% at 1 volt (Typ. .01% at 1 volt)
IM: less than .05% at 1 volt (Typ. .01% at 1 volt)
SIGNAL-TO-NOISE — Hi-level: 100 db below full output
SIGNAL-TO-NOISE — Phono: 84 db below a 10mv input
SIGNAL-TO-NOISE — Equalizer: 90 db below a 1 volt input
OUTPUT IMPEDANCE: 600 ohms
MAXIMUM OUTPUT: 5 volts into hi impedance, 2.5 volts into 600 ohms
EQUALIZER LEVEL: Zero-gain controls for left and right continuously variable, for unity gain compensation
EQUALIZER RANGE: 12 db boost and 12 db cut, each octave at 30, 60, 120, 240, 480, 960, 1920, 3940, 7680 and 15,360 Hz.
MAX. OUTPUT SIGNAL: Variable master volume control allows adjustment of optimum output to match amplifier
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DIMENSIONS: Walnut-grained case 7¼" x 20" x 11¼" deep
WARRANTY: 2 years parts and labor
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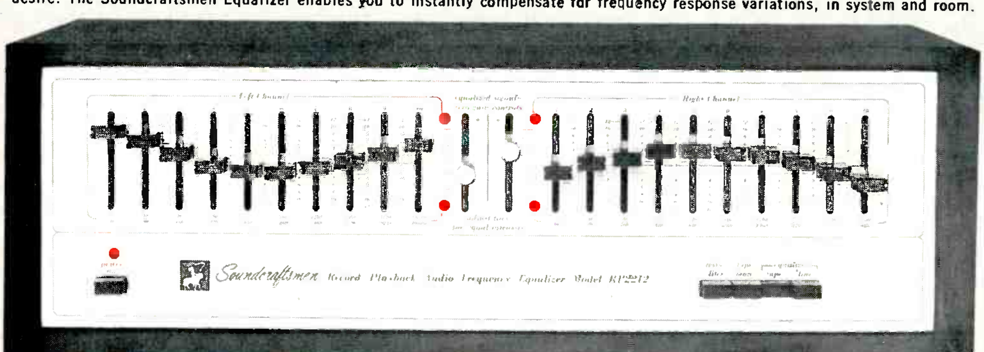

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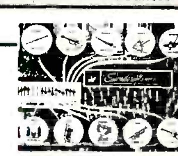

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FTC Power Ratings: *An Optimistic View*

Brian C. Wachner and Michael S. Robbins*

WIDE DISCREPANCIES in audio amplifier power claims have existed for years. Conservative manufacturers cringed when they saw brown goods manufacturers advertising "$199 complete" systems as having 350 watts of power. This credibility gap between power claims has finally been narrowed by the Federal Trade Commission, however, a fight by parties reluctant to change seems inevitable.

The so-called hi-fi manufacturers adopted a somewhat more meaningful set of standards in 1966—through the IHF [1]. However, this voluntary standard was antiquated with the coming of the solid-state era. Flagrant abuses of the term "continuous power" and the lack of meaningful standards has forced the Federal government to legislate a new standard for the protection of the consumer.

The ruling (see complete text on accompanying page) establishes a stringent set of guide lines and procedures to which all manufacturers must adhere if they wish to disclose power ratings. It is about time that all companies tested their amplifiers using the same set of standards and procedures, and that only realistic steady-state output levels be advertised.

The following power specifications are in the format required by the FTC under its new ruling:

BGW Systems Stereo/Mono Power Amplifier Model 750A

8-ohm Power Output: 200-watts average continuous power per channel; Power Band, 15 Hz to 15 kHz; Total Harmonic Distortion, 0.2%.

4-ohm Power Output: 300-watts average continuous power per channel; Power Band, 20 Hz to 10 kHz; Total Harmonic Distortion, 0.25%.

Monaural Operation (Bridge-Connected Mode)

8-ohm Power Output: 600-watts average continuous power; Power Band, 20 Hz to 10 kHz; Total Harmonic Distortion, 0.25%.

The most stringent aspect of the ruling, as applied to medium- and large-size power amplifiers, is the pre-conditioning test and the five-minute, full-power test. Before measurements may be made at all, the unit must be subjected to a one-hour burn-in. This is accomplished with all channels driven to one-third rated output at the lowest impedance at which the manufacturer wishes to disclose power. The test signal used must be a continuous sine wave. The power line voltage must be kept at 120 volts for domestic equipment, and the minimum ambient temperature must be 77° Fahrenheit. After one hour of continuous operation (the unit must have the ability to remain on without thermal cycling), the remainder of the tests are performed.

To electronic engineers, this pre-conditioning sequence appears to be very straight forward, however, some noted hi-fi writers are already thinking up ways around this part of the ruling [2,3]. The reason for their imaginative thinking is that a typical solid-state amplifier dissipates a tremendous amount of heat at the prescribed 33⅓% power level. In fact, a class-B amplifier exhibits its lowest efficiency at approximately 40% of maximum output power.

The great majority of the medium-to-large power amplifiers on the market today will not pass the pre-conditionng test even at 8-ohms. Amplifiers with built-in cooling and those designed for 2-ohm use comprise the largest number of existing designs which may continue to carry their old power-rating figures now that the law has become effective.

There are many good reasons why the law should be enforced without change. Without the new law, it would remain impossible for the audiophile to meaningfully compare specifications from one manufacturer to the next without guidance from a graduate EE. Many existing designs suffer from inadequate heat sinking and will be unreliable for that reason. The consumer will wind up with a higher quality product and a better investment because of the design conservatism now required for compliance.

Technically, there are very good reasons for keeping heat-sink temperature down, and this is basically what is required by the pre-conditioning test. Semiconductors are very rugged devices when compared to tubes, however, they can easily be destroyed by allowing the silicon junctions to be exposed to temperatures approaching 200° Centigrade. Power transistors, in fact, must be de-rated with temperature to insure safe operation. The curve in Fig. 1 illustrates the de-rating which applies to most silicon power transistors operated within their continuous capabilities. [4].

Thermal cycling is also a problem which causes power transistors to fail after extended operation. Any power transistor can be made to fail within a finite number of cycles by repeatedly heating it up to high temperature and cooling it off under power-applied conditions. Some semiconductor manufacturers have established data showing the number of thermal cycles to be expected from a device under repeated cycling conditions. Such a graph is presented for the type 2N3773 device (see Fig. 2), which consists of a 0.250-x-0.250-in. silicon die mounted on a molybdenum or copper

***President and Chief Engineer, respectively, of BGW Systems, Culver City, Calif. 90230**

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FTC TRADE REGULATION RULE ON AMPLIFIER POWER-OUTPUT SPECIFICATIONS

Power Output Claims for Amplifiers Utilized in Home Entertainment Products

• Section 1. Scope.

(a) Except as provided in paragraph (b) of this section, this Rule shall apply whenever any power output (in watts or otherwise), power band or power frequency response, or distortion capability or characteristic is represented, either expressly or by implication, in connection with the advertising, sale, or offering for sale, in commerce as "commerce" is defined in the Federal Trade Commission Act, of sound power amplification equipment manufactured or sold for home entertainment purposes, such as, for example, radios, record and tape players, radio-phonograph and/or tape combinations, component audio amplifiers and the like.

(b) Representations shall be exempt from this Rule if all representations of performance characteristics referred to in paragraph (a) of this section clearly and conspicuously disclose a manufacturer's rated power output and that rated output does not exceed two (2) watts (per channel or total).

(c) It is an unfair method of competition and an unfair or deceptive act or practice within the meaning of Section 5(a)(1) of the Federal Trade Commission Act [15 U.S.C. • 45(a)(1)] to violate any applicable provision of this Rule.

• Section 2. Required disclosures.

Whenever any direct or indirect representation is made of the power output, power band or power frequency response, or distortion characteristics of sound power amplification equipment, the following disclosures shall be made clearly, conspicuously, and more prominently than any other representations or disclosures permitted under this Rule:

(a) the manufacturer's rated minimum sine wave continuous average power output, in watts, per channel (if the equipment is designed to amplify two or more channels simultaneously);

(I) for each load impedance required to be disclosed in paragraph (b) of this section, when measured with resistive load or loads equal to such (nominal) load impedance or impedances, and

(II) measured with all associated channels fully driven to rated per channel power;

(b) the load impedance or impedances, in ohms, for which the manufacturer designs the equipment to be used by the consumer;

(c) the manufacturer's rated power band or power frequency response, in hertz (Hz), for each rated power output required to be disclosed in paragraph (a)(I) of this section; and

(d) the manufacturer's rated percentage of maximum total harmonic distortion at any power level from 250 mW to the rated power output, for each such rated power output and its corresponding rated power band or power frequency response.

• Section 3. Standard test conditions.

For purposes of performing the tests necessary to make the disclosures required under Section 2 of this Rule:

(a) the power-line voltage shall be 120 volts AC (230 volts when the equipment is made for foreign sale or use, unless a different nameplate rating is permanently affixed to the product by the manufacturer, in which event the latter figure would control), RMS, using a sinusoidal wave containing less than 2 per cent total harmonic content. In the case of equipment designed for battery operation only, tests shall be made with the battery-power supply for which the particular equipment is designed and such test voltage must be disclosed under the required disclosures of Section 2 of this Rule. If capable of both AC and DC battery operation, testing shall be with AC line operation;

(b) the AC power-line frequency for domestic equipment shall be 60 Hz, and 50 Hz for equipment made for foreign sale or use;

(c) the amplifier shall be preconditioned by simultaneously operating all channels at one-third of rated power output for one hour using a sinusoidal wave at a frequency of 1,000 Hz;

(d) the preconditioning and testing shall be in still air and an ambient temperature of at least 77° F (25° C);

(e) rated power shall be obtainable at all frequencies within the rated power band without exceeding the rated maximum percentage of total harmonic distortion after input signals at said frequencies have been continuously applied at full rated power for not less than five (5) minutes at the amplifier's auxiliary input, or if not provided, at the phono input;

(f) at all times during warm-up and testing, tone, loudness-contour and other controls shall be preset for the flattest response.

• Section 4. Optional disclosures.

Other operating characteristics and technical specifications not required in Section 2 of this Rule may be disclosed, *provided:*

(a) that any other power output is rated by the manufacturer, is expressed in minimum watts per channel, and such power output representation(s) complies with the provisions of Section 2; except that if a peak or other instantaneous power rating, such as music power or peak power, is represented under this Section, the maximum percentage of total harmonic distortion [see Section 2(d)] may be disclosed only at such rated output; *and provided further,*

(b) that all disclosures or representations made under this Section are less conspicuously and prominently made than the disclosures required in Section 2 of this Rule; and

(c) the rating and testing methods or standards used in determining such representations are disclosed, and well known and generally recognized by the industry, at the time the representations or disclosures are made, are neither intended nor likely to deceive or confuse the consumers, and are not otherwise likely to frustrate the purpose of this Rule.

(*NOTE 1*: For the purpose of paragraph (b) of this section, optional disclosures will not be considered *less prominent* if they are either bold faced or are more than two-thirds the height of the disclosures required by Section 2.)

(*NOTE 2*: Use of the asterisk in effecting any of the disclosures required by Section 2 and permitted by Section 4 of this Rule shall not be deemed *conspicuous* disclosure.)

• Section 5. Prohibited disclosures.

No performance characteristics to which this Rule applies shall be represented or disclosed if they are not obtainable as represented or disclosed when the equipment is operated by the consumer in the usual and normal manner without the use of extraneous aids.

• Section 6. Liability for violation.

If the manufacturer or, in the case of foreign-made products, the importer or domestic sales representative of a foreign manufacturer of any product covered by this Rule furnishes the information required or permitted under this Rule, then any other seller of the product shall not be deemed to be in violation of Section 5 of this Rule due to his reliance upon or transmittal of the written representations of the manufacturer or importer if such seller has been furnished by the manufacturer, importer, or sales representative a written certification attesting to the accuracy of the representations to which this Rule applies, *and, provided further,* that such seller is without actual knowledge of the violation contained in said written certification.

Promulgated: May 3, 1974
Effective: November 4, 1974
By the Commission.

Charles A. Tobin
Secretary

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graphically in Fig. 7. By inspection, we see that maximum heating occurs at about 150 watts or 40% of maximum power.

Looking back at the heat-sink thermal resistance of 0.2° C. per watt with 208 watts being dissipated under pre-conditioning, we can expect a temperature rise of:

(0.2° C/watt) (208 watts) = 41.6° C.

The power band attainable from a given type of output transistor is directly related to its switching speed. It is well known that the faster we make a power device, the more fragile it becomes. If the designer is most interested in reliability and ruggedness, he will choose the slowest devices for the application. Generally speaking, amplifiers used for audio applications are required to deliver greater power below 500 Hz than in any other part of the power spectrum.

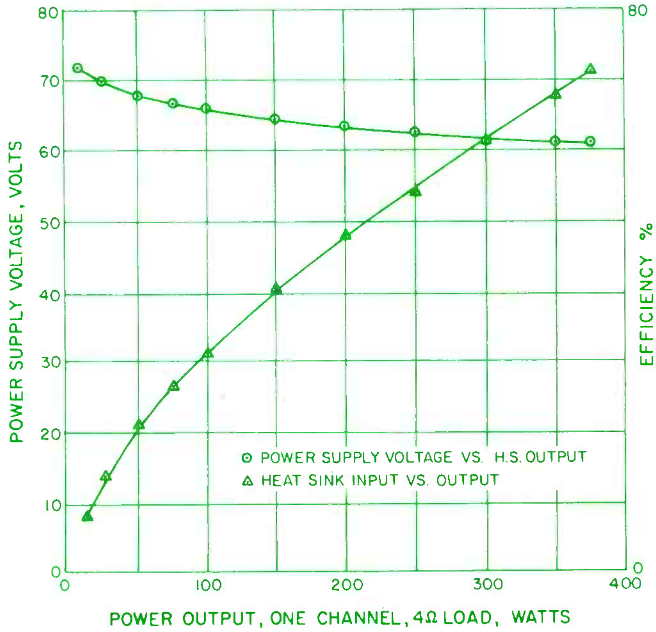

Fig. 6—Power-supply regulation and output-stage efficiency versus power output for a typical Model 750A.

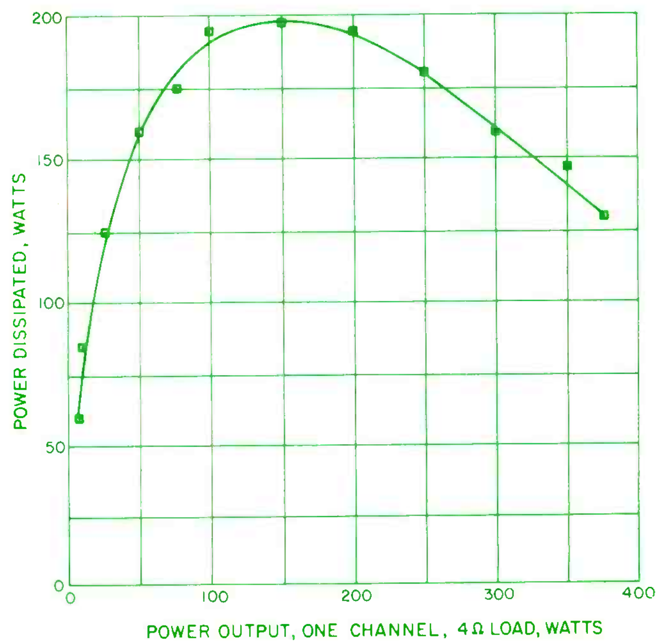

Fig. 7—Power dissipation versus power output for an actual Model 750A output stage.

A chart of power spectrum density is shown in Fig. 8. All speaker systems have far greater power-handling capacity at low frequencies than they do at high frequencies, and most program material is compatible with this parameter [6]. It is, therefore, unnecessary to require a high-power amplifier to deliver its full rated power at frequencies above 10 or 12 kHz. A controlled power bandwidth, along with a sufficiently wide frequency response, is the most rational choice, although contrary to the audiophile's never ending search for specification improvements. Our listening tests on the same amplifier circuit with fast double- or triple-diffused output devices versus the slower single-diffused types reveal no audible differences. These single-diffused devices have the largest safe operating areas and can handle tremendous surges of power without failing. This peak power capability allows the practical design of amplifiers without the use of current limiting circuits.

The Model 500D is a slightly smaller version of the 750A and is built on the same chassis. Its power output into 8 ohms is 150 watts per channel with a maximum THD of 0.2% over a power bandwidth of 20 Hz to 20 kHz. In order to achieve this additional bandwidth, transistors having smaller dice with the same power dissipation rating are employed. The 2N6262 used in the 500D measures 0.180 X 0.180 in. across the silicon die and can dissipate 150 watts. The mechanical construction is identical to the 2N3773. A slightly smaller power supply is used in the Model 500D to protect the faster power transistors.

By building an amplifier with enough muscle to pass the FTC preconditioning test, it is easy to overcome another fairly common problem. Most present high-power amplifiers (with greater than 100 watts) use some form of load line limiting to protect the output stage from short-circuit conditions. These limiters simply remove the drive to the output stage if excessive current flow exists. When this happens, the signal is grossly distorted, and spikes, rattles, chirps or buzzes may come from the speaker. Simple limiters act immediately upon application of the overload. More complex circuits have time delays of a few milliseconds before they are activated. A basic problem with any form of load line limiting is that speakers are reactive and can actually push power back into the amplifier and falsely turn on the limiters. The best solution is to design the output stage with enough strength to handle all the energy the power supply can deliver under short circuit conditions and to eliminate all forms of current limiting. Listening tests show dramatic improvements in the transient performance of an amplifier when the limiters are removed [7].

Our approach is to use a fast-acting magnetic circuit breaker to disconnect the power from the amplifier under short circuit conditions. Line fuses are not used, as improper fusing could damage the amplifier. Additionally, a fail-safe

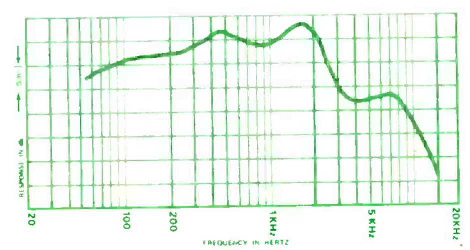

Fig. 8—Normalized average of peak energy levels of symphony orchestra. (From Electro-Voice data sheet No. 535430.)

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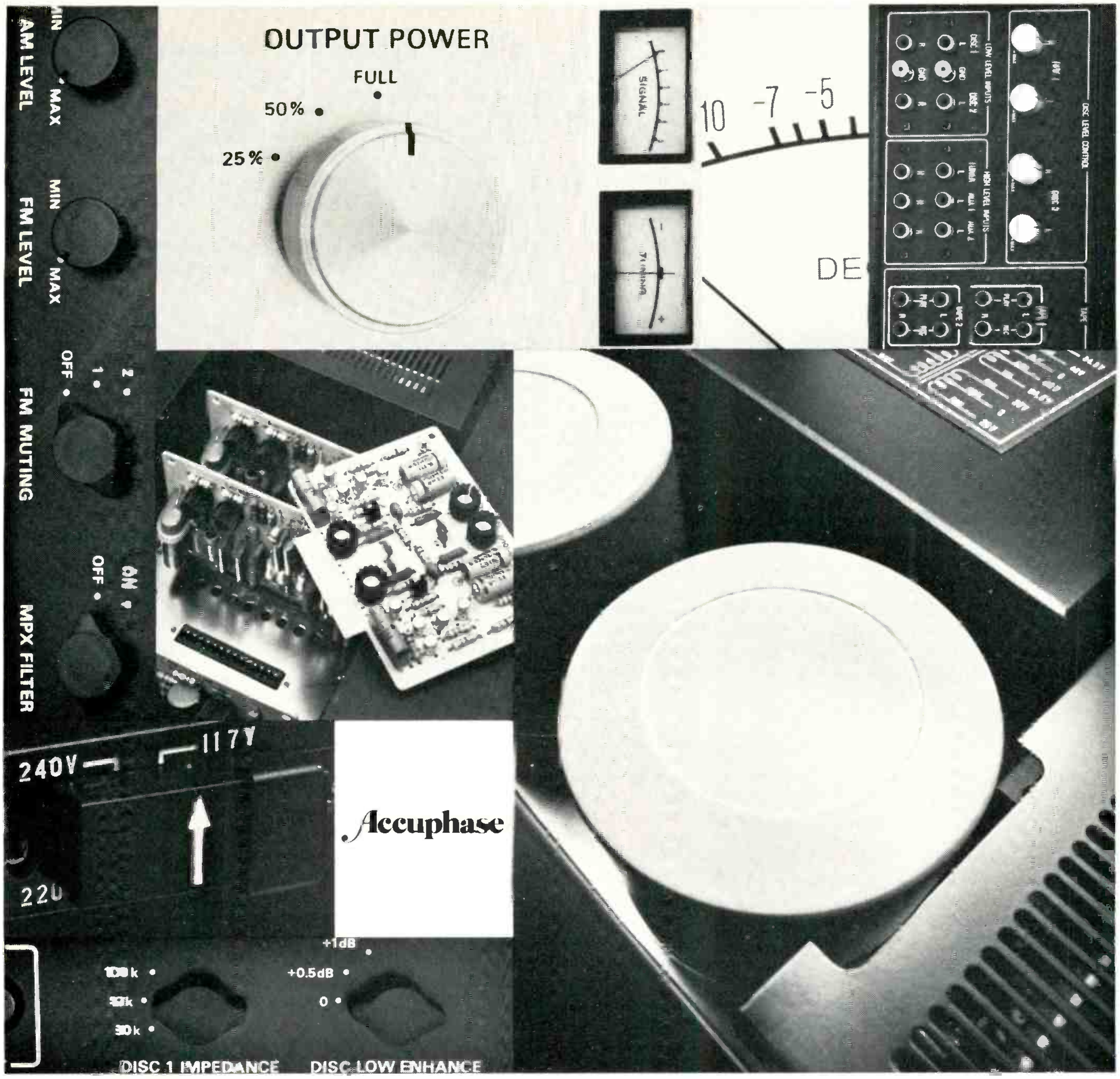
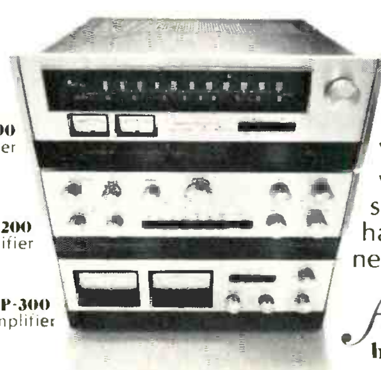


If the whole is greater than the sum of its parts, imagine what happens when each part is greater than it has to be.



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SCR Crowbar circuit is incorporated to quickly shut down the amplifier if a malfunction occurs. This circuit (Fig. 9) samples the output of each channel and triggers a large, high-current SCR which discharges the power supply and shuts the unit off, if necessary.

The schematic of one complete channel of the 750A is shown in Fig. 10. All of the components shown are mounted on the heat-sink module. The input circuit consists of an LM318H, wide-bandwidth, operational amplifier, which can handle the total audio spectrum with minimal phase shift. The LM318 has a slew rate 100 times that of the popular 741 type of amp found in many audio designs and 50-70 times higher than the 739 type used in other designs. Complementary transistors are used to source and sink the current required by the output stage pre-drivers and to provide the required voltage swing.

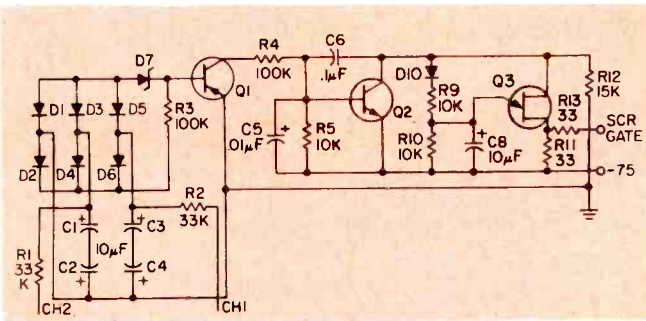

Fig. 9—Crowbar sensing and trigger circuit generates gate pulses for an SCR which discharges the power supply.

We have outlined here some of the approaches we have taken to produce rugged, reliable amplifier designs—approaches other designers may only now be forced to follow by the FTC ruling. While these are certainly not the only ways the FTC measurement standards can be met, whatever an amplifier designer does to meet and fulfill the regulations will benefit the consumer. At the very least, the FTC rules will narrow the credibility gap between power claims.

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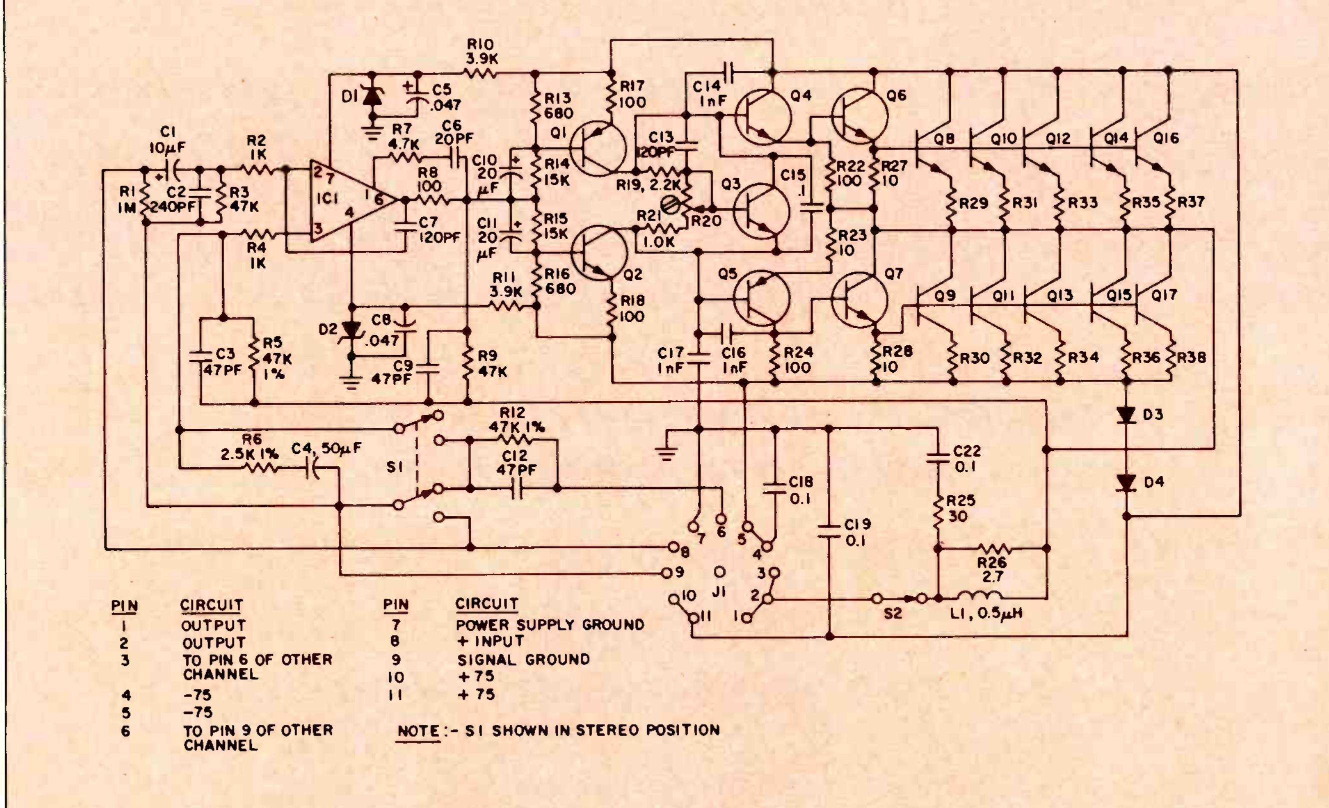

Fig. 10—Schematic diagram of one channel of the Model 750A.

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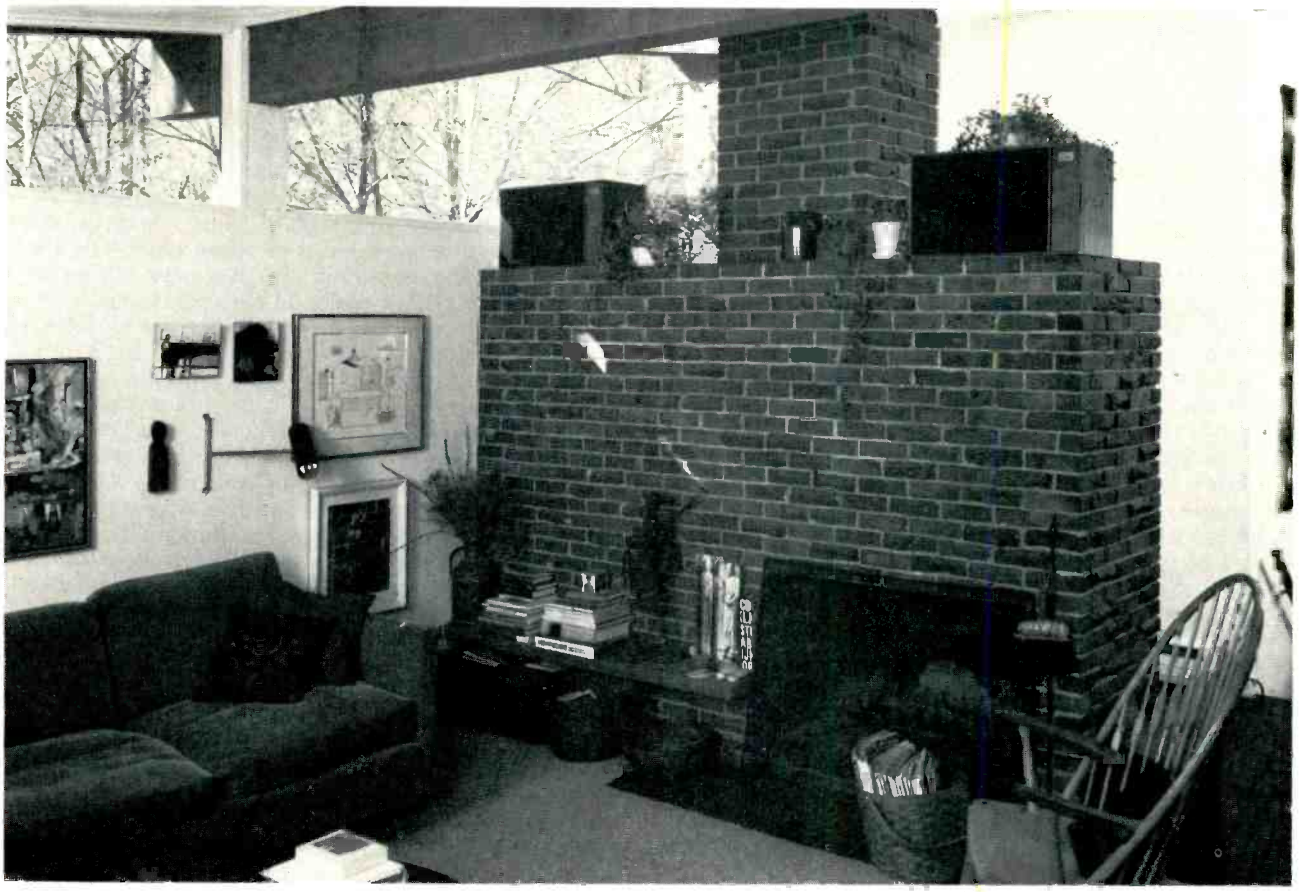

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An Alternative View

Robert H. Tucker*

THERE IS NO denying the need for and the essential validity of the basic Rule provisions in establishing a universal reference base for evaluating this one important aspect of power amplifier design. Let us not, however, lose sight of other significant parameters, only some of which are readily reducible to cold type, which help to define the sonic differences which may still be apparent between amplifiers of nearly identical specifications. Too, the past proliferation of amplifier test clinics, each asserting the singular importance of a different specification (which just happened to be the one which the promoting brand handled so competently) should give pause, in their conflicting claims, to those who seek numbers *ad absurdum.*

That caution stated, on to the Rule. Dynaco is on record, as far back as 1970, as actively supporting *only* "rms" or average continuous power ratings in the hearings before the FTC, to the exclusion of any short term or "music power" figures, because of the consumer confusion they engender. Further, two decades of Dynaco amplifiers have always been rated first and foremost by their average continuous power output. Thus, we were gratified with the early drafts of the Rule, when after years of FTC work, they were presented for industry comment. These were essentially identical to the Rule as promulgated, with the exception of the later addition of sections 3c and 3e, relating to preconditioning. These sections were instituted just prior to the last hearing dates, and apparently escaped much industry notice, despite the fact that any engineer would recognize that they radically altered the conditions for test. They will also have the effect of sharply increasing consumer prices with negligible audio benefit. Further, they will have the corollary result of reduced product information, and may thus engender equipment failure through inadvertent misapplication. This is widely at variance with the announced objective — to provide consumers with meaningful comparisons of power output ratings, and to prevent fraud.

Mindful of the onus which attends challenges to a consumer-protection authority, and which has thus precluded cohesive, overt support from other amplifier manufacturers who also find serious fault with the preconditioning clauses of the Rule, Dynaco still does not intend to shrink from its responsibility to the consumer to attempt correction. Accordingly, as of this writing, Dynaco has filed a petition before the Federal Trade Commission for a delay in implementation of the Rule, and for a reopening of hearings to permit modification of the Rule. To date, no official action has been confirmed.

The purpose for seeking a rehearing is to obtain a true industry consensus on those aspects which, through industry lack of awareness and intransigence, were not responded to at the appropriate time. Only later were they found to require alteration or redesign of existing models. Naturally, those manufacturers who regularly institute model changes were less affected than those whose designs normally stay current for extended periods. In the latter case, a de-rating of a model previously thought conservative by prior standards poses a serious credibility problem in a hobbyist field fraught with never-ending concern for "who is best?"

As a practical matter, the alternative of subverting the efficacy of existing protective systems has been the unfortunate corrective approach in some instances. We deplore such a crass commercial solution, which can only adversely affect the consumer, yet we must recognize the economic implications which impel such tactics.

That the Rule was not corrected prior to its implementation should not now preclude revision, now that its impact is becoming visible. In this small industry, the arbitrarily severe preconditioning requirements were not recognized until they filtered back to the engineering departments, long after the hearings ended. Indeed, the FTC staff has indicated that the 1/3 power point was purely a convenient "middle ground" between one proposal for a 10% preconditioning level, and another recommendation for full-power operation. That it closely approached the "worst case" operating condition was entirely accidental. It appears that these late insertions were simply overlooked by all of us, and thus no substantive data was submitted within the allotted time to encourage change. The FTC staff members have indicated that such a change could easily have been accomplished to a more sensible preconditioning base, if the facts were presented. It is the fault of the high-fidelity industry, not of the FTC, that this Rule was inappropriately drawn.

Mr. Wachner's thesis is not contestible on technical grounds, and if it were a fact that such (high-power) amplifiers were normally used with sustained signal levels which approximated average outputs of 20% or more of rated power, we believe his viewpoint would be far more defensible from the consumer's point of view. A ludicrous aspect of the whole argument, however, is that just those applications which justify such a stringent test condition — musical instrument amplifiers, public address equipment, instrumentation and industrial use, etc. are excluded from the Rule's rating requirements because these are not "home entertainment purposes."

It is a very real concern that a music amplifier be able to sustain an organ note, for instance, for its full duration. For that reason, "music power", or worse, "peak power" figures are meaningless bases of comparison, especially when they are established by connection of an external power supply. What the Rule is now asking, though, is that the amplifier sustain such a note for one hour into any designated impedance at a level which is worse (in terms of heat output) than full-power operation, and then continue for five minutes at any frequency within the specified bandwidth at full power, without exceeding rated distortion. Quite commendable, but wholly unnecessary, for even the loudest-fi listener. The amplifier which can do this is to be complimented (and Mr. Wachner's is a good example over most of the audio band) but must you build a tank to attack every target, when a Jeep-mounted recoilless rifle can do the job with greater versatility?

The desirability of high-power amplifiers is not predicated, in music listening, on operation at average power levels which are substantially greater than the average power levels employed with lower power amplifiers. Rather,

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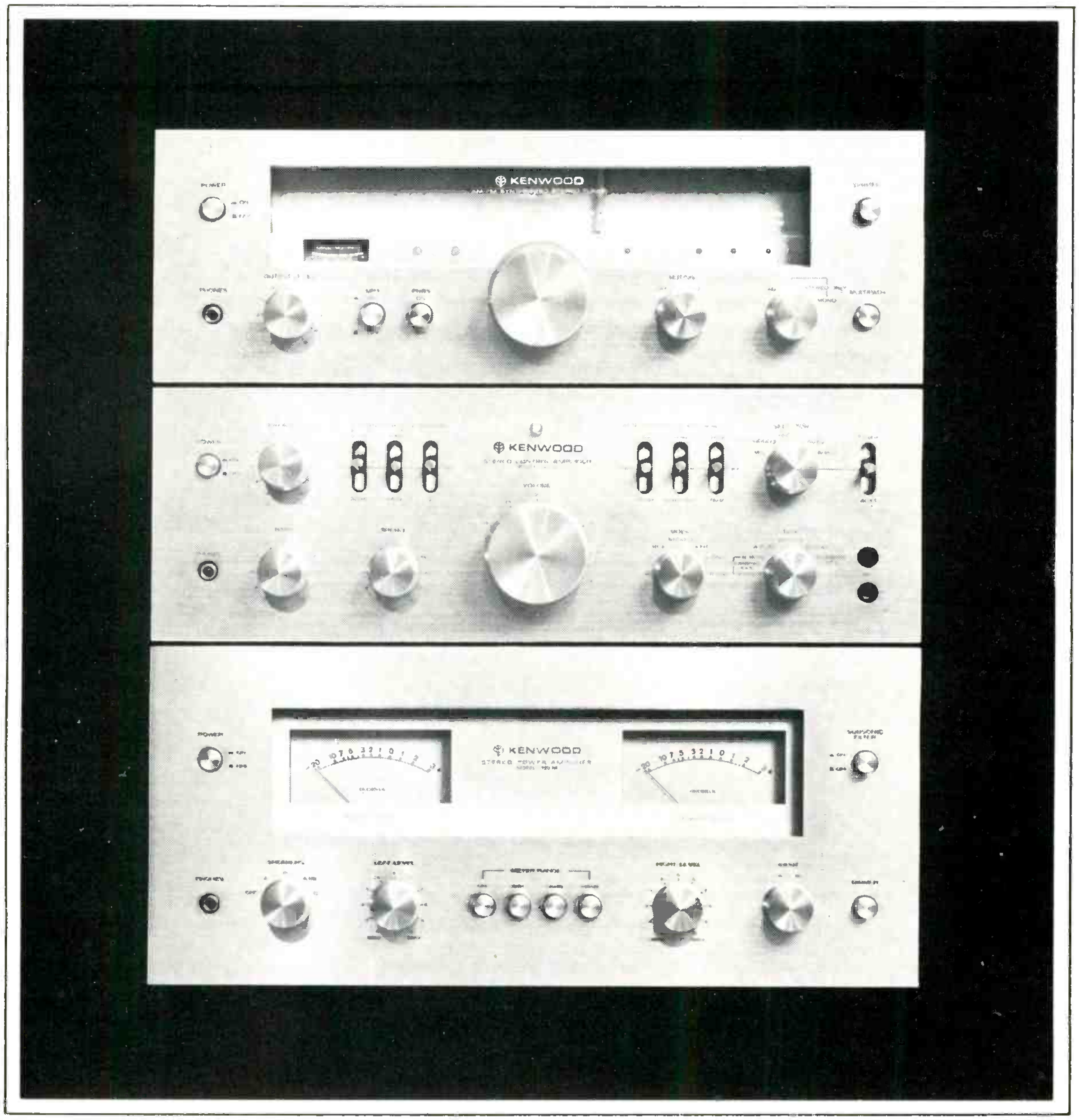

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Transient IM Distortion In Power Amplifiers

W. Marshall Leach*

THE DESIGN philosophy used in most transistor audio amplifiers today differs substantially from that found in the tube amplifiers of several years past. Aside from the obvious lack of output transformers, the transistor designs differ from the tube ones principally in two ways. First, most transistor amplifiers are d.c. coupled, at least in all internal stages. This has been made possible mainly by the availability of complementary transistors (i.e. NPN and PNP). There are no such equivalents in vacuum tube circuits. Second, in transistor amplifiers, a much larger amount of negative feedback usually is applied around the amplifier (i.e. from the output to the inverting input) in order to reduce distortion produced by nonlinearities to virtually unmeasurable levels. The negative feedback typically used may be as high as 40 to 60 dB. Such high levels are so effective in reducing nonlinear distortion that many designers have intentionally designed certain distortions into the "open-loop amplifier." For example, the final output stages of many amplifiers are operated class C (i.e. with no bias current) in order to obtain almost absolute thermal stability without the need for complicated thermal compensation. In such designs, the driver transistors drive the speakers for the first 0.1 to 0.4 volts, and the output transistors switch in above that level. The crossover distortion created by the switching of the output transistors can be neatly "covered up" with the application of sufficient amounts of negative feedback.

For the typical closed-loop gain of 26 dB, 40 to 60 dB of negative feedback requires an open-loop gain of 66 to 86 dB. Such high open-loop gains are easily obtained with relatively few transistor stages (normally two to three stages of voltage gain plus the current gain in the driver and output stages). Some of the latest amplifier designs have made use of high-gain, integrated-circuit (IC), operational-amplifier input stages. A single IC can replace the input stages of both channels is a stereo amplifier and provide the necessary open-loop gain for ultra-low distortion by conventional measurement techniques.

In order that an amplifier not oscillate when the negative feedback loop is connected, designs with a high open-loop gain require careful frequency compensation. The technique that is most often used is called lag compensation. It is given this name because it is accomplished by the addition of capacitors in the circuit which increase the phase lag in the amplifier at the higher frequencies. More importantly, lag compensation also reduces the open-loop gain of the amplifier at the critical high frequencies at which it would tend to oscillate. This tendency toward higher open-loop gains with attendant heavy feedback and lag compensation has led to the identification of a new distortion mechanism called transient intermodulation (TIM) distortion [1, 2]. TIM distortion sounds like crossover distortion, however, it cannot be detected with conventional sine-wave measurements. Indeed, there are presently no standards covering its measurement! TIM distortion occurs principally during loud, high-frequency passages in the reproduced signal, and recent investigations have shown that the ear is very sensitive to it [3]. Basically, it is an overload phenomenon that is caused by heavy feedback in the amplifier.

Tube amplifiers have been traditionally designed with much lower open-loop gains than their transistor counterparts of today. Indeed it was unusual to find open-loop gains higher than 46 to 51 dB in even the best tube amplifiers. For a closed-loop gain of 26 dB, this range of open-loop gain requires only 20 to 25 dB of negative feedback. With such relatively low levels of feedback (by the standards of today), quality tube amplifiers were necessarily designed for minimum distortion and maximum bandwidth before the addition of feedback. Consequently, TIM distortion was never identified as a distortion mechanism in tube amplifiers. (The author has measured a negative feedback of only 5 dB in a popular 10-watt monophonic tube amplifier from the late 1950s. A high-quality, 80-watt stereophonic tube amplifier of the early 1960s was advertised to have a negative feedback of only 22 dB.)

There has been much controversy over what has been called "tube versus transistor sound." It has been suggested by many who can detect the difference that the reason some transistor designs sound "harsh" compared to tube designs is because tubes overload more "gracefully" than transistors do. Whether this explanation is valid or not, TIM distortion must be considered a major reason for the difference in sound. This is particularly true for the cases in which continuous sine-wave tests indicate that a transistor amplifier has less distortion than a tube amplifier, however, the tube amplifier sounds "cleaner" than the transistor one does. Invariably, the transistor design can be shown to have a very high open-loop gain with attendant heavy feedback and lag compensation. Transistor designs with integrated-circuit input stages can be particularly susceptible to TIM distortion since so many integrated-circuit operational amplifiers have such a poor open-loop bandwidth after they are frequency compensated for stability. (The very popular 741

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IC operational amplifier with internal frequency compensation has only a 2-5 Hz open-loop bandwidth and an open-loop gain of 100-105 dB.)

The purpose of this paper is to discuss the causes and cures of TIM distortion in transistor amplifiers. Preferred circuit design techniques which minimize TIM distortion will be described. In a later paper, an amplifier which has been designed using these techniques will be described.

TIM Distortion: How Does It Arise?

To understand how TIM distortion is produced, it is first necessary to understand how negative feedback affects the gain of an amplifier. Consider the amplifier modeled in Fig. 1. The model has two input terminals, a non-inverting (+) input and an inverting (-) input, and an output terminal to which the speaker load is connected. The input signal v_1 is applied to the non-inverting input, and a negative feedback signal v_2 is applied to the inverting input. The negative feedback signal is taken from the output of a two resistor voltage divider network connected to the output terminal. The output signal is given by the product of the open-loop gain of the amplifier times the difference between the signals v_1 and v_2. This is given by the equation

$$v_0 = G(f)\,[v_1 - v_2] \qquad (1)$$

where G(f) is the open-loop gain of the amplifier which is a function of the frequency f. In general, G(f) is a complex function of frequency, i.e. it has both an amplitude and a phase. If the feedback signal were zero, the amplifier output signal would equal the product of the open-loop gain times the input signal. However, by "feeding back" part of the output signal to the inverting terminal so that it is subtracted inside the amplifier from the input signal applied to the non-inverting terminal, the gain of the amplifier is effectively decreased. At the same time, the frequency bandwidth of the amplifier is extended, distortion produced by nonlinearities is reduced, and the output impedance of the amplifier is decreased (or alternately its damping factor is increased.)

When the feedback signal v_2 is eliminated from Equation (1), it can be shown that the output signal is related to the input signal by the equation

$$v_0 = \frac{G(f)}{1+bG(f)} v_1 \qquad (2)$$

In this equation, b is the feedback factor which is given by

$$b = \frac{R_1}{R_1+R_2} \qquad (3)$$

If the magnitude of bG(f) is much greater than 1, Equation (2) can be approximated by the equation

$$v_0 = \frac{1}{b} v_1 = G_C v_1 \qquad (4)$$

This equation says that if the open-loop gain of the amplifier is sufficiently large, the closed-loop gain is "flat" (i.e. independent of frequency), and it is determined only by the feedback resistors. Most amplifiers are designed with $R_2 = 19R_1$ which produces a closed-loop gain $G_C = 1/b$ of 26 dB.

Equation (4) can be misused if one neglects the fact that it is only an approximation to Equation (2). For any particular amplifier design, there is a frequency above which G(f) decreases toward zero with increasing frequency. This rolloff in the open-loop gain is a natural consequence of the finite bandwidth of the transistors (or tubes) in the amplifier. In the rolloff region, the phase of G(f) can vary rapidly with frequency, leading to serious instabilities in the amplifier when the feedback loop is connected. To insure stability, the circuit designer must verify that in the rolloff region the phase and amplitude of G(f) cannot assume a value such that bG(f) = -1 (i.e. bG(f) has a magnitude of 1 and a phase lag of 180°.) Otherwise, Equation (2) says that the amplifier gain is infinite at the frequency for which this occurs, and this is precisely the condition for an oscillator. In most cases, it can be shown that the amplifier will always oscillate if there is any frequency for which bG(f) has a phase lag of exactly 180° and a magnitude that is equal to or greater than unity. A convenient "rule of thumb" used by many designers says that the phase lag in G(f) should not exceed 135° at the frequency for which the magnitude of bG(f) is unity. Otherwise, the amplifier may oscillate or at best be only marginally stable when the feedback loop is connected.

One convenient way to insure that an amplifier will not oscillate is to design it so that the open-loop gain is de-

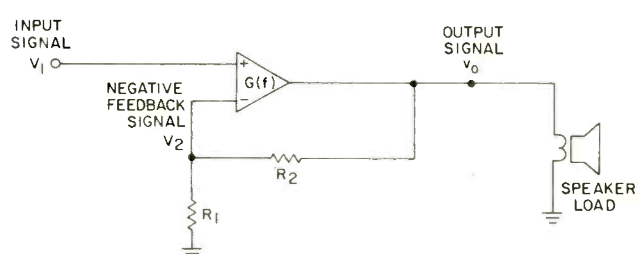

Fig. 1—Model of power amplifier showing non-inverting (+) input, inverting input (–), and resistive feedback network.

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creasing with frequency at a rate of 6 dB per octave at the frequency for which the magnitude of bG(f) is unity. It can be shown that a 6-dB-per-octave gain rolloff can have a maximum phase lag associated with it of only 90°, thus satisfying the above "rule of thumb." This is called lag compensation, and it is accomplished by the addition of capacitors which roll off the high-frequency open-loop gain at the required 6-dB-per-octave rate. This is illustrated in Fig. 2 where the open-loop gain of an amplifier which would oscillate when the feedback loop is connected is sketched versus frequency. Before lag compensation, the open-loop gain is decreasing with a slope of 12 dB per octave or greater at the critical frequency where the magnitude of bG(f) is unity. This critical frequency is that frequency for which the magnitude of the open-loop gain G(f) is equal to G_c, i.e. the closed-loop gain of the amplifier given by Equation (4). After lag compensation, the open-loop gain is decreasing with a slope of 6 dB per octave at the frequency for which the magnitude of G(f) is equal to G_c, thus making the amplifier stable when the feedback loop is connected. The frequency f_o defined in the figure is the open-loop bandwidth of the lag-compensated amplifier. This can be considerably smaller than the bandwidth of the uncompensated amplifier. Often f_o lies is the range of 1 to 5 kHz for transistor amplifiers. This is considerably less than the bandwidth of audio signals and can lead to the production of strong TIM distortion as will be explained in the following.

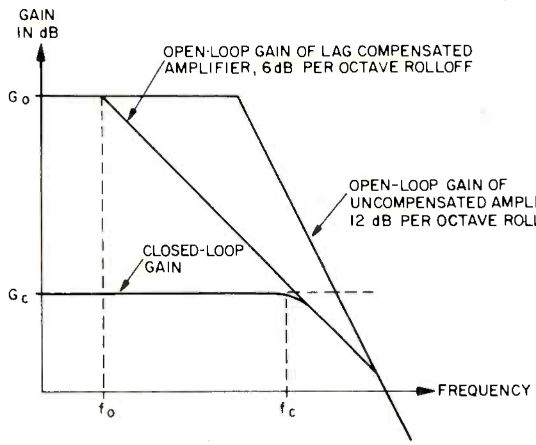

Fig. 2—Open- and closed-loop gains of a lag-compensated amplifier.

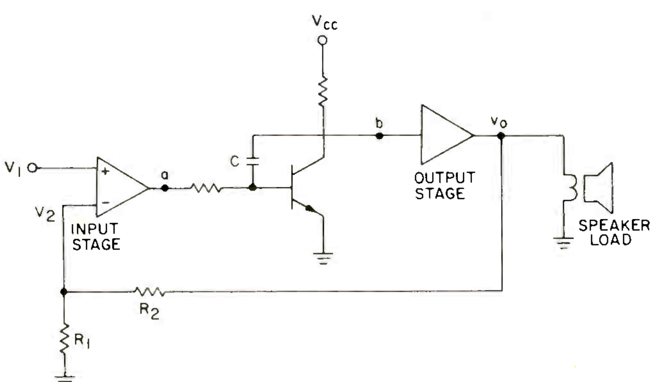

Fig. 3—Amplifier model showing internal transistor stage which is lag-compensated with the capacitor C.

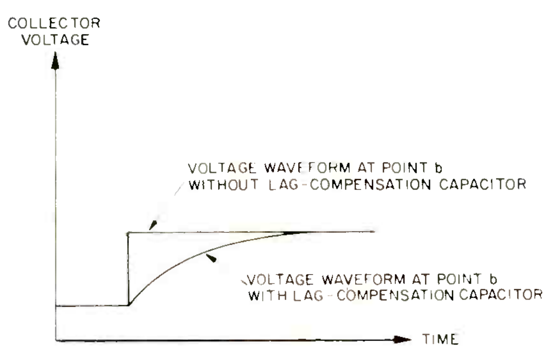

Fig. 4—Response of lag-compensated transistor stage in Fig. 3 to a voltage step applied to point A.

In Fig. 2, the closed-loop gain is also sketched to show the effect of negative feedback on the overall frequency response of the amplifier. The negative feedback ratio is defined as the ratio of the open-loop gain G_o to the closed-loop gain $G_c = 1/b$, or the difference in these gains when they are expressed in dB. The closed-loop cutoff frequency fc is defined in Fig. 2. In any proper design, f_c is larger than the highest frequency signal to be amplified. It can be shown that $f_c = f_o G_o / G_c$ for a lag-compensated amplifier. This equation says, for example, that an amplifier with a 1-kHz open-loop bandwidth will have a 100-kHz bandwidth if 40 dB of negative feedback is used. However, the amplifier would probably be susceptible to very strong TIM distortion.

To illustrate how TIM distortion arises, the amplifier modeled in Fig. 1 is redrawn in Fig. 3 with the diagram broken to show explicitly the transistor stage that is lag compensated. The capacitor that is connected from collector to base of this transistor rolls off the high-frequency, open-loop gain of the amplifier at the required 6-dB-per-octave rate to insure that it will not oscillate when the feedback loop is connected. Let us examine the transient response of this transistor stage. Figure 4 shows the signal at point b in Fig. 3 when the signal applied to point a is a voltage step (i.e. an abrupt or instantaneous change in voltage). The voltage waveform at point b is shown for the cases with and without the lag-compensation capacitor. With the lag-compensation capacitor, notice that there is a time delay before the collector voltage can completely attain its final value after the input step occurs. Both this delay and the smoothing of the collector signal shown in Fig. 4 are caused by the lag-compensation capacitor which requires a finite time to charge and discharge after a change occurs in the input signal to the transistor. The same conclusion could be reached by considering the high-frequency gain of the transistor. The lag-compensation capacitor provides a negative feedback path for the high-frequency signal components from collector to base, thus severely attenuating the high-frequency gain. It can be shown that a voltage step contains many high-frequency components. Their attenuation in the lag-compensated transistor causes the time delay and smoothing of the collector output signal.

Now let us consider the response of the amplifier when the voltage step is applied to its non-inverting (+) input. If the open-loop gain of the amplifier were flat and the time delay through it were zero, the voltage step would instantaneously propagate undistorted through the amplifier, back through the feedback loop, and into the inverting (-) input. There it would be subtracted from the input signal, and the difference would be amplified by the input stage to produce the signal at point a in Fig. 3. In this case, the difference signal itself would be a voltage step which occurs at the same time that the input signal does. However, this is not the case when the open-loop gain of the amplifier is not flat and the time delay through it is not zero. When the voltage step occurs, the limited high-frequency response of the lag-

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mize TIM distortion while providing stability at the same time. Lead compensation is accomplished by connecting a small capacitor in parallel with the emitter feedback resistor of each stage of voltage gain in the amplifier. This is illustrated in Fig. 7 for a typical transistor stage. The value of the lead compensation capacitor is selected to minimize the phase lag in the overall open-loop gain at the critical frequency where the magnitude of bG(f) is unity. Although it is not intuitively obvious how increasing the high-frequency open-loop gain of an amplifier can stabilize it and prevent it from oscillating, lead compensation is a technique commonly applied to stabilize control systems in which an optimum transient response is an important consideration.

In Fig. 8, the open-loop gain as a function of frequency for a lead-compensated amplifier is compared to that for a lag-compensated amplifier which uses a large negative feedback ratio. Notice that the low-frequency, open-loop gain of the lead-compensated amplifier is much less than that of the lag-compensated amplifier. However, as the frequency is increased, the open-loop gain of the lead-compensated amplifier does not begin to roll off until a much higher frequency. Optimally, it should be constant over the entire audio spectrum to minimize TIM distortion. In this particular case, there is a frequency above which the open-loop gain of the lead-compensated amplifier is greater than that of the lag-compensated amplifier. For this reason, the resultant closed-loop bandwidth of the lead-compensated amplifier is greater than that of the lag-compensated amplifier. In fact, a lead-compensated amplifier can easily have a closed-loop bandwidth of 1 MHz if it is properly compensated. Although a bandwidth this wide is not necessary for reproduction of audible frequencies, it is usually a natural consequence of lead compensation. Thus, it is desirable to use a passive filter at the amplifier input which has a high-frequency cutoff of 20,000 Hz to prevent the application of inaudible high-frequency signals which could overload the amplifier.

An examination of the behavior of the open-loop gains sketched in Fig. 8 in the high-frequency rolloff region will reveal the essential differences between lag and lead compensation. For the lag-compensated case, the open-loop gain is purposely rolled off so that its magnitude is decreasing at 6 dB per octave when it crosses the critical gain level equal to the low-frequency closed-loop gain which is given by $G_C = 1/b$. In the lead-compensated case, the high-frequency, open-loop gain is allowed to extend to as high a frequency as possible before it begins to roll off on its own. This rolloff is due to the finite bandwidth of the amplifier, and the roll-off rate is usually 12 dB per octave or in some cases more. In the region where the magnitude of the open-loop gain crosses the critical gain level, the lead-compensation capacitors add high-frequency gain so that the magnitude of the open-loop gain is decreasing at a rate of 6 dB per

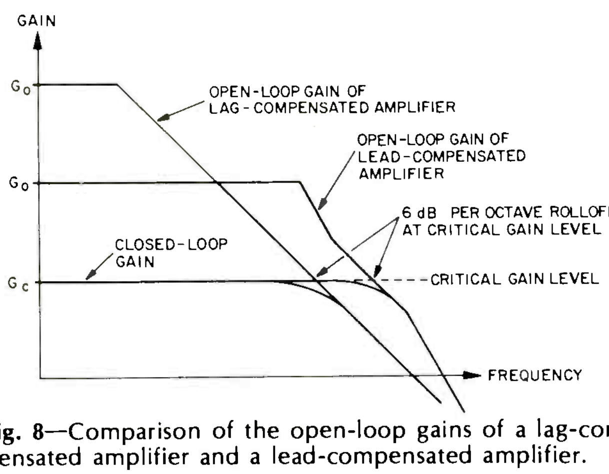

Fig. 8—Comparison of the open-loop gains of a lag-compensated amplifier and a lead-compensated amplifier.

octave at this level. Or equivalently, enough phase lead is added to prevent the phase lag in G(f) from approaching 180° at the frequency where the magnitude of bG(f) is unity. Thus, in both cases, the magnitude of the open-loop gains crosses the critical gain level with the same slope, and each amplifier will be stable when the feedback loop is connected.

Since the prevention of TIM distortion requires the use of much less negative feedback than is normally used, it is necessary to avoid certain circuit configurations which have become popular recently. For example, many amplifiers operate with zero quiescent or idle current in the output transistors in order to eliminate thermal drift in the output stage. The driver transistors in these amplifiers drive the speaker through a resistor of 10 to 50 ohms for the first 0.1 to 0.4 volts, and the output transistors switch in above that level. Without the use of a very large negative-feedback ratio, this can produce severe crossover distortion. Thus, the output transistors in amplifiers designed to minimize TIM distortion must be operated class AB, i.e. with a quiescent current usually of 10 mA or more. This requires that the bias current in the output transistors be thermally compensated. Otherwise, they can be destroyed by thermal runaway. Thermal compensation is usually accomplished with temperature-sensing diodes, which are mounted on the heat sinks with the output transistors and provide thermal feedback to maintain a constant quiescent current in the output transistors.

In summary, the two major design objectives for the prevention of TIM distortion are to design the "open-loop" amplifier for maximum linearity and to design it so that the open-loop bandwidth is at least as wide as the audio frequency spectrum. Both of these require the use of heavy local negative feedback in every stage of voltage gain in the amplifier. This minimizes the need for heavy overall negative feedback from the amplifier output to its inverting input. In addition, local feedback provides the gain reserve in each stage necessary to lead compensate the amplifier for closed-loop stability and maximum open-loop bandwidth. With an open-loop bandwidth at least as wide as the audio frequency spectrum, the propagation phase delay of high-frequency, transient signals through the overall feedback loop around the amplifier is minimized, thus minimizing TIM distortion. We can summarize the most important design considerations to obtain these objectives as follows:

1. All internal stages of the amplifier should operate class A except for the output transistors. These should operate class AB with a sufficient quiescent bias current to completely eliminate crossover distortion in the low-power region. Normally this bias current is 10 mA or more.

2. The input stages should be designed with a sufficiently high bias current in order to minimize their tendency to overload during the high-frequency, transient signals which cause TIM distortion. Since the bias current in the input stages has an important effect on the signal-to-noise ratio of the amplifier, it should not be chosen so high as to degrade the signal-to-noise ratio.

3. All stages in the amplifier should be designed so that each operates "push-pull." For example, this requires a completely complementary design with an NPN transistor for each PNP transistor, and conversely. This significantly improves the linearity of the "open-loop amplifier" and helps to minimize the need for heavy overall feedback to reduce distortion.

4. The driver and power output transistors should be operated in the emitter follower configuration for optimum open-loop bandwidth. In addition, the first driver transistors should be driven from a voltage amplifier stage rather than from a current amplifier stage as is done in most amplifiers which employ a complementary symmetry design.

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5. Wide bandwidth transistors should be chosen for each stage in the amplifier, i.e. transistors with a high gain-bandwidth product which is denoted by the symbol f_T. Normally, the f_T is lower for the high-current transistors used in the output stages. Typically, it will be in the range of 2 to 4 MHz. For transistors used in the lower power stages, available f_Ts are in the range of 40 to 200 MHz.

6. The overall high-frequency response of the amplifier should be rolled off above the audio spectrum with a passive input filter to prevent overloading by inaudible, high-frequency signals. This is best accomplished by connecting a small capacitor or capacitor in series with a resistor between the inverting (–) and non-inverting (+) inputs to the amplifier. In addition, a resistor is placed in series with the input lead to the amplifier. These circuit components roll off the high-frequency, closed-loop gain of the amplifier at a 6-dB-per-octave rate by effectively shorting together the two input terminals at the high frequencies. These components also can improve the amplifier stability in the same way that lag compensation does without producing TIM distortion [1].

Conclusion

TIM distortion is an overload phenomenon which results from the use of a very large negative feedback ratio in audio power amplifiers. It is caused by overloading of the input stages by high-frequency transient signals which experience excessive propagation phase delays in the overall negative-feedback loop around the amplifier. Since it does not occur with steady-stage, sinusoidal signals, it cannot be measured or predicted from standard harmonic or IM distortion tests, for these tests are performed with sinusoidal signals. The prevention of TIM distortion is simple and requires the use of an old design philosophy that proved its validity in the days of the vacuum-tube amplifiers. That is, the amplifier should be designed for low distortion and wide bandwidth without overall negative feedback. Feedback is then added to make a good design better and not to "cover up" problems in the basic amplifier. This design philosophy precludes the use of high-gain, narrow-bandwidth IC operational amplifiers and essentially non-linear circuits, such as class C output stages.

Some of the technical details concerning the causes and prevention of TIM distortion have been presented. It is hoped that the language has not been too technical for the average audiophile nor has it been too over-simplified for the electronics engineer. Those interested in pursuing the technical details further are referred to the excellent work done by M. Otala at the University of Oulu in Finland. Two of his papers are listed in the references.

In an ensuing issue of AUDIO, the complete design of a power amplifier designed to minimize TIM distortion will be presented. The amplifier is a d.c. coupled, completely complementary design which uses 26 dB of negative feedback. A technique for optimally lead compensating the amplifier will be described which makes use of a newly available audio-frequency gain-phase meter manufactured by Hewlett-Packard. At present, this project is behind schedule because of a difficulty in obtaining transistors, some of which have been back ordered for six months.

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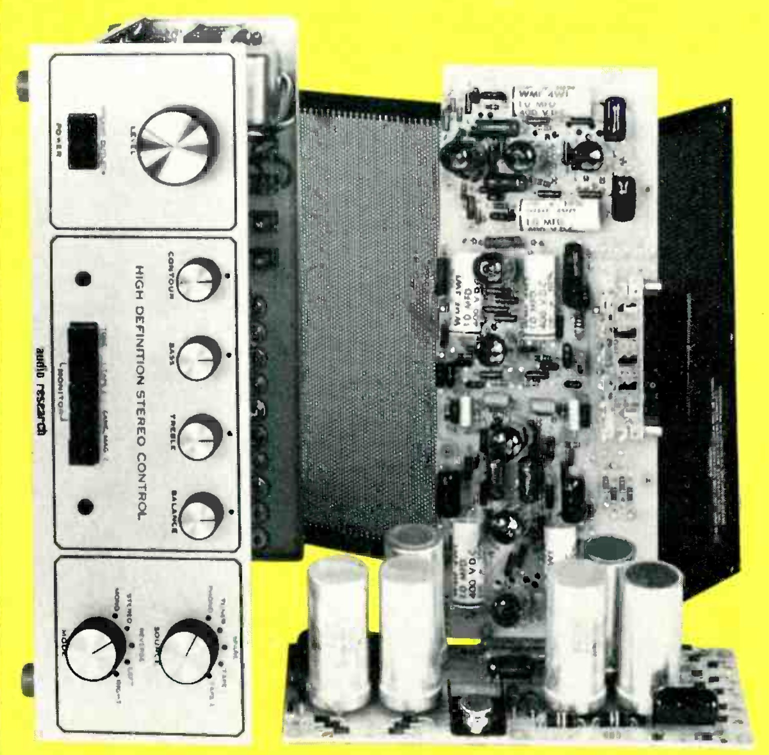

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teristics, VI curves for a bipolar power transistor, HFET, and power pentode are shown in Figs. 3, 4, and 5. The biggest visual difference between the triode and pentode characteristics is in the relative values of output resistance. Output resistance is related to the slope of the VI curves, the more horizontal the curves, the higher output resistance. From this, it can be seen that triode devices have intrinsically lower output resistance. The output resistance of VFETs is about 5-10 ohms, whereas a typical bipolar power transistor has an output resistance in the range of 100-300 ohms. It is desirable for power amplifiers to have low output resistance so that the output voltage delivered to a speaker load won't change with frequency as the speaker impedance varies.

Most speakers are designed to be driven from a low impedance source of perhaps 1 ohm or less. Low output resistance is usually obtained by liberal use of negative voltage feedback around the output stage and/or the whole amplifier circuit. Common practice is to use bipolar transistors as emitter followers in the output stage. This configuration amounts to close to 100% local negative voltage feedback and usually results in an output resistance before overall feedback is applied of 1-10 ohms. Triode characteristics are generally more linear than those of a pentode-type device. When the performance of push-pull class A and AB amplifiers are compared using triode and pentode (or beam power tetrode) tubes, the triode amplifier has lower amounts of higher-order odd-harmonic distortion and can handle a more reactive load with less distortion and less relative loss of power than the pentode for equal reactive loading. The Ultra-Linear circuit retains the best advantages of both triode and pentode characteristics resulting in essentially the power output of the pentode and the low distortion of the triode. This circuit behaviour, however, comes about because of negative feedback applied to the output stage via the screen grid taps on the primary of the output transformer. The performance in terms of distortion and effects of reactive loads without any local output-stage feedback is still superior with triode-type curves. A similar analogy exists between the new VFETs and bipolar output transistors; the VFET is like a triode tube, and the bipolar transistor is more like the pentode tube in terms of higher-output resistance and tendency towards more higher-order odd-harmonic distortion. Although little is published about the distortion performance with reactive loading of output transistors operated in common emitter without feedback, it would be expected from their characteristics that they would not be as good regarding higher-order odd-harmonics and susceptibility to reactive loads as a triode-type semiconductor. Comparisons of the harmonic content with resistive loads of VFET and bipolar single stage and complete amplifiers have been shown by Yamaha and Sony. In the case of a typical bipolar amplifier vs. a VFET amplifier, such as shown in Figs. 6 and 7, the bipolar amp indeed shows a more complex harmonic spectrum with 5th, 7th, and 9th harmonics being present. The VFET spectrum is much simpler and the 5th harmonic is just detectable. Generally speaking, the output-stage idling current of most bipolar amplifiers is relatively low—perhaps 25-100 mA. The VFET amps that have been evaluated thus far run idling currents in the output devices of 400-500 mA! The Yamaha B-1, a dual 150-watt unit, has an output-stage idling power dissipation of about 64 watts/channel. The Sony TA-8650, a dual 80-watt amp-preamp, also has an idling power dissipation of about 64 watts/channel. This is much closer to the way tubes are run in good class AB designs. What is generally known, but not done in practice because of thermal stability considerations, is that bipolar amplifiers are very free of higher-order odd harmonics when run at idling currents of 400-500 mA.

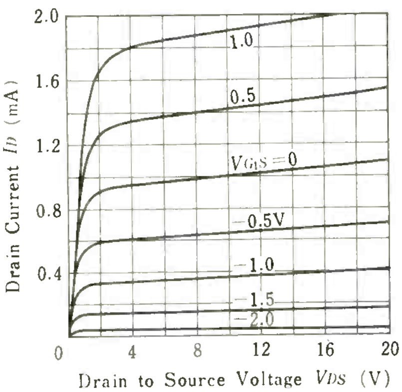

Fig. 4—Typical VI curves for a horizontal-junction FET.

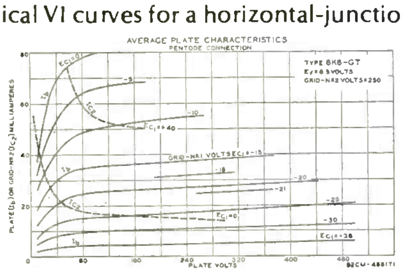

Fig. 5—Typical VI curves for a power pentode.

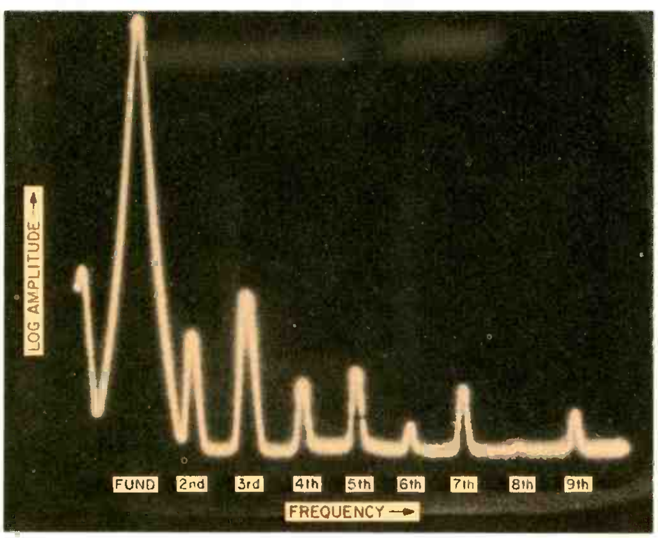

Fig. 6—Harmonic spectrum, bipolar transistor amplifier without feedback.

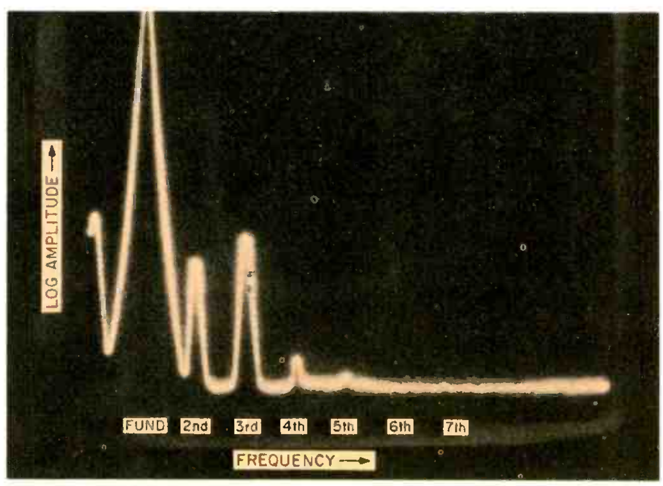

Fig. 7—Harmonic spectrum, VFET amplifier without feedback.

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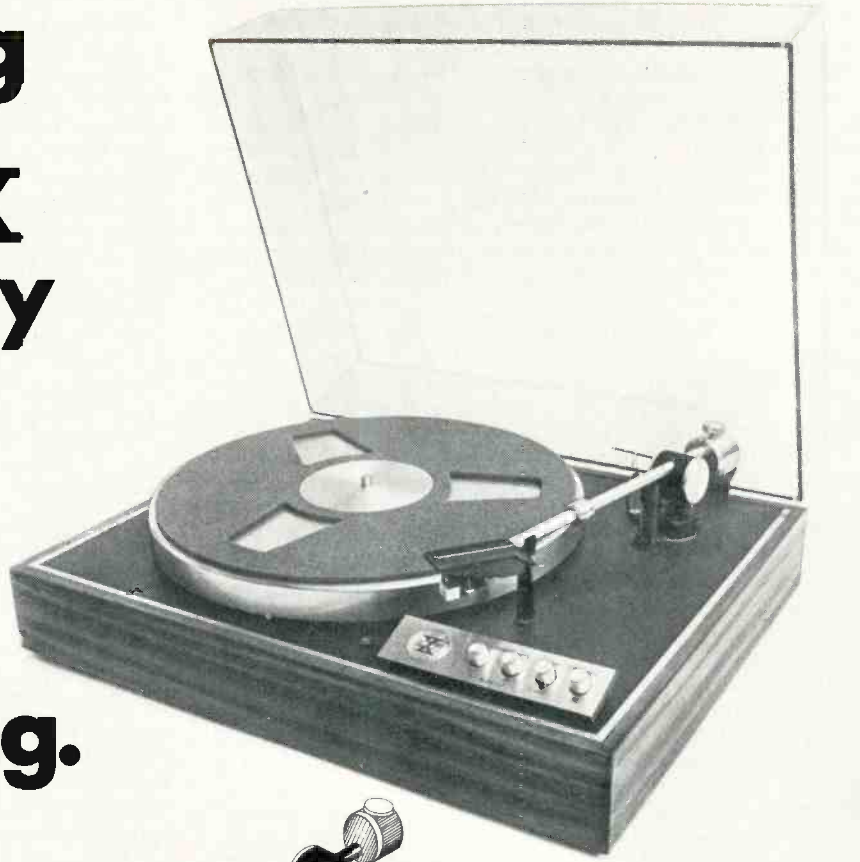

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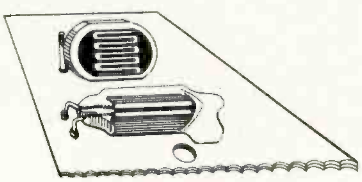
So why make a turntable? (And we are making it—not just slapping our name on someone else's product. Every part is *hand* assembled in our plant in Cambridge, Mass.)

The answer is in the product itself. The Model Sixty is a two speed, belt-driven, transcription quality turntable that combines *all* of the most wanted features with exceptional performance and a maximum of something we call "human engineering."

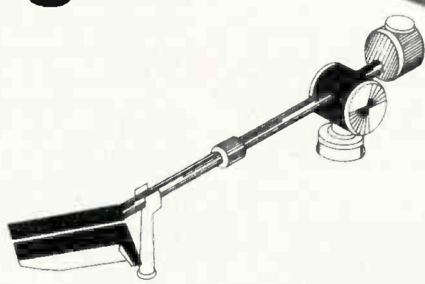
What is human engineering?

It's designing an electro-optical system that automatically shuts off the turntable at the end of the record and gently lifts off the tonearm. This is achieved through the use of a light detector resistor



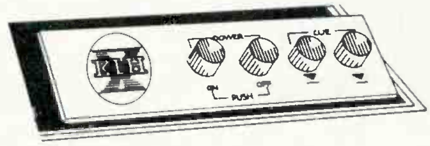
(shown here) rather than a mechanical device which would have to be tripped by the side force of the tonearm. Since our system requires no side force, it virtually eliminates all potential distortion and side thrust problems.

Human engineering is designing a special low mass aluminum tonearm and unique low friction pivot block and post assembly to such exacting standards that



usage deterioration and performance deviation is all but eliminated.

Human engineering is designing all of the electronic controls into an upright module for incredibly simple and convenient operation. It's also making the controls *feel* as good as they look.



(Just one touch and you know there's something substantial here.)

In short, human engineering is finding out what people want and need in a product and putting it there. That's why the Model Sixty also features push-button electronic cueing, anti-skating control, a discrete suspension system that minimizes rumble, acoustic feedback and vibrations, one piece dynamically balanced platter, 24-pole synchronous motor and every other important feature you could want in a precision turntable.

All for $150.

Now *that's* human engineering.

The Model Sixty. Another superb new product from KLH Research X—a new era in audio.

For more information, visit your KLH dealer or write to KLH Research & Development Corp., 30 Cross St., Cambridge, Mass. 02139.

Specifications

Rumble: -58 dB (CBS-RRLL), exceeds DIN requirements.
Wow & Flutter: .09%, lower than one half of DIN requirements.
Tracking Force: Continuously adjustable from 0.5 to 4.0 grams, with precision calibrated scale.
Average Absolute Tracking Error: 0.5°, less than 0.01 radian.
Arm Structure: Low inertia, precision ground, high strength aircraft aluminum alloy.
Suspension: Tripoint seismic suspension of arm and turntable on single precision casting, damped to minimize influence of external vibrations causing high order resonances.
300 RPM Motor: Precision polyphase synchronous low speed motor for minimal vibrations and optimum instantaneous speed accuracy and freedom from counter-rotation.
Timing Accuracy: Better than 5 seconds per average LP side; twice as good as DIN requirements.
Speeds: 33⅓ & 45 RPM
Record Sizes: 7", 10", 12"
Operates on: 105-125 volts, 60Hz only, pilot light indicates power "ON"
Dimensions: 17" (W) 13⅜" (D) 6¼" (H) with dust cover.

KLH®

KLH Research X Division
KLH Research & Development Corp.
30 Cross St., Cambridge, Mass. 02139

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Furthermore, if the idling current is reduced much below 400 mA in the VFET amps, the higher-order odds start to appear. If the current is reduced to say 50 mA, crossover distortion and consequent presence of higher-order odds is ghastly. The nature of the transfer characteristics of VFETs requires that they be run at idling currents of around 400 mA if crossover-type nonlinearities are to be avoided. Fortunately, the devices don't have thermal stability problems because of a negative temperature characteristic that causes idling current to decrease slightly with increased temperature. The main point here is not that many bipolar amps can be made to look bad against the VFET amps in a comparative harmonic analysis but that there are a few very good bipolar amps around on the market which are virtually free of higher-order odds. The superiority of VFET amps regarding harmonic content over many bipolar amps is due in part to their intrinsic linearity characteristics and to the way they are operated—hot with lots of idling current.

VFETs have high breakdown voltages of 200-300 volts and are free of secondary breakdown effects that are troublesome with bipolar devices. This is due to the nature of VFET construction which allows for uniform current density over the area of the chip, thereby eliminating local hot spots. The devices have to be protected from excessive currents, and from examination of the limited information on protection circuits thus far available, it appears that the protection circuits do current limit.

Another significant difference between VFETs and bipolars is that the VFET is a majority carrier device and, unlike the bipolar which is a minority carrier device, does not suffer from storage time problems. Storage time effects in bipolar amps cause secondary crossover distortion, reduced high-frequency power efficiency, and increased high-frequency distortion. Figure 8 shows the relative effects of stored charge in a switching circuit using a bipolar device. The upper trace is signal input, and the lower trace is output current. Note that the current stays "on" for a short period of time when the input is switched "off" which is the storage item.

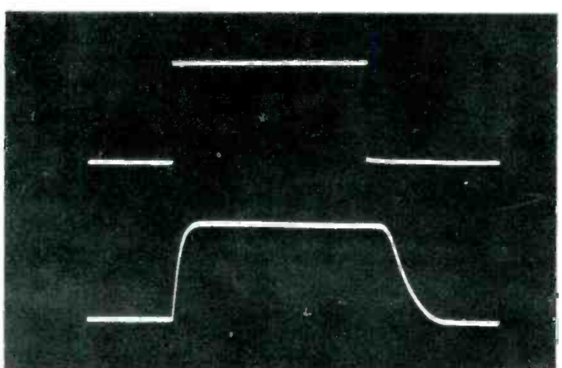

Fig. 8—Switching performance of a bipolar power transistor; top trace is input, bottom, output.

Fig. 9—Switching performance of a VFET; top trace is input, bottom, output.

Figure 9 shows the performance of a VFET in a similar switching circuit. Note that the lower trace, which is output current, abruptly switches "off" when the input does. These two 'scope photos were supplied by Sony, and although time and amplitude scales weren't given, it is assumed that the conditions are comparable for the two devices. An interesting curve by Yamaha (See Fig. 10) shows the frequency response of one of their VFETs in a single-ended circuit for two different values of source resistance, 0 and 50 ohms. If the drawing is correct, the actual source resistances are 50 and 100 ohms as the generator has a 50-ohm internal resistance. A rough calculation of equivalent input capacitance works out to about 2200 pF if the rolloff of 720 kHz for a total Rg of 100 ohms is assumed to all be in the input circuit. Of interest is the wide bandwidth of the device when driven with a low resistance and the fact that the equivalent input capacitance is rather high and therefore needs low-impedance drive to get these bandwidths.

Applications

Circuit configurations at this point seem to be of two types—one utilizing the complementary devices made by Sony and NEC and the other developed by Yamaha for driving their same-polarity N-channel devices. Two of Yamaha's devices, the YT 304, are capable of 150-200 watts output power. The units are large—about 50% larger than the standard TO-3 power transistor package. Sony uses three Ns in parallel and three Ps in parallel as complementary source followers for a total of six devices per channel, producing a power of 80 watts/channel in their TA-8650 and 100 watts-channel in the TAN 8550, a power amp only which is supposed to be available in the U.S. in early 1975.

It would seem that it would take 4-5 Sony devices in parallel to equal the capabilities of one Yamaha YT 305. In comparing a complementary bipolar design to a complementary VFET design like Sony's, several important differences become apparent. The operating gate bias for a drain current of 500 mA and a drain voltage of 60 volts is about 20 volts. This bias is minus in respect to the source for the N channel and plus in respect to the source for the P channel. This means that the control gates have to be separated by 40 V (± 20 V in respect to ground), since the sources are essentially tied together. If the driver circuit were simplified to be a complementary common-emitter amplifier, as shown in Fig. 11, the supply voltage to the drivers would have to be about ± 100 V in order to swing the load to ± 60 V, assuming no saturation drop in the VFETs, class A operation of the output devices, and perfect regulation of the ± 60 V supply. VFETs have more saturation drop than bipolars. This, coupled with the regulation of the output power supply and the fact that the output stages are operated class AB, would reduce the driver supply to perhaps ± 85 V, which is what Sony uses for the bias supply stage that actually drives the VFETs. A VFET amp of this type then requires another supply voltage that is higher than the output supply. The preceding amplifier block, which is a several stage differential amplifier with a current mirror-output stage, has a regulated ± 65 V supply and a regulated + 9 V, which are yet

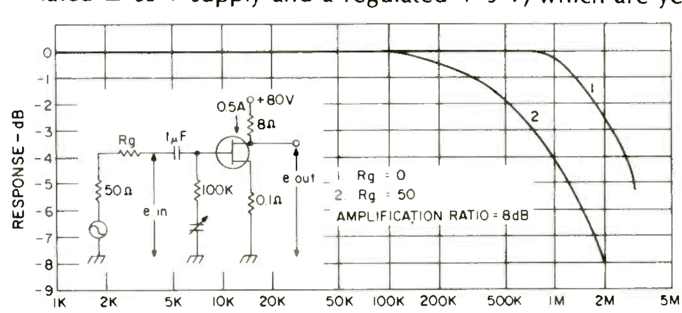

Fig. 10—Voltage gain/frequency response characteristics.

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With other cassette decks, finding your tape selection is hit or miss. You press fast forward — stop — rewind — stop — fast forward— over and over in a mad search for each selection. But not with Sharp's RT-480. Just press fast forward or rewind. Our Automatic Program Finder finds the precise beginning of your selection. And does it automatically. No fumbling, bumbling, or mumbling.

We eliminate the hiss as well as the miss. With a built-in Dolby "B"* type noise reduction system.

The RT-480 is professional all the way. With Micro Crystal Ferrite heads for CrO_2 tapes. A selector switch for normal, low-noise, and CrO_2 tapes. Pause control for editing. Automatic shutoff in every mode. Lighted, expanded scale VU meters. Advanced hysteresis synchronous motor for inaudible wow and flutter: 0.15%, W. rms. S/N ratio: 58 dB, with Dolby on. And the frequency response is from 45-15,000±3 dB, using CrO_2 tape.

All this, plus great styling, 2 microphones and dust cover. And under $250. For the name of your nearest Sharp hi-fi dealer, contact "Audio", Sharp Electronics Corp., 10 Keystone Pl., Paramus, N.J. 07652.

MAKES OTHER CASSETTE DECKS OBSOLETE. THE RT-480. ONLY FROM **SHARP**

*Dolby is a trademark of Dolby Laboratories, Inc.

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third and fourth supply requirements. It is evident that VFET circuits are more complicated in terms of requiring more supply voltages than the usual bipolar power amp which usually has one plus and minus supply.

Another complication is the need to insure that the output stage supply voltage doesn't come "on" without bias being present on the VFETs. Remember that they are fully "on" with zero bias and if powered up without bias, would present a low impedance path between the plus and minus 60-volt supplies and surely result in their destruction. The bias voltage in the Sony circuit comes "on" immediately and the output stage is held in current limit by a time-delay mute circuit for 4-5 seconds.

A final difficulty is the problem of matching the paralleled devices in the output stage. The bipolar method of current sharing of multiple paralleled devices by using individual emitter resistors is not practical with VFETs. This is because the required drop across each source resistance to do significant current equalizing would be excessive in order to be a appreciable fraction of the 15-20 V source to gate bias voltage. Sony solves the problem by brute force matching of sets of output devices for an amplifier channel. There are bias voltage range codes on the cases of the devices and instructions in the service manual on how to replace a blown output stage with a new set of *six* new matched devices. Repairs on this amplifier apparently will be expensive. A simplified schematic of the TA 8650 is shown in Fig. 12.

The Yamaha B-1 circuit is completely different and would have to be termed a single-ended push-pull circuit rather than quasi-complementary. The distinction is as follows:

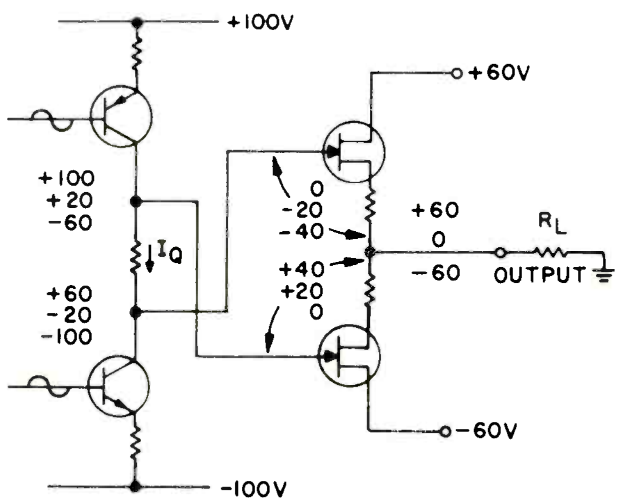

Fig. 11—Example drive circuit for a complementary VFET source follower output stage.

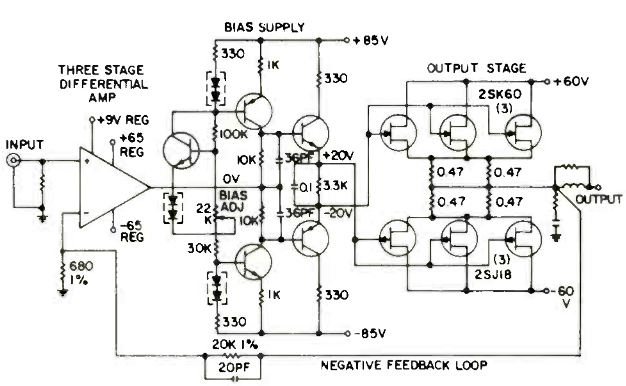

Fig. 12—Simplified circuit of the Sony TA-8650 power amplifier.

Most bipolar output stages that use same polarity output devices have one device operating as an emitter follower and are driven from an emitter follower. The mating device, which is acting as a common emitter amplifier, is made to look like an effective voltage follower in order to match the gain of the first emitter follower by the use of another complementary polarity driver. Hence, the name quasi-complementary for such an output stage. The basic circuit used by Yamaha has been seen in a few bipolar power amplifiers and is used by a well-known mixing-board manufacturer in its basic amplifier-gain block. The circuit in a simplified form is shown in Fig. 13. For the sake of simplicity, assume a bias voltage for Q13 and Q14, the output devices, of −20 V. Q7 & Q8 form a balanced differential amplifier that is fed from an earlier differential amplifier in the overall circuit. If the resistors marked R1 & R2 are the same value, the equal currents flowing into Q7 & Q8 will establish equal voltage drops in each resistor. Since these voltages are the bias voltages for the output devices and assuming the output devices are matched, the output will be at zero volts d.c. as indicated. Now assume that the drive to Q7 & Q8 becomes unbalanced such that Q7 is turned "on" more and Q8 less. Since Q7, 8 are sinked to a current source, the current change will be equal but opposite in Q7, 8. Since the output impedance of both Q7 & Q8 is high due to being horizontal junction FETS, this change in current, ΔI, will cause the drop across R1 to increase by an amount ΔE essentially independent of where the output junction goes. Similarly, the current decrease, ΔI in Q8, will reduce the bias voltage drop in R2 by an amount ΔE. This action has turned Q14 "on" more and Q13 "on" less, causing the output junction to move in the minus direction. A similar but opposite action occurs with the input polarity reversed to Q7, 8. Q13 turns "on" more and Q14 turns "on" less, causing the output junction to go in the positive direction. The drive circuit supplies balanced out-of-phase voltages that are applied effectively between source and gate of Q13, 14 (except for some source degeneration in the 0.22-ohm source resistors), effectively driving them as common source amplifiers. Q7, 8 swing different voltages in respect to ground into unequal impedances. The drain of Q7 swings the output voltage of the amplifier ± the bias required to swing this output, whereas the drain of Q8 only changes by the bias voltage required by Q14. The dynamic load on Q7 is about u-1 times higher than R1 while the load on Q8 is simply R2. (u is the amplification factor of Q14 and is in the range of perhaps 3-8.) Aside from the different load conditions on the drivers, the output devices are driven in a balanced fashion, hence the name single-ended push-pull. The actual circuit is somewhat more complicated, having a set of source followers driving the output devices, which is similar to a Darlington connection

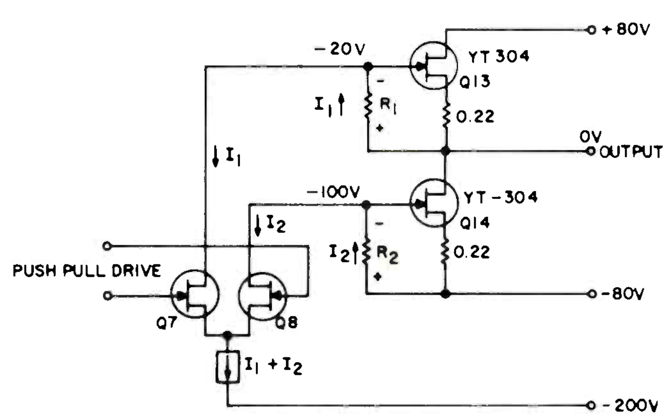

Fig. 13—Simplified drive circuit of the Yamaha B-1.

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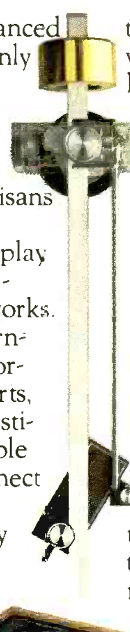
The single-play turntables only a great changer company could have made.

Garrard Zero 100SB, $209.95

Garrard's new single-play turntables are so advanced in their solution of basic engineering problems that only a leading manufacturer of automatic changers (yes, *changers*) could have produced them.



This may sound paradoxical to the partisans of single play, but it's a perfectly realistic view of the situation. The truth is that it's easier to make a single-play turntable that works (never mind outstanding performance for the moment) than a record changer that works.

The very qualities that make the single-play turntable the preferred choice of certain users—straightforwardness of design, lots of room for relatively few parts, fewer critical functions, etc.—also permit an unsophisticated maker to come up more easily with an acceptable model. Take a heavy platter and a strong motor, connect them with a belt... you get the picture.

As a result, there are quite a few nice, big, shiny and expensive single-play turntables of respectable performance in the stores today.

A thoroughbred single-play automatic is another matter.

We're talking about a turntable that gives you not only state-of-the-art performance in terms of rumble, wow, flutter, tracking and so on, but also the utmost in convenience, childproof and guest-proof automation, pleasant handling, efficient use of space, balanced good looks and, above all, value per dollar.

Here we're back on the home grounds of the changer maker. He alone knows how to coordinate a lot of different turntable functions and niggling little design problems without wasted motions, space and expenditures. The kind of thing Garrard is the acknowledged master of.

No other proof of this argument is needed than a close look at the new Garrard Zero 100SB and 86SB.

Yes, they have heavy, die-cast, dynamically balanced platters. Yes, they have belt drive. Yes, they have -64dB rumble (DIN B Standard). And the Zero 100SB has Garrard's unique Zero Tracking Error Tonearm, the first and only arm to eliminate even the slightest amount of tracking error in an automatic turntable.

But that's not the whole story.

What gives these turntables the final edge over other single-play designs is the way they're automated.

Both are fully automatic in the strictest sense of the term. Your hand need never touch the tonearm. The arm indexes at the beginning of the record, returns to the arm rest at the end of the record and shuts off the motor, all by itself. The stylus can't flop around in the lead-out groove.

Garrard 86SB
$159.95

There are also other subtle little features like the ingeniously hinged dust cover (it can be lifted and removed even on a narrow shelf), the integrated low-profile teak base, the exclusive automatic record counter (in the Zero 100SB only) and the finger-tab control panel. Plus one very unsubtle feature.

The price.

For your free copy of The Garrard Guide, a 16-page full-color reference booklet, write to Garrard, Dept. G-2, 100 Commercial Street, Plainview, N.Y. 11803.

Garrard
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of two bipolar devices. A common-gate push-pull stage is interposed between Q7 and Q8 of the simple circuit in Fig. 13 and the gates of the above mentioned source followers. Preceding Q7, 8 of Fig. 13 and going towards the amplifier input is another common-gate differential stage, preceded by two more common-source differential stages, the last of which is the input differential amplifier and phase inverter. A more complete simplified circuit for the power amp is shown in Fig. 14. The active devices in the direct signal path are all FETs, with Q5, 6, 9, 11, and 12 being VFETs and the rest being small-signal horizontal-junction FETs. The three current sources for the first, second, and fourth stages are implemented with bipolar devices. The common-gate stages are in the circuit to provide more input isolation between stages and to presumably help feedback stability margins.

As in the Sony unit, this circuit has a number of regulated supply voltages for various stages of the circuit. Details of the protection circuitry were unavailable at the time of this writing.

Listening Tests

It was found by measurement that the bias voltage for the output stage upon turn "on" is immediately high and comes down to the operating value after some seconds of delay. A filter amplifier is available at the input to eliminate subsonic energy. Two attenuation curves are available: a 6 dB/octave rolloff with a 3 dB point of about 1.7 Hz, and a 12 dB/octave cutoff with a 3 dB frequency of 10 Hz. All measurements and listening on this amplifier were done through the direct input which bypasses the filter amp.

The Sony TAN 8550 was available to the writer only for an afternoon. This proved sufficient to make a listening evaluation and a number of quick measurements mainly concentrating on basic linearity characteristics. The amplifier sounded very smooth, detailed, and free of irritation. It wasn't necessary to compare it to very many amplifiers to find out that it was quite excellent. IM distortion measurements revealed a characteristic that would gladen the heart of any triode-tube power-amp designer—essentially third-harmonic distortion up to clipping with magnitudes in the low hundredths of a percent.

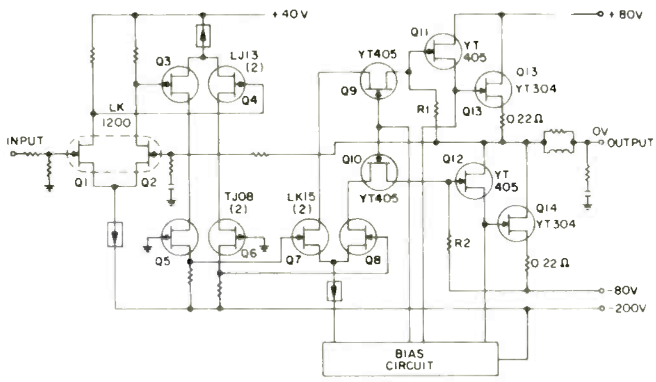

Fig. 14—Simplified schematic of the Yamaha B-1.

The Sony TA 8650 and Yamaha B-1 have been in the possession of the writer for several weeks and more time has been spent in evaluating these two units. Pictures of each are shown in Figs. 15 and 16. The Yamaha B-1 is a beautiful hunk of amplifier—all 95 lbs. of it! Construction is all plug-in PC boards, with even the four output-device heat sinks having plugs for their easy removal. The TA 8650 is also a very nicely made unit, using PC boards throughout. It is a smaller amplifier and weighs in at 46 lbs. An interesting feature of this amp are the two indicators on the front panel, one of which indicates clipping in the power amps and the other indicates clipping in the phono preamps.

Considerable listening was done on the writer's speaker system, which are large equalized arrays of 4-in. drivers containing 30 fours and three tweeters per side. This speaker system is rather efficient in the mid-range and for the listening levels used only requires about 5-10 watts per side. As a consequence, the low-level end of the power range of a large power amp is used, making it relatively easy to detect roughness and edginess due to low-level nonlinearities. Under these conditions, both amplifiers sounded almost incredibly good without a trace of edginess. They are slightly different, however. The Sony seemed to have a little more high-end definition, giving a bit more air and space to the music. The Yamaha was a bit more subdued, giving the high-end a clean, smooth nature which could be listened to for long periods of time. The Sony sounds more like the very best bipolar amplifiers, while the Yamaha is more like a very good tube amplifier.

Additional listening tests are being carried out using the less-efficient Magnepan NG-2167F speakers, which will tax another portion of these amplifiers' operating range to produce the same SPL. Results thus far are only tentative, but will be reported when these amps are reviewed.

Measurements of linearity mainly by using IM distortion and analyzing the harmonic content of the IM residue revealed that both the Yamaha and Sony amplifiers were free of higher order odd harmonics. The Yamaha did exhibit some distortion products containing higher order odds above 10 watts or so. It was found that the bias current was low and adjustment of bias to 400-500 mA straightened this out. The bias level on these amps is rather critical and if underbiased very much, odd harmonics do creep in due to relatively less gain near the origin. More complete measurements will appear later in reviews of both of these amplifiers.

In conclusion, it must be said that these VFET amplifiers are more complicated than their bipolar counterparts and, due to the development costs of the VFETs, are bound to be more expensive when first brought out on the market. The Japanese must be admired for developing this new power device in an attempt to get more realistic music reproduction. The writer believes in the concept of these devices and looks forward to seeing better amplifiers emerge with this technology and, alas, dreads the near day when these two units will have to be given up so others can see and hear them!

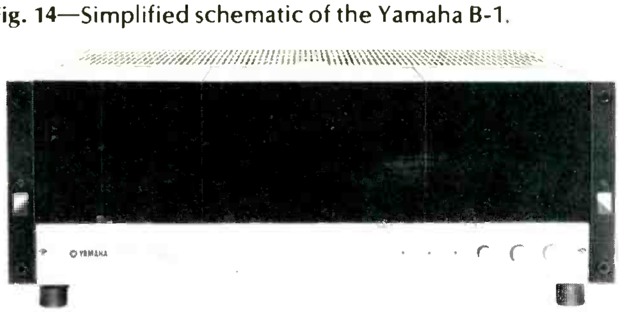

Fig. 15—Yamaha B-1.

Fig. 16—Sony TA-8650.

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It doesn't just put out. It pulls in.

Don't get us wrong. Our superb new C/M RR805 stereo receiver would be a treasure for its amplifying abilities alone. The unit delivers 54 watts RMS of continuous power per channel with both channels driven into either a 4Ω or an 8Ω load, with only 0.2% harmonic distortion at all frequencies from 20 to 20,000 Hz.

But we didn't just concentrate on the amplifier section of the RR805 and then relax when it came to the tuner. After all, we specialize in components for the professional and for the serious audiophile. So we also did everything possible to make sure that all of the amplifier's input signals would be as superb as its output.

WEAK AND DISTANT STATIONS COME IN LOUD AND CLEAR

As a result, the specially designed AM-FM tuner in the RR805 provides such advanced features as a phase-locked loop decoder and an LED stereo indicator. Sensitivity in the FM mode is a remarkably high 1.8μV with an extremely steep slope, and only 6μV is required for 60db quieting. Translation? You can pull in weak and distant stations easily and hear them with the same sharpness and clarity as local stations.

Other sections of the RR805 receiver are equally advanced—with such refinements as directly coupled output circuitry and an electrically separable preamp for interconnecting a crossover network or an additional equalizer.

No wonder Station WLIR is using this receiver for off-the-air monitoring and for radio relay work.

You'll also like the RR805's full mode selector, which has Mono and Stereo positions plus a Stereo Reverse to let you correct transposed channels. The unit has an extra phono input, too, for plugging in a children's record player or for playing your old 78 rpm records on a separate machine...and there's an extra tape input and tape monitor to permit you to dub in and rerecord existing tapes.

What's more, the RR805 is the only receiver with inputs specifically designed to accommodate C/M's new feedback-controlled loudspeakers.

This remarkable unit is so new that your dealer may not yet stock it. If he doesn't, just drop a line to C/M Laboratories, 327 Connecticut Avenue, Norwalk, Connecticut 06854. We'll not only send you additional data on the RR805, but if you wish, we'll arrange a demonstration for you at a dealer in your area...no obligation, of course.

Hear C/M's RR805 soon—and discover how beautifully a receiver can put out. And pull in.

C/M LABORATORIES
EXCEPTIONAL COMPONENTS FOR THE EXCEPTIONAL EAR.

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What's New in Audio

Sony/Superscope Tape Deck

The Sony TC-758 professional open-reel unit is a three-motor, auto-reverse stereo deck using ferrite and ferrite roto-bi-lateral heads. Bi-directional recording and playback, plus 10½-in. reel capacity give the TC-758 the longest recording and playing time of any deck in Sony's line. A servo-control motor and closed-loop dual capstan drive system assure optimum speed and mechanical operation. Logic-controlled transport functions, ultra-high frequency bias and stereo headphone monitor head are several additional features. Price: $999.95.

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Fideltone Disc Care

Fideltone's Intensive Care Kit #3052 contains a Fidelstat, a plush record cleaner that reduces static charge in addition to cleaning discs. Also included is a Disc Jockey soft-bristle brush which attaches to your turntable for continuous cleaning, liquid stylus cleaner and antistatic fluid. Pick up the complete package for $10.99.

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Dynascan DVM

B&K Model 282 is a 3½-digit digital volt meter, said to have d.c. accuracy of 0.5 percent. Other features include automatic polarity and decimal point positioning, positive out-of-range indication, 1 mV resolution, 10 megohms input impedance on both V a.c. and V d.c., and full overload protection. It is supplied with the PR-21 probe, with switchable 100K ohm isolation resistor to prevent capacitive loading while measuring d.c. in r.f. circuits. Price: $200.00.

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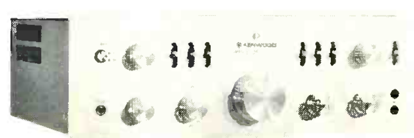
Kenwood Pre-Amp



Model 700-C is a highly sophisticated control center designed with virtually no limit to the variety of control and switching functions that may be performed. In terms of dynamic range and linearity, this unit, with its inherently low residual noise (less than 50 μV), handles a dynamic range in excess of 85 dB, referred to its nominal 1-volt output level. The controls themselves provide minute adjustments in volume, balance, tonal compensation and noise filtering. There is also selectable phono-cartridge input impedance, with settings for 600 ohms, 30 kohms and 50 kohms. Selectable low and high frequency filtering, audio muting, and a two-step loudness control add to the unit's control capabilities. Price: about $700.00.

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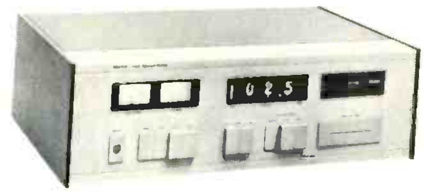
Scott Digital FM Tuner



Model T33S doesn't use a tuning capacitor, dial cord or knob for station selection. Instead, a specific broadcast channel is selected via punched card using the tuner's card reader or via automatic or manual scanning with front panel controls. As the digital display reads out the desired frequency, a self-contained, special purpose digital computer synthesizes the proper station frequency by counting up from a highly accurate quartz-crystal reference standard. Other features include a low-noise MOSFET r.f. section to provide IHF sensitivity of 1.8 μV, and two pre-tuned, phase-linear, lumped six-pole filters which maintain alignment in the i.f. section. Price: $999.95.

Check No. 94 on Reader Service Card

Design Acoustics Speaker

The Model D-4 is a 3-way system using a multi-faceted, trapezoidal enclosure. The woofer is 10 in. in diameter, loaded by a sealed enclosure, and mounted on the rear of the cabinet. By acoustically coupling the woofer to the room boundaries, Design Acoustics claims uniform bass response to below 40 Hz. One 5-in. midrange unit radiating through a 2-in. diameter aperture provides an optimally damped and well dispersed midrange. Three 2½-in. diameter cone tweeters are mounted on each of the front facets to provide uniform propagation of high frequencies into the listening area. Provision is also made to reduce output level of low and high frequencies by 3 dB for achieving correct balance under a variety of acoustic conditions. Price: $199.00.

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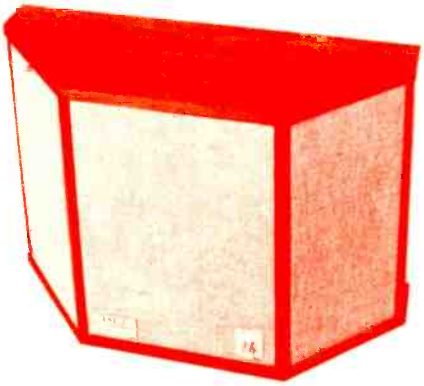
Acoustic Research Speaker



The LST-2 represents a blending of drivers employed in other highly successful AR speaker systems. A unique crossover network and spectral balance switch permit the user to select the energy output best suited for his individual room acoustics and program material. The geometric design of the walnut cabinet along with the characteristics of the drivers (10-in. acoustic suspension woofer; three 1½-in. midrange hemispherical dome radiators, and three 3/4-in. hemispherical dome tweeters) are said to result in uniform dispersion at all frequencies. Price: $400.00.

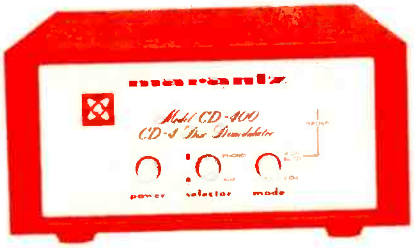
Check No. 100 on Reader Service Card

Kenwood Turntable

The KP-5022 uses a direct-drive system powered by an 8-pole brushless d.c. motor. Wow and flutter are rated at 0.05 percent and rumble at 58 dB. A statically balanced tubular arm with an elliptical cross-section, die-cast aluminum shell is incorporated. Shell position is fully adjustable for optimum channel separation for stereo, matrix, or CD-4 discs. Also featured are repeat play, arm return, power shut-off, anti-skate and a stroboscope speed adjustment. Price: $319.95.

Check No. 101 on Reader Service Card

Marantz CD-4 Demodulator



The CD-400 incorporates PLL for the 30-kHz subcarrier, Automatic Niose Reduction System circuitry, and a built-in RIAA equalization network. This demodulator can be used with any 4-channel receiver on the market. Purchased separately, the CD-400 is $139.95; bought in conjunction with other Marantz stereo/quad componentry, the price is $99.95.

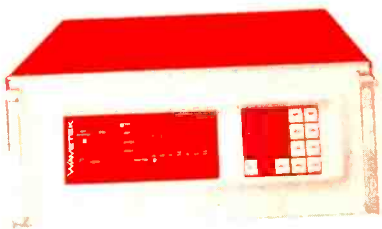
Check No. 102 on Reader Service Card

Speakerlab Components

Speakerlab offers a variety of speaker components from single drivers to crossovers or complete speaker kits. Kits may be purchased with speakers, crossover, and front board, or as a kit or completely assembled unit including enclosure. Prices for complete speaker kits range from $57 to $385; assembled units from $95 to $650. Accessories such as fiberglass, capacitors, and wire are also offered.

Check No. 103 on Reader Service Card

Wavetek Function Generator



The Model 152 Variphase Generator has variable phase outputs with manual or remote control of phase angle. Phase may also be referencedto an external sync input or to the unit's own sync output, and controls with 4-digit resolution. Each output is independently programmable for sine, cosine, triangle, or square waveform or d.c. voltage as well as amplitude and offset to ±9.99 V peak. Frequency is common for all channels and programmable with 3-digit resolution over a 1 Hz to 100 kHz range. Price: $4,995.00

Check No. 104 on Reader Service Card

Sony/Superscope Parabolic Reflector

Depending on climatic conditions and surroundings, the PRB-400 is capable of picking up high quality sound from a distance of several hundred yards. Primary uses of this sound-gathering device include live recording of concerts, speeches, sport events, and field research. The unit may be hand held or mounted on a tripod and is said to improve the sound sensitivity of most omni-directional mikes by 10 to 20 dB. The price of $99.95 includes hard-vinyl carrying case and mike-stand adaptor.

Check No. 105 on Reader Service Card

3M Audio Tapes

The Scotch brand "Classic" line is said to have a more brilliant high-frequency response, excellent response at low frequencies and a higher overall output than previous 3M tapes. The manufacturer claims the Classic tapes have high-frequency response superior to low noise ferric oxide and display unexcelled performance in the vital low range. The Classic line will be available in cassette, 8-track and open-reel formats. Typical prices: $4.35 for a C-60 cassette; $5.00 for an 8-track 90-minute cartridge, and $12.45 for a 90-minute (1800 feet) open-reel tape.

Check No. 106 on Reader Service Card

RTR Speaker System

Model 400E is a 3-way system incorporating three kinds of drivers. The woofer is an acoustic suspension 12-inch unit with a two-inch voice coil. Midrange is handled by an array of four RTR electrostatic wide excursion panels. Extending the frequency response to 25,000 Hz is a solid-state technology piezoelectric tweeter. The cabinet of the 400E is made of hand-rubbed walnut veneers. Power requirement is 20 watts to 100 watts program material. Price: under $300.

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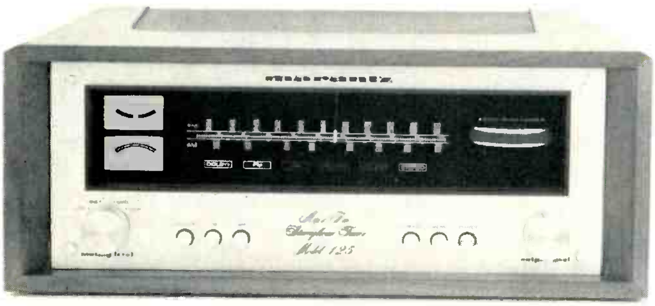
Equipment Profiles

Marantz Model 125 AM/FM Stereo Tuner



MANUFACTURER'S SPECIFICATIONS
FM Section
IHF Sensitivity: 1.8 μV. **Quieting Slope:** Mono, 56 dB at 5 μV; 61 dB at 10 μV; 71 dB at 50 μV; stereo, 52 dB at 50 μV; 65 dB at 1000 μV. **S/N:** 73 dB in mono; 65 dB in stereo. **Selectivity:** 80 dB. **Capture Ratio:** 1.1 dB. **AM Suppression:** 63 dB. **THD:** Mono, 0.2%; stereo, 0.3%. **Image Rejection:** 100 dB. **I.F. Rejection:** 100 dB. **Spurious Response Rejection:** 100 dB. **Frequency Response:** 30 Hz to 15 kHz ±1 dB. **Stereo Separation:** 42 dB at 1 kHz; 29 dB at 10 kHz. **Output Level:** 100% Modulation, mono, 1.7 volts; 50% modulation Dolby, mono, 580 mV.
AM Section
IHF Sensitivity: 20 μV. **Selectivity:** 48 dB. **I.F. Rejection:** 60 dB. **S/N:** 55 dB. **THD:** 30% Modulation, 0.6%. Output Level: For 30% modulation, 470 mV. **Retail Price:** $329.95.

Ever since Marantz introduced their fabulous 10-B tuner some years ago, the company has enjoyed a reputation for producing FM and AM products that are beyond the ordinary. Their new Model 125 proves that you can remove such luxuries as multi-purpose oscilloscopes (thereby saving more than $200.00 compared with their higher-priced Model 120B) and still come up with a top-performing tuner that will be limited in its performance only by the kinds of radio station signals it receives. To this reviewer, the complete manner in which Marantz chose to publish its own product performance specifications was the first clue to its excellence. How many other manufacturers bother to tell you about three specific points on the "quieting slope"? Yet this information tells more—much more—than the almost meaningless and archaic "IHF Sensitivity." In fact, Marantz has incorporated in this tuner's specs nearly all of the newly proposed measurements that the IHF hopes to make mandatory in the near future.

The new tuner bears the usual family resemblance to other Marantz tuner, amplifier, and receiver products. The gold-anodized front panel measures 15¼ in. by 5¾in. high and extends beyond the classis and metal wrap, so that if you want to custom mount the unit behind a wooden front panel, even an imprecise hand-sawn cut-out will do nicely. The unit measures just under 12 in. in depth, not including panel, knobs, and AM bar antenna (once it's pivoted away from the chassis). "Gyro-touch" tuning, an edge-mounted, thumb actuated flywheel tuning knob, is carried over into this model, and we still find it to be one of the most elegant (and really quite simple) station tuning arrangements around. The two metal-turned large knobs at the lower left and right of the panel are a continuously variable output level control and a four-position (including OFF) muting switch, about which more in a moment. Three push buttons at the lower right take care of power ON/OFF, MONO/STEREO selection, and insertion of a high-blend MPX filter circuit, useful when listening to noisy or weak stereo FM signals. Two of the three matching buttons at the lower left select AM or FM reception. The third button (or rather its nomenclature) caused us our single minor concern as self-appointed consumer-confusion preventer. The button is labelled FM DOLBY, and if you were confronted with those words, wouldn't you think that a Dolby decoder (for new FM Dolby broadcasts) was included? Well, what is included is a choice of de-emphasis settings—the usual 75 microseconds for ordinary mono or stereo FM reception, and 25 microseconds, now sanctioned by the FCC for stations using Dolby encoding. To properly decode such broadcasts and gain the attendant noise reduction and dynamic range advantages, you'd still need an outboard Dolby box, though we suspect that most audiophiles interested in a tuner of this quality will already have the outboard Dolby unit. Incidently, then the Dolby button is depressed, the output level is no longer governed by the front-panel level control but is available at fixed level (see specs above) so that you can permanently calibrate your associated Dolby decoder for correct playback decoding. If you don't own a Dolby decoder in separate form, you'd be better off listening to Dolby-encoded broadcasts without the Dolby button depressed.

The rear panel, pictured in Fig. 1, has the required pair of output jacks, a detector jack which Marantz calls an *FM Quadradial Output* (for a four-channel adaptor of the

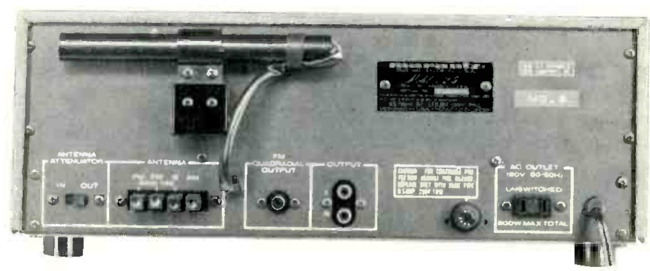


Fig. 1—Rear panel of the Marantz 125.

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future), a line fuse, an unswitched a.c. convenience receptacle, and four push-to-insert-wire connection terminals for 300-ohm, 75-ohm, and AM external antennas. Next to these terminals is a two-position slide switch identified as an "antenna attenuator," useful for reducing signal strength if you're "right on top" of a transmitter. In our laboratory tests, which included injection of signals up to 200,000 μV, we did not find it necessary to use this switch for any reason of overload or distortion, but we know of cases where listeners are bombarded by *volts* of signal, under which circumstances the extra attenuator might be helpful. The long AM ferrite-bar antenna pivots away from the signal insulating qualities of the metal rear panel.

Removal of the walnut-clad metal wrap supplied with the 125 reveals the usual, orderly Marantz approach to circuit identification and layout. Each circuit board is fully shielded by its black cover and, where alignment points are required, strategically located holes, suitably identified, are provided in this fully shielded unit. While a schematic diagram of the unit was not supplied with our test sample, discussions and correspondence with the people at Marantz yielded the following insight into some of the design philosophy.

Marantz suggests that the performance of an FM tuner is determined, largely, by the performance of its i.f. section. The ideal amplifier should pass the entire band of frequencies which contains desired sideband information, with a minimum of phase distortion. On the other hand, if one wants to stress selectivity or the ability to reject unwanted frequencies outside the passband, a familiar technique has been to use crystal or solid state filters. With these, unfortunately, phase distortion sometimes tends to be high. For the i.f. section of the 125, Marantz engineers claim to have developed a constant phase filter. Phase linearity of frequency dependent networks is expressed in terms of "group delay"—the rate of change of phase with frequency and the use of an 18-pole, linear-phase LC filter in the Model 125 results in a group delay difference of less than 100 nanoseconds over the critical 200 kHz center portion of the passband. Marantz claims that this represents a 15-to-1 improvement over group delay difference achieved by other, more conventional design approaches. In fact, they go so far as claiming that the newly designed 18-pole filter actually gives performance superior to that of their now-classic Model 10-B in such areas as IM and THD, separation stability, lack of intermodulation products between main channel and any SCA signals which might be present, and improved "quieting" sensitivity. The internal layout of the chassis can be seen in Fig. 2.

FM Measurements

Some of the claims made by Marantz in the above discussion were quickly confirmed as we began to measure performance. Consider the data shown in Fig. 3. Aside from reaching an IHF sensitivity of just under 2.0 μV, quieting was actually better than −70 dB at a mere 20 μV of input signal, having reached a listenable 50 dB at a mere 2.2 μV in mono. Equally impressive was the 50 dB quieting point in stereo, which occurred at an input signal of only 18 μV. Mono THD was as low as our equipment would allow us to read, 0.09%, while in stereo (a far more difficult achievement) THD was only 0.15% for mid-frequencies. Ultimate quieting reached 75 dB for mono, 69 dB for stereo—both figures well beyond those stated by Marantz.

Stereo separation, plotted in Feb. 4, was 42 dB for mid frequencies and 29 dB at 10 kHz, exactly as claimed. At low frequencies (down to 50 Hz) it was still above 35 dB. In the same graph, THD versus frequency is plotted for mono and stereo operation. Even at the 7 kHz extreme (the highest frequency for which audible harmonics would occur in FM transmission), mono THD was just a bit over 0.1%, while the stereo reading was 0.5%. Despite the excellent rejection of carrier products by the Marantz 125 MPX circuitry, frequency response is not sacrificed at the high end. It remains within 0.5 dB all the way out to 15 kHz. Other measurements included capture ratio of 1.0 d'b, selectivity of 80 dB as claimed, spurious response rejection of 98 dB, and image rejection of a bit better than the 100 dB claimed. Stereo threshold occurs at an ideal 7 μV, by which time S/N in stereo is already −42 dB and THD is down to 1.5%. Three of the four muting positions are ideally set to provide thres-

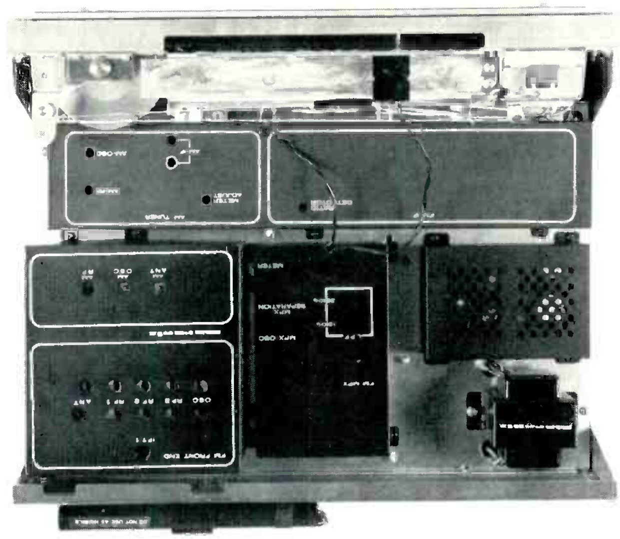

Fig. 2—Internal view.

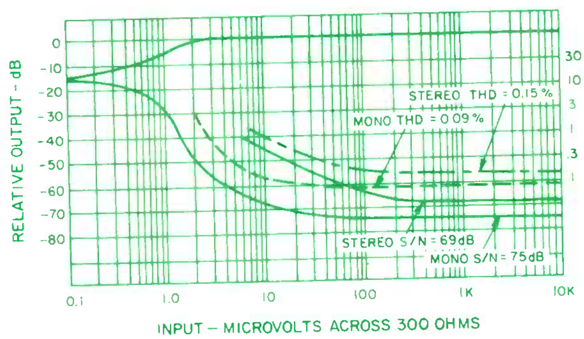

Fig. 3—FM quieting and distortion characteristics.

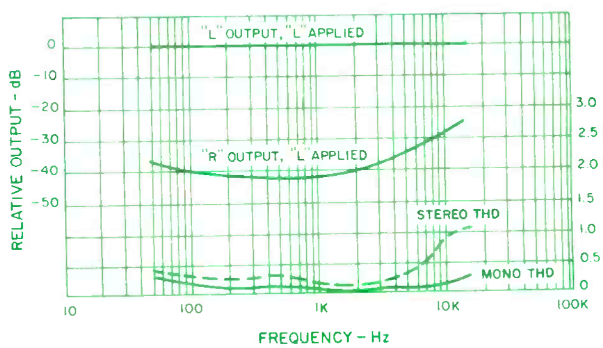

Fig. 4—FM separation and distortion versus frequency.

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other carries normal LINE IN and LINE OUT jacks as well as two DIN sockets for the same functions.

Workmanship is first-class, and the capstan assembly, heads and tape guides are up to professional standards. Styling is a personal matter but I found the black and satin panel with the contrasting blue meters and colored pushbuttons most attractive.

Three motors are used, an a.c. servo type for capstan drive and two eddy current motors for the reels. Now a few words of explanation regarding some unusual control functions. First, as some readers may have guessed, Quadra-Sync is AKAI's name for the *recording* head monitoring system that permits making synchronized multiple recordings. For example, you can record a group on tracks 1 and 3 and then add a piano on track 2, plus a guitar on track 4 later. Or you can make multiple mono recordings, and the signal level of any track can be increased to dominate if desired. In fact, the possibilities are endless!

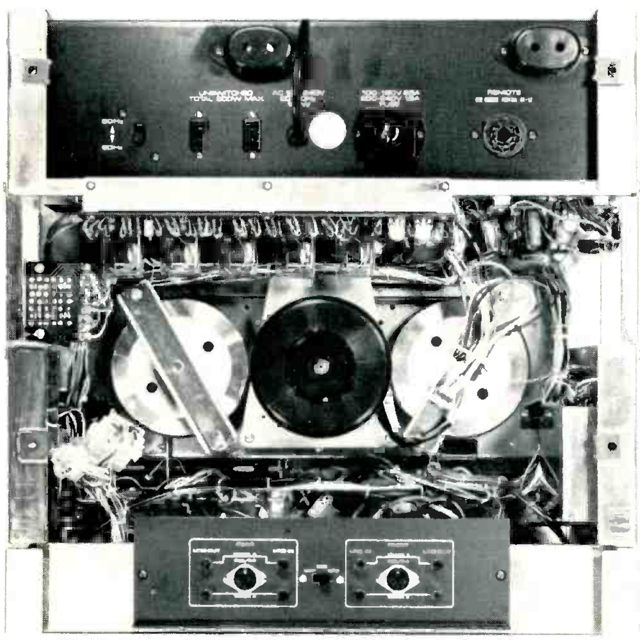

Fig. 2—Rear (bottom) layout of AKAI GX-400D-SS deck.

The REPEAT-REVERSE switch has three positions: single, continuous, and off. To make use of this feature one applies a small piece of sensing foil to the tape; with the switch in the SINGLE position the tape will play up to the foil, then automatically rewind and stop. In the Recording mode, the tape will be recorded up to the foil, rewind and then it will stop. Now, with the switch set to CONTINUOUS (the sensing foil applied at two places on the tape) the machine will play back and forth continuously. In the two-channel (stereo) mode it is possible to play back in two directions, record and stop, or play continuously in both directions—truly versatile! The CUE switch brings the monitor heads down near (not quite touching) the tape during REWIND so that what the manual describes as a "tweeting" sound (speeded-up Donald Duck?) can be heard, facilitating tape editing. The remote control socket at the rear is for the optional RC-17 Remote Control which can operate all machine functions.

No circuit details are given, beyond the information that the electronic section uses 95 transistors, 88 diodes, and 4 ICs.

Featured in this machine is AKAI's ADR noise-reduction system, which, they explain, varies the recording equalization according to the signal level to improve the reproduction above 8 kHz at slower tape speeds. This system achieves results somewhat similar to the Dolby and ANRS noise reducing systems and possibly accounts for the excellent Signal/Noise ratio found in our tests (below) at the slower speeds.

Measurements

Figure 3 shows the playback response from a standard test tape, and the record-play response at 15 ips is shown in Fig. 4. Maxell UD 50-7 was used and it can be seen that the upper

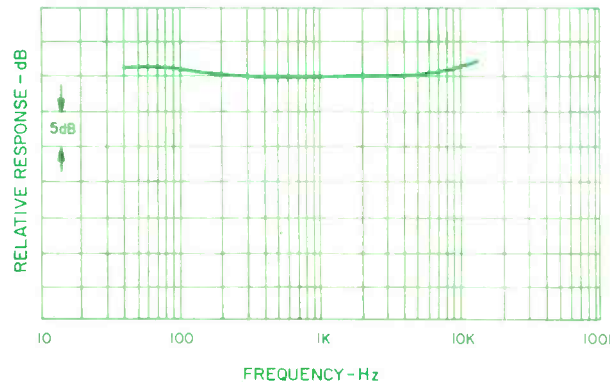

Fig. 3—Response with standard 15 ips test tape.

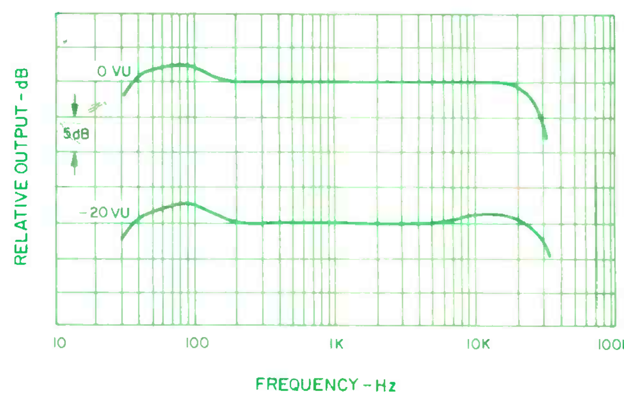

Fig. 4—Record-play response at 0 VU and -20 VU with Maxell UD 50-7 tape at 15 ips.

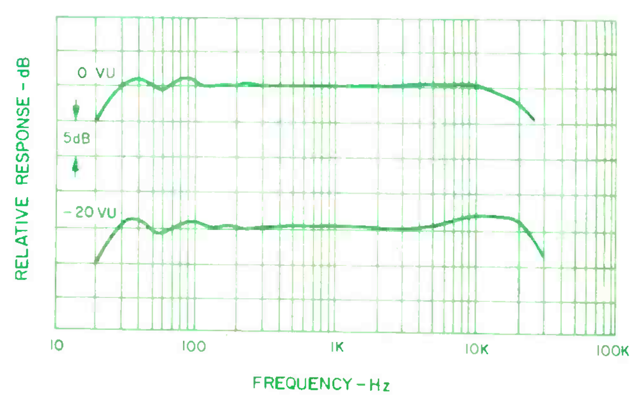

Fig. 5—Record-play response at 7½ ips with Maxell UD 50-7 tape.

3 dB point is 31 kHz. Overall response is within 2 dB from 35 Hz to 30 kHz—a very creditable performance. At 7½ ips, the response was almost as good, the 3 dB point was at 27 kHz. Saturation at high frequencies, shown by the 0 VU upper cur-

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ves, was somewhat less at 15 ips, as might be expected, and it is likely that recordings made with really top quality microphones at 15 ips might sound slightly better, so far as high energy transients are concerned. Several other tapes were checked at 7½ ips, including Capitol 2 and the new Scotch Classic. The latter is a fine grain formulation which measured close to the Maxell, with the Capitol tape not far behind. Figure 7 shows the results at 3¾ ips. The effect of tape saturation can be seen clearly. Recall that 20 kHz response was considered excellent for a studio machine not so long ago, and the overall performance of the AKAI may be seen as a tribute to its head design (and a new generation of tape formulations).

At 1 kHz the distortion at 0 VU was 0.45% and this did not increase significantly over the audio range, as shown in Fig. 6. The standard 3% distortion level was reached at +6 VU,

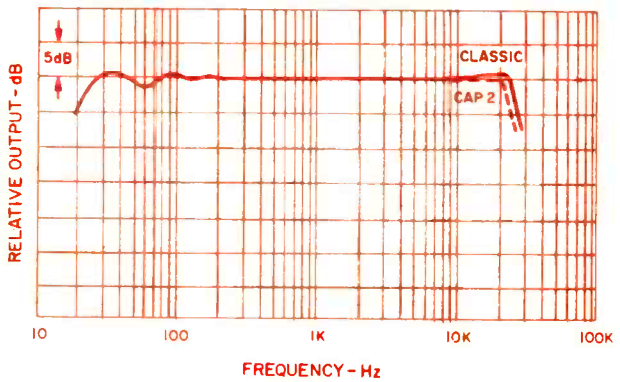


Fig. 6—Record-play response with Capitol 2 and Scotch Classic tapes.

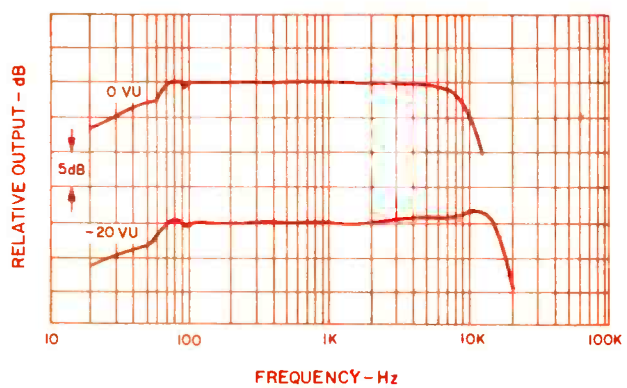


Fig. 7—Record-play response at 3¾ ips.

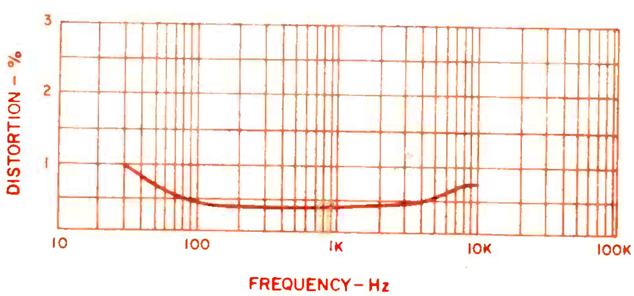


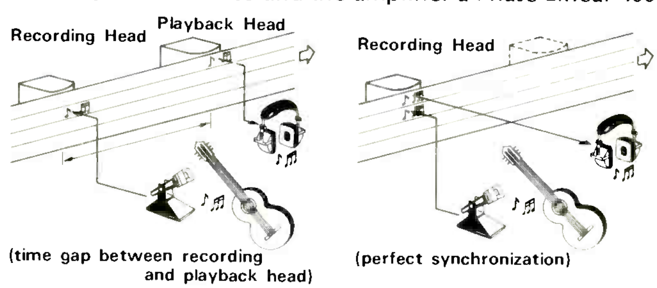
Fig. 8—Distortion versus frequency at 0 VU.

providing more than adequate headroom. Signal-to-noise ratio came out at 57 dB (ASA weighted) referred to 0 VU, or 63 dB referred to 3% distortion. These figures are for the Maxell tape; the Capitol 2 measured 62.5 dB, and the Classic 64 dB. Wow and flutter (record-play) checked out at 0.03% at 15 ips, 0.05% at 7½ ips, and 0.095% at 3¾ ips! Input signal required for 0 VU was 22 millvolts (line) and 0.2 millivolts (microphone). Output for this input signal was 1.4 volts. Rewind time was 72 seconds for a 1200-foot reel.

Apart from the aircraft-panel styling mentioned above, I found the most impressive feature of the 400D-SS to be the remarkably efficient logic control. For example, I put on a 15-ips tape. After a few seconds I realized that the machine speed was set to 7½ ips, so I turned the speed switch to 15—the reels came to a stop. Nothing happened for two or three seconds, then they started turning at the right speed. Uncanny. If you want to change tape direction in midstream, you press the appropriate button, which lights up, the tape stops and, after a brief delay, away it goes. AKAI calls this their Direct Function Change System and says it eliminates the need to use the STOP button between changes. They do warn against using very thin tapes but I found the action so gentle that the tape would have to be extremely thin and fragile to be harmed.

Listening and Recording Tests

As this is primarily a quadraphonic machine, the first tape I played was a quadraphonic one, the Ambiphon demonstration tape *The Sound of Space*. I then made some disc transfers at 3¾ ips and most commercial records were indistinguishable from the tapes, or should I say that the other way around? Anyway, the phono cartridge I used was an Audio-technica AT-20S and the amplifier a Phase Linear 400



AKAI Quadra-Sync recording (right) permits monitoring one track while recording another track *from the same head*, providing accurate sync for sound-with-sound recording. Normal separate play head monitor system (left) introduces time delay.

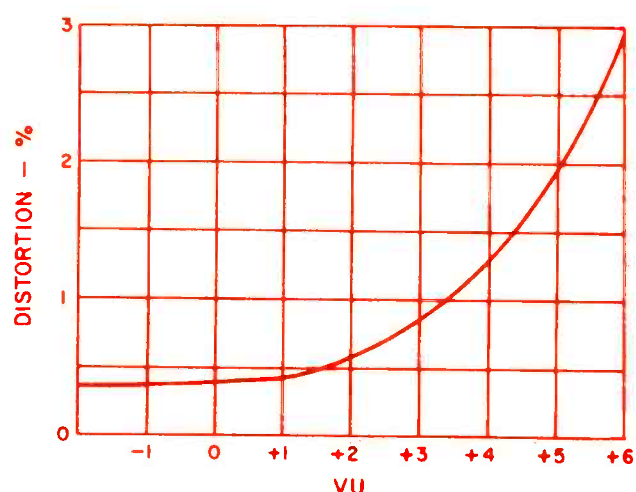


Fig. 9—Distortion at 1 kHz.

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with a Sony 2000F preamplifier. Loudspeakers were Acoustic Research LST's or an experimental dynamic-electrostatic hybrid. Direct recordings were made with a pair of AKG C-451E microphones, and here the 15 ips showed its superiority. No doubt about it—tapes made at this speed were cleaner than those made at 7½ ips, but you would have to make a rapid-switching A-B comparison to tell. The Quadra-Sync controls worked very nicely and even the most ham-handed novice could follow the simple instructions. All-in-all, the AKAI GX-400D-SS can be recommended to those who want a versatile 4-channel machine with professional performance.

Footnote: This machine tips the scale at 69 pounds, so make certain that your shelf or table is strong enough to hold it!

Check No. 81 on Reader Service Card

George W. Tillet

Shure Model M64 Stereo Preamplifier

MANUFACTURER'S SPECIFICATIONS
Equalization: Phono, Tape, and Flat. **Gain:** 34.5, 37, and 27.5 dB respectively at high-gain output; 11, 13.5, and 4 dB respectively at low-gain output. **Frequency Response**: Phono ±2 dB of RIAA curve from 40 to 15,000 Hz; Tape, ±2 dB of 7½-ips NAB curve from 50 to 15,000 Hz; Flat, ±2 dB from 20 to 20,000 Hz. **Distortion:** Under 1% THD for an output of 2 volts at 1000 Hz; in Phono position, THD is less than 1% at 30 Hz with 2 volts output. **Clipping Level:** Phono and Tape, 100 mV input; Flat, 250 mV input. **Channel Separation:** 50 dB or better at 1000 Hz. **Hum and Noise:** Phono, better than 71 dB below 10 mV input from 20 to 20,000 Hz; Flat, better than 64 dB below 10 mV input from 20 to 20,000 Hz. **Dimensions:** 5 9/16 in. W, 4½ in. D, 2⅝ in. H. Flanges extend ½" on each end. **Weight:** 1¾ lbs. **Price:** $36.00.

While nearly every modern hi-fi amplifier is equipped for proper equalization of phono cartridges, there are relatively few that are similarly equipped for tape-head inputs, although most tape recorders have the necessary equalization built in, and present an output that is essentially flat. The equalization provided for phono inputs is not always as exact as it should be, particularly in "economy" amplifiers. Furthermore, it is often desirable for the user to have two inputs for phono available, for instance, with front panel switching available to select either a turntable or a changer. The M64 preamplifier is an ideal device for such applications, and is small, self-powered, and effective. The two inputs employ phono receptacles, and the outputs are pairs of phono receptacles, one of each pair for high-level and one for low, being 24 dB below the high output. A three-position slide switch selects the mode of operation—phono, flat, or tape. On the rear of the cabinet are two terminals which supply 30 volts of well-filtered d.c. for whatever purpose the user may want. These terminals may also be used to power the preamplifier from any 30-volt source, possibly from three

(Continued from page 18)

er. (Maybe E-V and Philips should contact him on that point. . . .) But my challenge to you, the audio engineer, is to understand that here you have a solid piece of the future in audio software, and you might as well start figuring your pulses right now. For, as I see it, there is no reason at all why—all in due time—Knight shouldn't be able to play his big work one one tape recorder, and none of this 32-channel jazz, please. This is a portable show.

Dare I suggest that the day after tomorrow you engineers should be able to reduce those 40 channels to minimal size with no trouble at all, maybe even on quarter-inch tape? So that Entity One, and Entity 25, and a thousand other new works of coming sonic interest can be trotted around with a lone tape recorder under one arm to play them, and the whole thing set up (aside from the 40 speakers) in five minutes. Could be, if you really get your digital transmission in hand. Oh yes—the amplifier. See last month. There would be only one, of course. With 40 channels in it. That, too, ought to be in the works if I guess rightly. I'm an incurable optimist and so I say get on with it and have fun. Digitality is here to stay. Burma-Shave. Over & Out.

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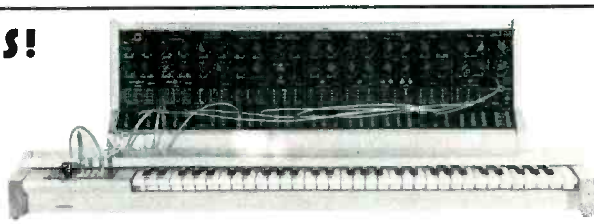

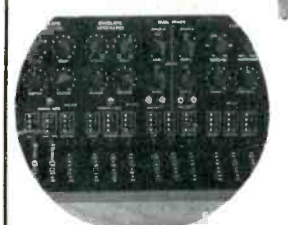

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9-volt transistor batteries in series, which would have a life of over 100 hours. The power switch on the rear of the case also opens the 30-volt circuit so the switch would also serve to turn the unit on or off when batteries were used.

The circuit of the preamplifier is relatively simple. Two low-noise transistors are used for each channel—the first is an NPN unit which is direct coupled to the second, a PNP transistor, with equalization provided by the feedback. The power supply consists of a transformer feeding two diodes in a full-wave rectifier circuit, with 500 uF of filtering resulting in less than 20 mV of ripple at the output, and the circuit itself minimizes the effect of power-supply ripple so that the output is 40 dB below the 20 mV, which is 80 dB below the nominal 2 volts output in the phono position with the input terminated in a dead short.

If the gain is not adequate for the application the user wants, instructions are given for increasing the gain by as much as 12 dB by simply adding two resistors across two already in the circuit. The increase may be as little as 3 dB or as much as 12 in 3-dB steps. Instructions are also given for providing balanced-line output by adding a transformer at the output—a need which would arise if the preamplifier were to be used to feed broadcast mixers.

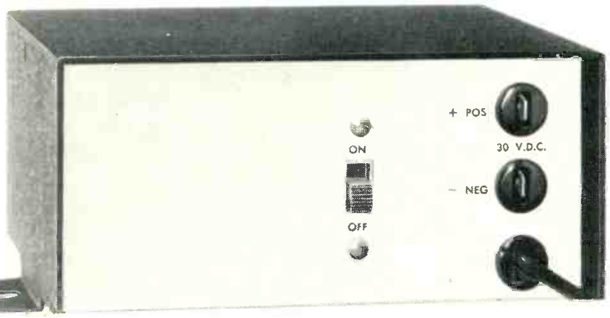

Fig. 1—Rear of stereo preamp showing power switch and terminals for supplying 30 volts to external equipment, or for connecting batteries for portable operation.

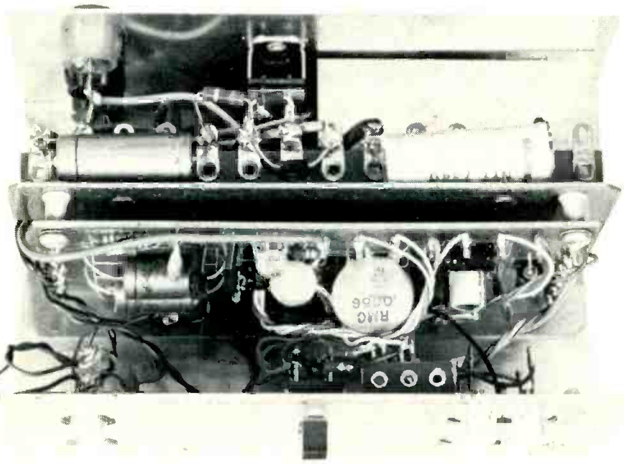

Fig. 2—Top view of stereo preamp with cover removed. Note metal shield between power supply and printed circuit board.

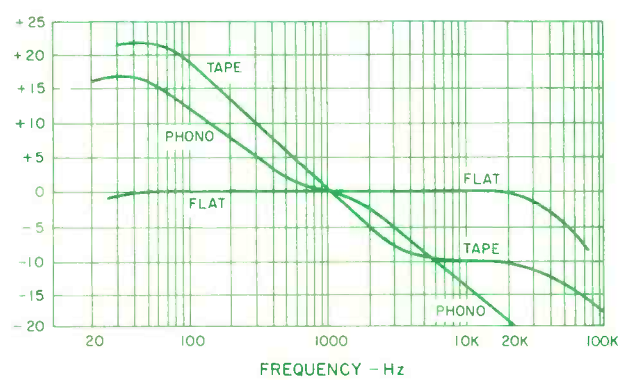

Fig. 3—Response curves for the three modes of operation of the preamp.

Performance

The curves of equalization follow those specified well within the 2-dB limits mentioned in the specifications. Distortion at 1000 Hz measured 0.08 percent at the two-volt output, and 0.12 percent at 3 volts. Gain in the phono position measured 36 dB at 1000 Hz; in the flat position 27 dB, and in the tape position, 37.1 dB. Hum and noise was measured at better than 80 dB below 2 volts output in the phono position, and better than 70 dB in the flat position. At 30 Hz, distortion measured 0.45 percent at the two-volt output. Crosstalk in the phono position measured better than-65 Db at 1000 Hz, and better than-57 dB at 10,000 Hz, also compared to the two-volt output.

This is a simple, well-engineered preamplifier which could well serve as a laboratory preamp. This observer has long used a battery-operated preamp for test and experimental use—sometimes an additional package of gain is needed. Battery operation eliminates the possibility of hum, of course, but this unit is so hum-free that the inconvenience of battery operation is completely eliminated. For example, when displaying square-wave patterns on a 'scope, the cartridge must be fed into a flat amplifier with sufficient gain to provide a suitable display on the 'scope, and this unit serves the purpose admirably.

The only possible disadvantage of this unit is its input impedance—47,000 ohms, which limits its use to stereo cartridges, since CD-4 cartridges require an input of 100,000 ohms. For use with discrete four-channel records and cartridges, the output from the cartridge would normally be fed directly to a demodulator anyway, so this one objection has little validity. In every other particular, it is an ideal instrument.

C. G. McProud

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WIND MUSIC

Mozart: Arrangements for Wind *(Don Giovanni, Die Entführung).* Netherlands Wind Ensemble. **Philips 6500 783,** stereo, $7.98.

An unpretentious title, but this is one of the greatest discs ever—it knocked me over. Superbly intelligent playing of arrangements from two Mozart operas; the Overtures plus familiar segments, done with such *legerdemain* you'd swear the original could never be as good. Even opera specialists would be happy; Mozart lovers should melt into a puddle with sheer joy! Big, clean, spacious, colorful recording too, stunningly good. A premium-price bargain on all counts.

Annapolis Brass Quintet. Crystal S202, stereo, $6.98.

Berlin Brass Quintet. Crystal S201, stereo, $6.98.

Two brass quintets and lo! the U.S. model comes off best. Annapolis plays mostly 17th c. German and English, including some "new" names. The sound is pro and modern, not very "authentic" for old music, but musical even so, and never show-off. Berlin, using rotary-valve trumpets and a very fat tuba on bass, somehow projects a "German band" sound, sort of gnomes in the black forest a la Volkswagen. Nice and plump, but not good for the similar old-music arrangements and rather unbrilliant for the modern music on side 2. Annapolis wins.

The Little Prince, Saint-Exupéry, original version (in French), G. Philipe, G. Poulouly. **Everest 3352,** stereo, $4.98.

The Little Prince, Read by Peter Ustinov. **Argo ZSW 520-1,** two discs, stereo, $13.96.

Coincidence? Hardly. **The Little Prince** is out as a new Broadway musical, which these two ain't. Just cashing in. Everest's "original" is reissue of an excellent French dramatic condensation, radio style, omitting the lengthy philosophizing of the original printed story of lost aviator and small child from a space asteroid. Better know your French! Argo's Ustinov reads the whole thing in English, doing all the parts; he works hard but the results are heavyhanded, inflating the little fantasy into a big overlong bore. Fussy Mozart music bridges. Much better to read the original yourself—cheaper and faster. N.B. The musical's original-cast disc will be along shortly, I expect.

The Art of the Viola da Gamba, vol. 1 (Bach, Telemann). Eva Heinitz; Malcolm Hamilton, hps. **Delos DELS 15341**, stereo, $5.98.

Well matched performing—Heinitz is a senior gambist from 'way back, a pioneer, Hamilton (as previously noted) plays curiously old-style harpsichord. Good, intense playing throughout, three Bachs and a Telemann; but the recording is stuffy, the gamba close and unresonant, the harpsichord tending to thump. You get used to it; the music is persuasive.

O Vilanella. The Consort of Musicke, Anthony Rooley, dir. **L'Oiseau-Lyre SOL 334, stereo, $5.98.**

A new slant here. In this old-music consort from England the instruments are all strings, from rebec to viols and lutes in two sizes; the voices are all-male, all-ensembles; they sing loud and minus vibrato, a barber-shop-plus blend. It's good.

Beethoven Joyously! 3 Duets for Clarinet and Bassoon. Michele Zukovsky, David Breidenthal. **Avant AV 1011**, stereo, $5.98.

Early-Beethoven duets, played with plenty of life and joy—but why the so-close mike placement? It robs us of the hall sound, barely audible in back, dampens the tone, you hear breaths, close-up. These instruments can sound so big in duets! Back away, Avant, and try for that illusive perfect pick-up point, for larger-than-life sound.

Harry Partch: The Bewitched, a Dance Satire (1957). Univ. of Illinois Musical Ensemble. **CRI SD 304,** 2 discs, sim. stereo, $11.90.

A CRI reissue of 1957 recording on Partch's Gate 5 label, one of his gigantic works, the excellent sound here rechanneled for stereo effect. Better to see *and* hear the gorgeous Partch instruments, the dancers and "lost musicians," the Witch; you can, study the story and significances for days even here—but just listening to 4 sides of twangs, gongs, crashes, all out of tune, plus assorted yamps, ho-ho-hos, zowies from the voices, is entertaining and instructive. What an indominable man!

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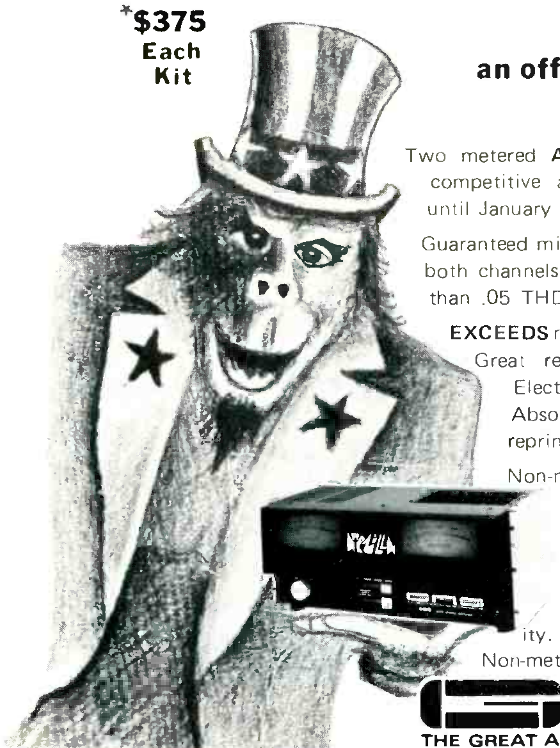

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The Elite Disc

Beethoven: Piano Concerto No. 3. Claudio Arrau; Concertgebouw Orch., Haitink. **Philips 6580 078,** stereo $7.98.

Rachmaninoff: Piano Concerto No. 3. Rafael Orozco; Royal Philharmonic Orch., Edo de Waart. **Philips 6500 540,** $7.98.

Eight bucks apiece? Well, here's the new world of elite recording, and the idea is worth thinking about. It is an unheard-of price for an LP.

But don't forget that in the 1930s the same music on quantities of shellacs—as many as 11 or 12 of the heavy breakables—would have cost even more, in dollars that were worth a vast deal more than the $ today. That was the time of the Great Depression, and assorted Recessions, remember? It is curious that in difficult times a case may be made, and usually is made, for two opposite approaches towards such wanted "luxuries" as these records. One says make 'em cheap. Columbia made history by lowering its shellac discs to a dollar each in the early 1930s. The other says make 'em dear. People will pay for the privilege of having a product that is difficult and expensive to produce. Now, we are pondering exactly the same sort of situation, even though the economics of today are very unlike those of the Thirties.

If I were buying, I would buy these. They are by today's standards absolutely *elite* discs, not in mere big-name public relations but in the fact, the musical performance, and the recorded sound. Both are just plain superb. So good that you can barely believe it.

I have come around to Arrau from once disliking his pianism. He is now one of the elder giants, with no longer any "career" to push forward into—he has long since done all that. Now, it is a matter of sheer music, and that is what you hear. He is a less showy Rubinstein, both men in their age as strong fingered as in youth. As the perfect foil, the thoughtful Dutch Concertgebouw playing never rushes, never shows off BEETHOVEN—yet is never dull. And such impeccably beautiful recording, such surfaces!

As for Rachmaninoff, I usually listen enthralled for five minutes, then get bored. He does go on and on. Not here. This is a tremendously appealing, youthful performance, absolutely fresh and new, dynamic, full of energy but not mere look-at-me energy; musical energy. Young De Waart is one of the most musical

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conductors of his generation. When this Concerto wound into its rousing finale I literally jumped up and shouted, a home-based *Bravo!!*

As a PS, I think that we in the U.S. can duplicate any aspect of these Philips recordings, if we will, except perhaps the final step, the disc itself. Our tapes are clean and quiet. We have the music, when we can afford it. Our discs lose too much. Depression or no, we will have to pull up our disc technology if we are to meet *this* competition. Even inflated, our similar LPs aren't yet worth $7.98, the elite price.

The Organ of Coventry Cathedral. Christopher Herrick. (Bonnet, Brahms, Mozart, Reubke.) **L'Oiseau-Lyre SOL 335**, $6.98.

Well—they come in all shapes and sizes, and when the wrong organ plays the wrong music, it can be awful. This enormous conglomerate organ goes with the enormous and barn-like new Coventry Cathedral, replacing the one the Germans bombed down, and it is a pro organist's dream machine, but not mine. At least in these Herrick performances. I found it musically harsh, loud, generally hideous in impact, whether in the Bonnet Variations, the chestnutty Reubke (that old 94th Psalm again) or the very unstylish Mozart. Only the gentle Brahms chorales come through with musical persuasiveness for the non-organist ear. Still—for an organ professional there is plenty of interest, in case you are one.

Mozart: Symphonies No. 38 ("Prague"), No. 41 ("Jupiter"). B.B.C. Symphony Orch., Colin, Davis **Philips 6500 313**, stereo, $7.95.

Curious. Colin Davis has a marvelous affinity for these last Mozart symphonies; his interpretations of them are on the very highest level of perceptive understanding as conveyed through a working orchestra of musicians. And yet his "Don Giovanni", also on Philips, misses this same level by a mile, though perhaps largely due to the solo voices, who seem to go their own way (and no doubt with only the sketchiest of last-minute rehearsals—what could the poor man do?). Here, you will find near-ideal balance and weight given to the profound inner materials of the works (often brought out too sententiously) as opposed to their suavely invariable high styling. In particular, the slow introductions, difficult to assess and play well, are unusally fine. The recording seems a bit on the dark-toned side. Maybe the hall acoustics?

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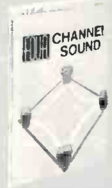

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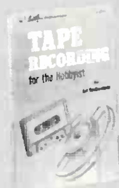

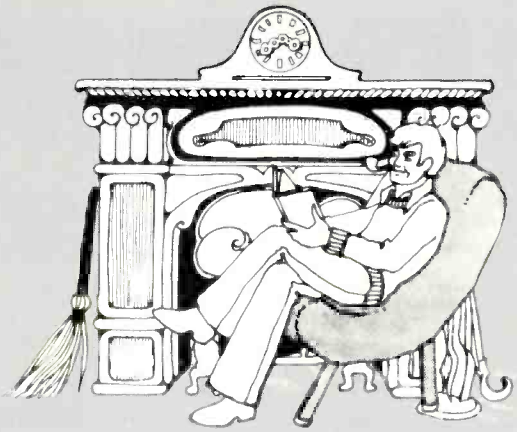

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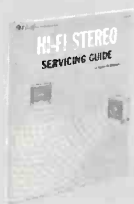

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The Column

Fred DeVan

STREETLIFE SERENADE: Billy Joel
Columbia PC-33146.

Billy Joel may be a new face and not exactly the most experienced performer around, but when he does something right, he does it very right. **Piano Man** (Columbia CQ 32544) was his first album, and the title song might well stand the test of time and vagaries of rockdom to become a true classic. The other cuts on the **Piano Man** album seem pale in comparison and may be the weakness of that album. Its strong lead is so strong it makes you expect too much of this one. Many other more-established folks suffer this same syndrome of having one or two heavies and a bunch of flotsam surrounding them to fill the disc. Billy Joel had a lot of middle-weight material vying with a blockbuster. The temptation to bypass much of his material may lead one past the quality that is there.

His new album, **Streetlife Serenade,** sets out to overcome this difficulty; it succeeds. True, the blockbusters are there, but this time out they do not seem bigger than life. They are in proportion. The material is all written by Billy Joel and is held together by his excellent keyboard work. The tasteful, complementary arrangements by Billy and his producer, Michael Stewart, work well, and make the album a completely satisfying work. As the piano player has matured, so have his words and themes.

Billy Joel is able to write sensitively about almost ordinary things without becoming maudlin. He writes about love without resorting to Paul Williams style of omnipresent tragedy as he did on **Piano Man.** Joel writes about an entertainer (himself?) honestly and with a touch of bitterness. He, too, is feeling the crush of staying alive and healthy in today's music world, and his life is pretty much where most of this album comes from.

It may be unfair to compare him to Elton John, but much of what he does is what Elton would do if he stopped to reflect on himself during those few hours between record albums. Billy Joel pulls off this second album with far more maturity than I expected when I first saw it. *Weekend Song* is the only cut that I would exchange for another. *The Entertainer* is the star of the album, but *Souvenir, Roberta, The Mexican Connection,* and *Streetlife Serenade* all are strong contenders for top billing. The textures of this record change and flow from song to song,

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and serve to make it complete. A good album—well done and interesting. The production is both sparse and rich. The sound is just great. All in all a most pleasant surprise, or maybe I just understand Billy Joel.

Columbia gave us an SQ version of **Piano Man.** I hope it is not too long before they give us a quad version of **Streetlife Serenade** and/or get around to eliminating pop stereo altogether in favor of quad only.

Sound: A Performance: A

JOANNE GLASSCOCK
A&M SP - 3636

It was sheer gut craziness that made me choose this record out of a stack of maybe 50 or so to listen to while I made a summer salad for a friend on a rainy, late summer night. Joanne Glasscock—Humpf. For some reason I flipped the record over to look at the back. I really did think it absurd, but did it to prove that song titles tell you little or less than nothing about the record inside. I am more assured than ever that this is true, since the song titles told me nothing, except it probably is nothing special. Always being open to any inspiration, I started reading the smallest of the small print. The first and least important (but one of those mus-biz anomalies) thing that struck me was this A&M album was recorded at CBS, San Francisco. Okay. What other surprises? Well the big one was next. In real tiny type I saw: words and music by S. Silverstein. Could that be Shel Silverstein, that marvelous madman who taught me songs like *Beans, Beans Are Just Fine*? The clown that brought us Dustin Hoffman in a movie that was not about Harry Kellerman (whoever he is)?

Then I saw it—Chet Atkins as a sideman. Somebody, somewhere in the small type is a bit of a wit. Then I saw Pat Gleason on ARP synthesizer and thanks to Roy Halle (of Simon & Garfunkel fame), for what I don't know. Well, now this record had to be heard. Poor Joanne, at that moment, was secondary to these other known quantities. Thank heaven for the delay in semi-automatic turntables; I would have killed myself on the third turn. What I heard confirmed another hard felt belief of mine—not all good records need be great and a great record is not always a good one.

This is a good one. Joanne Glasscock should not be ignored, but first images first. Now, Shel Silverstein is not a fantastic musician, just a very clever crazy man, who always sees the ambiguities in life, and he wrote all but one of the songs on the album. He is usually full of backhanded humor. Here, however, is Silverstein of the mid 70s and he is full of up-front human awareness. Enter Joanne Glasscock. She sings the songs in a way that Shel's gritty voice never could. She's lithe, sometimes cold, sometimes warm, sometimes fragile, sometimes strong—just as the songs demand. The production is around her voice and the words, always letting both come through, but being an added virtue rather than a clutter of covering support. Joanne stands alone on a solid foundation. The final product is not all that appealing to me, but it's growing fast. My tastes are mine and many people will be totally smashed by Joanne Glasscock, but her record is sort of like grown-up country/folk gloss. But with body and the vast musical colors of 1974. I am aware that other tastes will differ from mine and it's to those that this is written. It also followed a day full of Beethoven,

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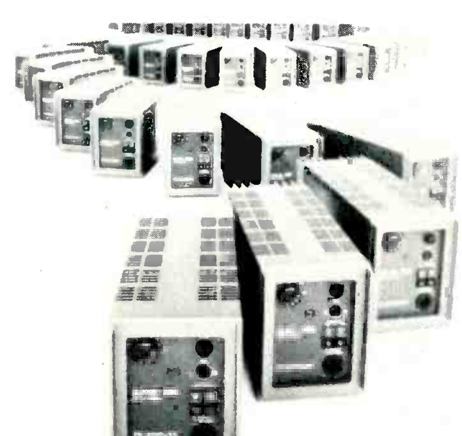

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Nielsen, and Telemann. Now, I can tell you that transition was severe. Had I been listening to Linda Ronstadt, Wendy Waldman, Tracy Nelson, Charlie Rich, Charlie Pride, Janis Ian, or the entire Dot catalogue, my initial and sustained response might have been different.

If you appreciate any of the above or like sensitive, intelligent, aware adult words and wholesome American musicians without a touch of bad taste to contend with, you will like all or most of Joanne Glasscock's record. It's well worth checking out, but bring very open ears and a very open mind with you. There are a lot of messages on this lovely recording.

MICHAEL d'ABO: **BROKEN RAINBOWS**
A&M SP 3634

This reviewing of records thing is getting very troublesome for me since there is only a limited number of linguistic superlatives and music is a far more elastic and expansive media than reportorial/critical journalism. Musicians have more strings on a piano than we writers have superlatives which apply to a piano. They have an infinite capability to put musical tunes together, compared with our limitations such as participles and conjunctions, and they can escape the dictionary with a well placed *La-La* or *Oh-Wha*. Why, they can even transfer a fly speck of a concept like sitting on a wood floor into a thoroughly happy and positively unforgettable song like Michael d'Abo did with his song titled (can you guess?) *Sitting On A Wood Floor*. And *Handbags and Gladrags* (now, would you expect that concept as a song title) is sure to be everywhere on FM radio to everyone's great pleasure.

That song (which was written in 1967 by d'Abo) is why I tend to play this record backwards. Records start at the beginning of side one and end at the run-out groove of either side 2, side 4, or side 6. If the musical minds that make the records have an awareness of the format of a record, and I know they do, I should respect their presentation of it. I usually do, but in this case I like it better side 2 first, but I love it all.

D'Abo can really get into such a fine mix of humor, truth, poetry, sensitivity, gut awareness, and caring about others that somebody should send a copy of Michael d'Abo's record to Dory Previn and Tim Hardin. They would love the music just like the rest of us and it might just perk them up a bit—just like the rest of us. D'Abo just seems to lightly remind us

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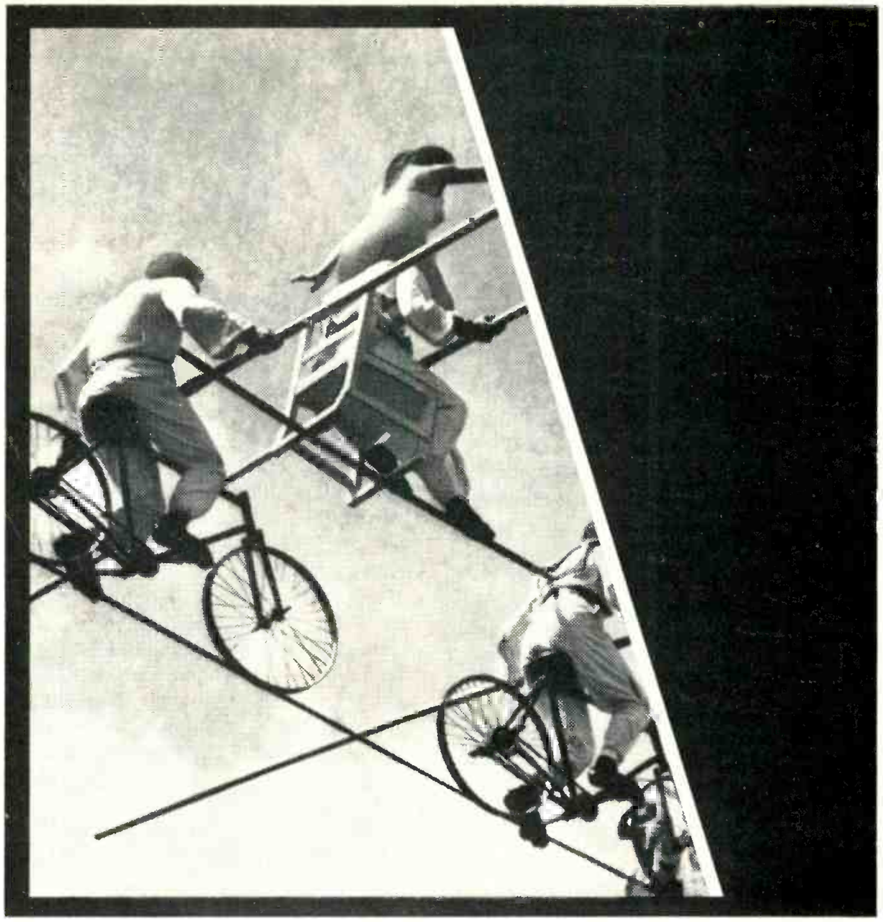
that our world is not just inside ourselves, but a part of those near to us—and their worlds are part of us. Learning is a positive thing in his words, not a wrenching of our inner pains, struggling to be aware and real enough to simply smile.

This Is Me, track two on their side one (my side two—remember) is a gem of a statement that really is a prelude to *Broken Rainbows* that is as apt a song to communicate what I have said about the basic health that he infuses into his words. It's a rare and welcome kind of sensitivity to what we all really are and/or could be, glad to be alive and it's even getting better. **Broken Rainbows** is not to be missed by anyone who likes fresh air and warm feelings.

TIM MOORE
ASYLUM 7E 1019

This record is one of the many bonafied sleepers of 1974, and it is one of the best first albums anyone has made, certainly the best for an unknown singer/songwriter. Tim Moore's songs are so thoughtfully pretty and free of hype, gimmicks and fillers, it almost hurts to write about him. His appeal should (and maybe someday will) be as universal as Carole King, Stevie Wonder, just to name two.

This is a recording by a man with an inordinate quantity of good taste and great capabilities. He is not overly aware of being important as a showman and that is what makes this record such a joy to listen to. The music, the words, and the sound are very much together, very confident and complete. Immense energies went into making this record balanced and unpretentious, yet never is a detail left out. How they managed this subtle, soft presentation is part of the art and magic of its appeal. Tim Moore's words and melodies are so thoughtful, only a butcher could damage them. These ten songs immediately put Tim among the most important writers of our time. His voice is the perfect instrument for his songs: young, yet sensitive; agile, yet never a bluster or strain. When he reaches into the top of his range, he smoothly glistens in articulate clarity. He sings well, writes well, plays well, and puts it all together with a finesse so right that you feel stupid waiting for the filler song or dumb lyric to come along. You'll get grey hair waiting; the accepted level of mediocrity never happens. There are things and subjects that are different and could be considered strange if heard as a singular element, but this is truly an **album.**



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Jazz & Blues

Billy Cobham: **Crosswinds**
Musicians: Billy Cobham, percussion; John Abercrombie, guitars; Michael Brecker, woodwinds; Randy Brecker, trumpet; Garnett Brown, trombone; Lee Pastora, latin percussion; George Duke, keyboards; John Williams, acoustic and electric basses.
Songs: *Spanish Moss—A Sound Portrait,* (a) *Spanish Moss,* (b) *Savannah the Serene,* (c) *Storm,* (d) *Flash Flood; The Pleasant Pheasant; Heather, Crosswinds.*
Atlantic SD 7300, stereo, $5.98.

Savannah the Serene is a very subtle ballad done as a bossa nova. Cobham presents a not-often-displayed but not-to-be-overlooked dimension of his virtuoso abilities. The technique which Cobham has to flaunt gives way to some very graceful, subdued stickwork, as more consideration is laid upon the artistry of dynamics. Add to this the seasoned trombone of Garnett Brown and this relaxing composition is transformed into a masterpiece. *Heather* is similar to *Savannah,* except that Mike Brecker and pianist George Duke are featured soloists.

Storm is a drum solo of a somewhat different hue. Cobham attempts to concoct the sounds and moods of an ocean storm. Through the use of echo and other special effects, an army of tom-toms, and a pair of lightning-fast hands, he does effectively convey the temper of each tidal wave building, thundering by, subsiding and preparing for the next. *Storm* takes advantage of the intricacies that go exclusively with studio productions; and audiophiles ought to pay special attention to the sounds of this high-quality reproduction.

All in all, **Crosswinds** brings with it a gust of new compositions by Cobham that demonstrate much more musical variety than his last effort, **Spectrum.** Cobham has shifted his musical outlook away from a strictly Mahavishnu-oriented center.

He is still leading the pack when it comes to industriously converting raw technique into clever ideas. But, harbored in the grooves of **Crosswinds** are signs of a much mellower composer.

Oh, by the way, don't look under "Dreams" to find this album. This is Cobham's own. *Eric King.*

ANTHENAGIN. Art Blakey and the Jazz Messengers featuring Woody Shaw and Cedar Walton.
Prestige P-10076, stereo, $5.98.
Songs: *I'm Not So Sure; Love: For the One You Can't Have; Fantasy in D; Anthenagin; Without a Song; Along Came Betty.*
Musicians: Art Blakey, drums; Woody Shaw, trumpet; Carter Jefferson, tenor sax; Cedar Walton, piano; Mickey Bass, bass; Tony Waters, conga; Michael Howell, guitar; Steve Turley, trombone.

Jazz is lucky to have **Art Blakey.** He along with his group the **Jazz Messengers** endlessly pursue artistically stellar standards in progressive music, transcending the temptation of heeding fads and get-rich-quick stigmas that so many other groups often succumb to. Blakey has surrounded himself with the top notch established side men and up-and-coming talent in every edition of the group. In this way has he achieved the no-compromise sound he sought. **Anthenagin** is another showcase of what Art Blakey means in terms of modern jazz.

If you heard Blakey's last release, **Buhaina,** you are probably familiar with a very exciting young tenor player named Carter Jefferson. **Buhaina** gave us but a mouth-watering taste of Jefferson's growing ability. Most notable on his finest recorded solo to date *(Gertrude's Bounce)* is his full-bodied tone and rhythmic phrasing reminiscent of the sound Trane was seeking circa the **Giant Steps** period.

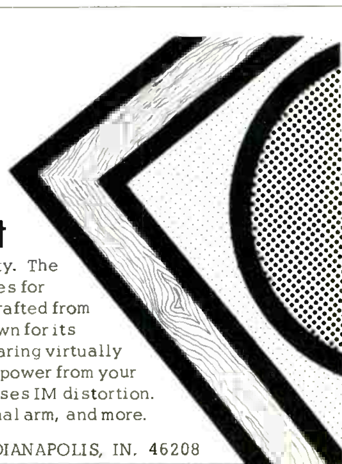
With **Anthenagin,** Jefferson receives much more flying space. Most listeners ought to appreciate that. His performance on *I'm Not So Sure* is the antithesis of what the title suggests. This Walton original features the ensemble backed by Tony Waters' congas and an African feel with Blakey's drums. The tension is reduced as the tune is transformed into a swinging vehicle for Jefferson's virile tenor.

Shaw's *Love* is a roaring bossa with a refreshing melody. The wrath of the tune develops with Shaw's own fiery trumpet bursting into the limelight.

Cedar Walton's *Fantasy in D* is possibly titled so because of the name of the studio in which the recording was made: or probably titled so because that's what key the song is in. Nevertheless, when the music is so good, titles are secondary. The head is a simple blues followed by solos from all except Blakey. The leader opts for perching atop the rhythm section from where he kicks the band in the pants to keep it churning.

Anthenagin, the title tune, follows a tradition established on Blakey's previous release, being an overly long tune with a sometimes monotonous afro-latin rhythmic backing. Although some of the 11 minutes and 56 seconds of this tune features some inspired blowing by Shaw and Jefferson, the thing tends to be too long. Perhaps, a ballad, a jazz waltz and/or a samba might have better rounded out this already good set.

Without a Song is the one track exposing the rhythm section by itself. Walton's rubato opening leads into an



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easy-going rendition of this pleasant standard.

On the back cover of the record jacket is a ditsy explanation of why they elected to include an instrumental version of *Along Came Betty* on this album, since they had included a vocal of it on the last release. Frankly, the explanation is unnecessary and neither producer nor artists need feel guilty about re-releasing this excellent instrumental.

Michael Howell's guitar adds a minty tingle to the group's overall sound on *Betty*. Listeners will agree that his solo boasts well his own musical finesse. Walton is always a pleasure to listen to. His solo here is as effective or more so than the one he took on *Along Came Betty* from **Buhaina.**

Anthenagin is saying: Here's that vital force in jazz that keeps reevaluating and updating its music in striving for higher plateaus. They have to call it **Anthenagin** because they keep telling everybody where it's at (through musical communication) but not everyone is listening. Without making them say, "Well anthenagin Art Blakey . . . " followed by your glib "un-huh" . . . How about Art Blakey this time? OK?

Eric Henry

Benny Goodman and Helen Forrest: The Original Recordings of the 40s Columbia KG 32822, mono, $6.98.

At the age of 65, clarinet great Benny Goodman, who seems to have added fresh, new audiences to his legion of long-time fans, is enjoying another cycle of enormous popularity. The reissues are pouring out at a dizzying pace, and this new Columbia double-set is a welcome addition to the recorded repertory of Goodman memorabilia. Focusing on the work of Helen Forrest, who many consider the best of the big band singers, the recordings offer remarkable testimony to that merger of vocal and instrumental talents which is a hallmark of Swing Era dance music. Within the confines of the one-chorus vocal that was typical of the period, Miss Forrest had a rare ability to project nuance, shading, and meaning, to phrase gracefully and rhythmically so that her work dovetailed perfectly with the swinging beat of the ensemble.

It's a pleasure to listen to Miss Forrest handle tunes like *Cabin In the Sky, Taking a Chance on Love, Bewitched, Shake Down the Stars, The Moon Won't Talk,* and *Mr. Meadowlark* with a complete lack of affectation, pretention, and gimmickry. Her intonation is flawless, and her beat is solid. All the performances are done in easy, relaxed dance tempos

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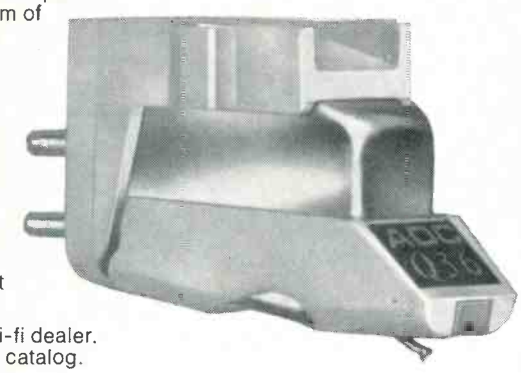

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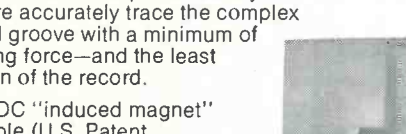

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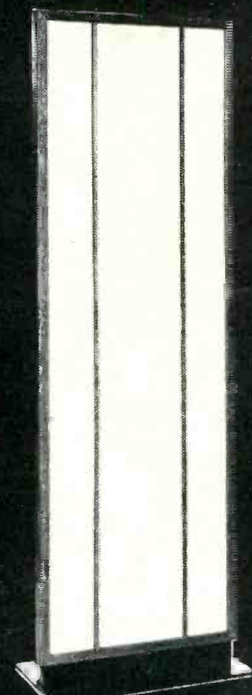

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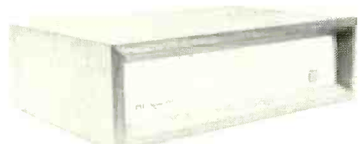

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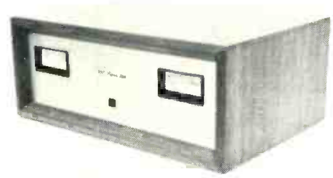

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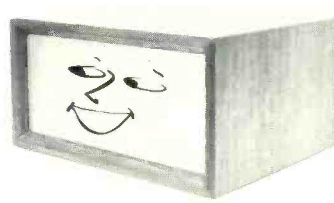

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that emphasize Miss Forrest's uncluttered lines, the tonal elegance of Goodman's clarinet, and the lovely, precise sound of the Goodman reed section. This is lilting, jazz-based dance music, very commercial in its day, yet always on a high, artistic level.

I wish that Columbia's sound transfer job on the collection was as consistent as the performances. A few selections on record one, side one, sound as if they were dubbed from some collector's 78s. (Borrowing from collectors is a common practice engaged in by Columbia and RCA who have often lost or destroyed the original 78 rpm master. However, most of the tracks do get a good transfer job from master to tape, and they retain the clean, full-bodied presence of the original 78s that Columbia recorded in their fine Leiderkrantz Hall studios.

John Lissner

DEXTER GORDON: Ca' Purange
Musicians: Dexter Gordon, tenor saxphone; Thad Jones, trumpet, flugelhorn; Hank Jones, piano; Stan Clarke, bass; Louis Hayes, drums.
Songs: *Ca' Purange; The First Time Ever I Saw Your Face; Airegin; Oh! Karen O.*
Prestige 10051, stereo, $4.98.

Here is another superb album by tenor titan Dexter Gordon. *Ca' Purange* is composed of a wide variety of material. There is a funky tune bearing the same name as the title of the album to open it up. Dexter and Thad have equal times for solos after the head. Hank takes a couple of choruses and brings back the ensemble for some cleanly executed statements. The one thing this cut has going against it is Louis Hayes' overly busy drumming. He sacrifices the tempo for overdone and tasteless fills between ensemble statements. He occasionally plays right through the fill into the following ensemble, drowning out the beginning of the ensemble. Hayes would have done a great service to the rhythm section had he made better use of his bass drum kicks and sock cymbals on this funky rock chart rather than riding the shallow, tinny ride cymbal as he did. These are merely suggestions and the reader shouldn't assume that these minor annoyances at all ruin the cut or the album.

The second tune is a welcome contrast to the first cut. *The First Time Ever I Saw Your Face* is a pretty ballad allowing Dexter to stretch out and demonstrate that he can perform with virtuosity in almost any setting. Thad follows with a solo which can be described only by the way the trumpet section in his big band always put it: "Cut that out, Thad; that's too pretty." Hayes lays down the time with some nice brushwork. Here he plays the all-important part of the listening drummer, and it is evident how much more this does for the group.

Airegin (Nigeria, spelled backwards) is an early Sonny Rollins original. Dex has often used Sonny Rollins' compositions on previous record dates, attesting to Dex's great admiration for one of the masters of the instrument. Dexter is in a very comfortable setting in this up-tempo swinger. This is his groove. His ideas come quickly and are well articulated.

Oh! Karen O is the final track on the album. The title refers to Karen Krog, one of the ladies in Dexter's life. The composition opens with an extended solo by brother Hank Jones. It's a blues with a two-beat feel. Dexter comes in for a solo and builds into a heavy swing. Stan Clarke really "gets down." Thad solos, bringing the swing back down to the two-beat, but brings it right back up, swinging through several choruses. Dexter's best solos on the date can be found right on this track and no less can be said about Thad. I find myself listening to this track again and again.

Ca' Purange heralds Dexter's tone as one of the clearest and fullest in the music. Note here as on his album *A Day in Copenhagen* how his tone has matured and incorporated the best of Coltranes's piercing tone. (For comparison listen to Coltrane on Prestige in the late '50s; especially Trane with Sonny Rollins on *Tenor Madness*.) Dexter has always done the best in straight-ahead jazz and Ca' Purange is no exception. His inventive lyricism, stemming from his roots as a true bopper, yield an unmistakable quality to his performances.

For a group gathered together in the studio only, these tracks are excellent. It is encouraging to hear a small group use dynamics effectively, as this one has. It is much more difficult to play softly (as on *The First Time Ever I Saw Your Face*) with good taste than vice versa. Dexter's groups have never lowered themselves to do commercial junk and this album follows in that tradition. It is unfortunate for jazz buffs that Dexter is an expatriate living in Copenhagen. But, jazz as an art is appreciated overseas. Hence Dex's trips to the States for recording dates and tours are few and far between. This album can, thus, be considered a rare treat. Need I say more? *E.N.*

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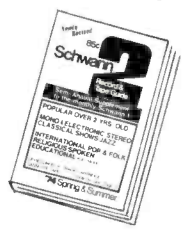

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