Audio®

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THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • MARCH 1980

47425

RCA SHOWS SelectaVision

Interview:
DOUG SAX ON LIMITS OF DISC RECORDING

JUNG: CAPACITOR SELECTION — Part II

NEW—
THE BORGIA COLUMN

changes in temperature. But even the best of them just seem to reduce drift instead of eliminate it.

The Pioneer PL-400, on the other hand, has a Quartz PLL servo system that keeps rotational speed at a constant. And keeps the PL-400 unaffected by temperature changes, voltage fluctuations and other powerline anomalies.

These features work to keep the PL-400 sounding like a much more expensive turntable. But without our specially designed Coaxial Suspension system, they wouldn't be nearly as effective.

This free floating suspension system isolates the platter and tonearm from the rest of the turntable. So even if the base vibrates, the platter and tonearm don't.

This means you can shake, rattle and roll a lot more with a lot less worry that your turntable is doing the same thing.

Even the tonearm of the PL-400 is designed to give you better sound. Its new "Mass Concentrated" design improves crossmodulation distortion and tracking accuracy. So you get more sound clarity and better channel separation.

All these features on a turntable the price of the PL-400 is unheard of. But Pioneer didn't stop there. The PL-400 also has full automatic controls. Including automatic lead-in, viscous damped cueing, automatic return, and automatic repeat. An easy to read one-stripe strobe that confirms platter speed accuracy. A quick start mechanism that starts the platter revolving as soon as the tonearm begins to move. And more.

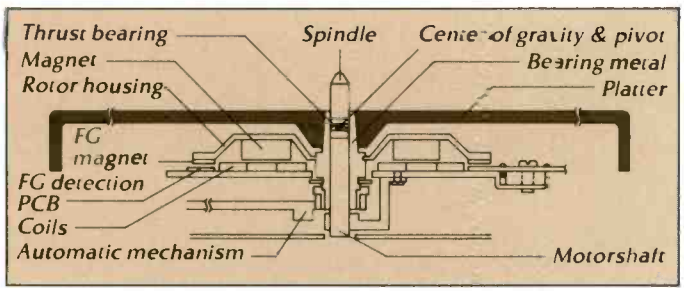
So if you want to buy a $200 turntable and are just interested in great specs, there are any number you can buy. But if you're interested in a $200 turntable that will give you great sound, there's only one.

The Pioneer PL-400.

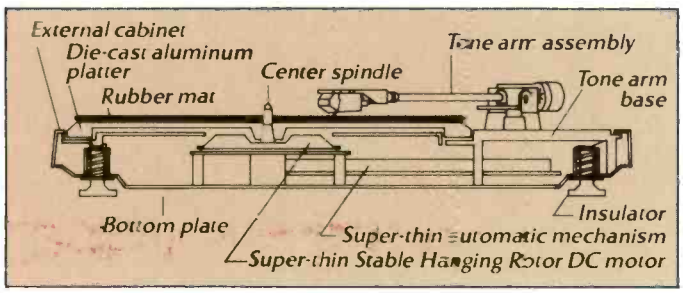
PIONEER®

We bring it back alive.

INTRODUCING THE NEW PIONEER PL-400.

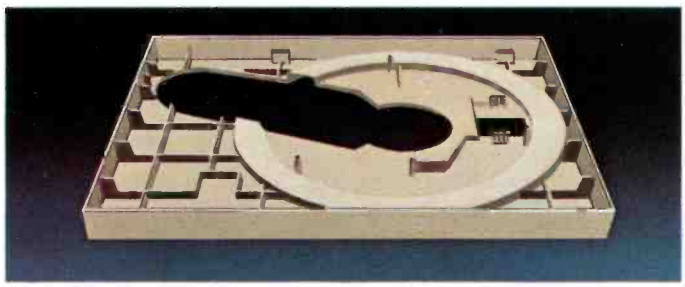


PIONEER'S NEW STABLE HANGING ROTOR.
BY RAISING THE CENTER OF GRAVITY, WE LOWERED THE RATE OF DISTORTION.



PIONEER'S COAXIAL SUSPENSION SYSTEM.
IT VIRTUALLY ELIMINATES VIBRATION AND RUMBLE.

THE PIONEER QUARTZ PHASE LOCK LOOP SYSTEM.
BY AUTOMATIC MONITORING, ROTATIONAL SPEED IS KEPT CONSTANT TO REDUCE WOW AND FLUTTER.



THE PIONEER COMPUTER-DESIGNED HOWL-PROOF ENCASEMENT.
BY SLIMMING DOWN THE SIZE, WE SLIMMED DOWN ACOUSTIC RESONANCE.

PIONEER'S BEST-SOUNDING REASON OF ALL: THE PRICE.
UNDER $200.

Today, most turntables in the same price range look practically the same on paper. But they don't sound at all alike in your home.

Because equal specs don't necessarily mean equal sound. In fact, specs are just a measure of the distortion caused by your turntable itself. They tell nothing about how your machine prevents distortion caused by your environment.

Pioneer's new PL-400 turntable was designed to also keep external interference from coming between you and great sound.

Much of the success of our new PL-400 turntable revolves around our all new "Stable Hanging Rotor." The world's thinnest direct drive motor.

Unlike more massive conventional motors, the motor in the PL-400 is so thin, it allows the center of gravity to be at the pivot point of the rotating mechanism. So instead of the platter wobbling like a top, the platter on the PL-400 acts like a gyroscope to stabilize itself.

Although this technology is very difficult to understand, the result of it is very easily appreciated. You no longer are bothered by distortion caused by stylus mistracking or speed deviations. So you get just what's on your record. Nothing added to it. And nothing taken away.

But this super thin motor does more than eliminate distortion. It also eliminates any space wasting elements used in conventional motors. And because it's so much thinner than any other motor, the cabinet around the PL-400 is also a lot thinner. This 20% reduction in cabinet size means the PL-400 is 20% less likely to suffer from acoustic distortion.

Many turntables in this price range are direct drive. Some of them offer DC motors. Some of them have servo motors aimed at eliminating drift caused by

IF ALL $200 TURNTABLES HAVE THE SAME SPECS, HOW COME THE PL-400 SOUNDS BETTER?

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March 1980 Audio Vol. 64, No. 3

"Success 1917"

About the Cover: Phono cartridges are the vital link between record and sense, as is clearly reflected both in the colored disc on this month's cover and in Doug Sax's comments to our interviewer (see p. 30). Photo: Photographic Illustrations, Philadelphia.

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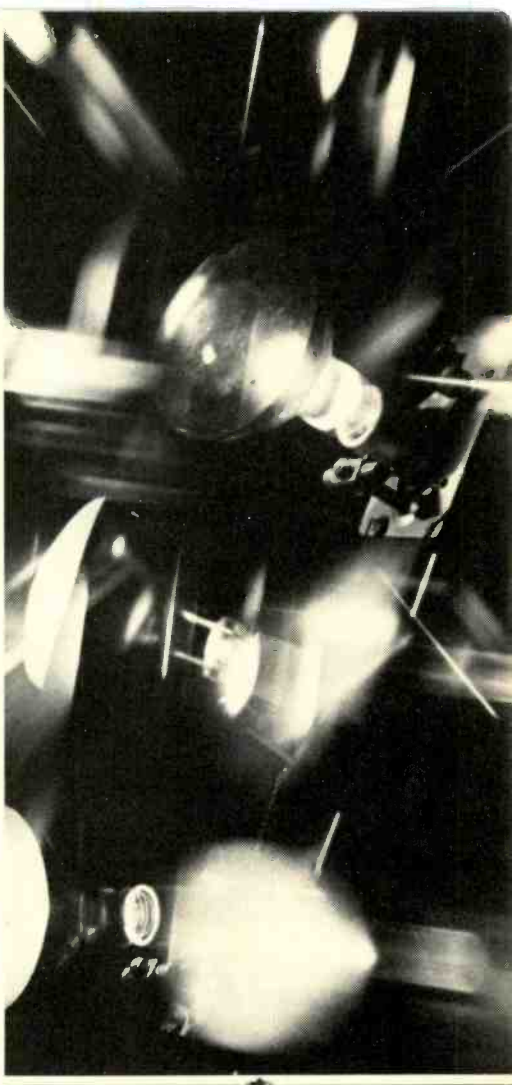

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Three great reasons why a recent survey published by Billboard Magazine reveals that for the third year in a row Stanton has increased its share of the Disco phonograph cartridge market. The Stanton share has grown to an impressive 55.8%...a full 24 percentage points more than its nearest competitor.

The 500AL, known as the workhorse of the broadcast industry, meets the extremely rugged requirements of live application without sacrificing performance quality.

The 680EL is designed to deliver sound excellence and at the same time stand up to back cueing, vibrations and mishandling.

For home Disco, the 680SL is the perfect choice. It features the patented Stereohedron™ stylus tip assuring longer life for record collections.

From Disc cutting to Disco...to home entertainment ...your choice should be the Choice of the Professionals...Stanton cartridges.

STANTON #1 in DISCO

THE CHOICE OF THE PROFESSIONALS™

For further information contact: Stanton Magnetics Inc., Terminal Drive, Plainview, New York 11803

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AUDIO (ISSN0004-752X) is published monthly by CBS Publications, The Consumer Publishing Division of CBS, Inc., 1515 Broadway, New York, N.Y. 10036.
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England: The Paul Singer-Lawrence Media Group, 54 Burton Court, London SW 3 SY4, England. Telephone, 01-730-3592

Dewey Decimal Number 621.381 or 778.5

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

Printed in U.S.A. at Columbus, Ohio. Application to mail at controlled circulation postage rate is pending at Columbus, Ohio and New York, N.Y.

U.S. Subscription Rates: 1 year $11.94, 2 years $19.94, 3 years $25.94.
Other Countries: Add $6.00 per year.
Back issues, when available, $5.00 postpaid.

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

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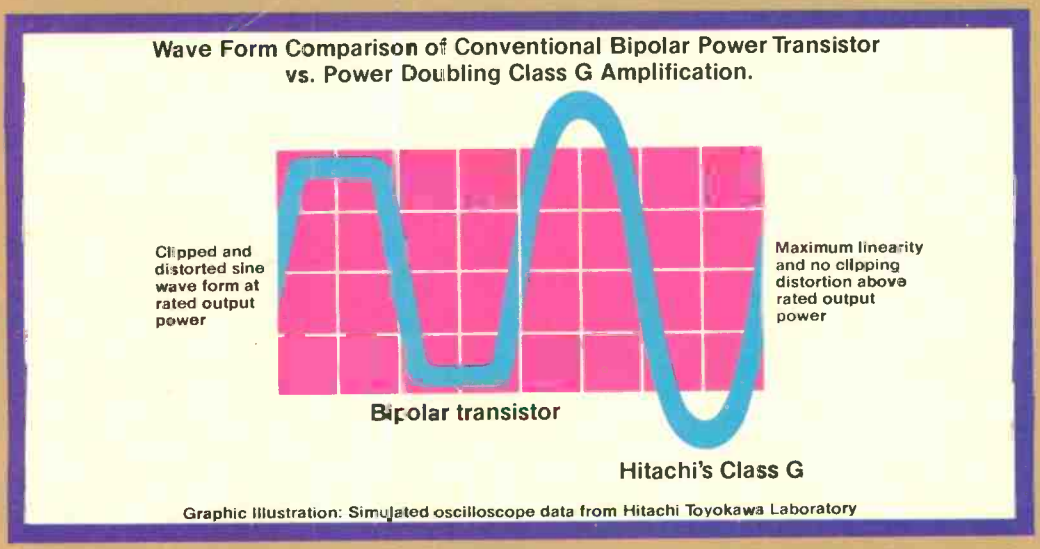

Power Doubling Class G

SR-604

The beauty of the SR-604 stereo receiver:

In normal operation, it delivers 35 watts per channel, both channels driven at 8 ohms, from 20-20,000 Hz, with no more than 0.05% total harmonic distortion. But when it's confronted with a demanding musical peak, it switches over to power doubling Class G amplification, becoming a super power auxiliary amplifier delivering a massive 70 watts per channel.

The result? Clean, unclipped musical peaks and outstanding dynamic range. You'll also like what it does to the tuner section, in critical areas like sensitivity, selectivity and signal-to-noise ratio performance.

The amazing SR-604—super-power, low distortion, all the good things you're looking for in stereo.

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Borgia Column

The KARMA X Speaker
Serial No. X000n
Source: Manufacturer's loan.
Price: Depends on review quotient.

As I sit here on my imported Lotus Flower in a state of enlightenment concocting, or might I say, creating a gently pretentious, verbose but astringent review for the next issue of *Objective Audio*, a veritable spectrum of celestial sounds float into my heightened consciousness.

I am reviewing appropriately, the ultimate, the definitive sound experience of the new KARMA X mirror-image speakers. I know our readers, or should I say the cognoscenti, will be awaiting this issue with bated breath, and this time they will not be disappointed.

Some lesser mortals may be reduced to a state of catatonia by the soul-shaking eruptions of the KARMA X. This reviewer was merely assailed by the cries of a thousand cherubim (pardon Mephistopheles). I must mention at this point, knowing that you all are intimately aware of the dimensions of my listening room, that I recently had the prison-like 2.5 meter ceiling trepanned and now the music can expand upward, unchecked, to the outer galaxies.

The Drivers

are divine!

The absolute piquancy of the tweeters made all other tweeters sound drivelling, untitillating — dank even. They uplift exultantly, stratospherically to 50,000 kHz with the agility of an astral body homeward bound, sans flesh, sans hum, sans everything. I heard these tweeters at their heights with elation. No wonder during a recent sojourn at home in Spain they christened me "Orejitas de Oro" (Little Golden Ears).

The insanely sweet midrange drivers combine the silky smoothness of Quattrocento bellies with the mahogany purr of wine-aged Stradavari.

I might add that these mighty speakers accept up to 2000 watts with nonchalance.

The Bass speakers. Ah, the bass speakers! They growl like the gutsy, golden crucifixion of a crumpet, and when they plummet to their unique 8.5 cycles, they sound like the amplified uuummm of a multitude at prayer, or with the level up, like a private *Gotterdammerung*.

If one is not careful, one is lured away from serious comment by the sheer impact of these KARMAS. In fact one might be tempted to slip into cartoonese and utter such succinct but eloquent phrases as WOW! or even, upon hearing the iron driver in the velvet glove that punches out the sound, an incredibly vulgar POW!

Finally I must say that the linearity, the dimensionality, the specificity, the precocity, to say nothing of the preciosity of these speakers is of such magnitude that the mundane considerations of listening pleasure become totally irrelevant, not to say irreverent.

Drawbacks

It is difficult to describe these speakers in their physical manifestation. It's rather like The Emperor's New Clothes. They say something different to each enthusiast. They speak their appearance in a myriad of tongues. One small sadness cringes on the fringes of my euphoria. The KARMA X speakers, due to the inbuilt characteristics of their mystical ICs, can only be heard by virgins, Virgos, Leos, Libras, bus drivers and Ph.Ds.

I was a little disturbed to find on the back cover of the accompanying incomprehensible booklet of specifications, an illustration of a heavenly body. It was of a vacant-eyed hi-fi groupie in a swelling tee shirt holding a booklet that pictured another distant-eyed lady etched forever on the front of another tee shirt, and so on, all spewing softly backwards into a retrograde infinity. I failed to see the symbolism of all that. Maybe it hints of an alternative path to enlightenment.

Revaluation

I would further like to add that I now reject, in fact abjurate and annihilate, my review last month of the PELLUCID P speakers. In the light of the KARMA X revelation, I now know the PELLUCID Ps to be unspeakable. Please don't doubt my credibility. Who was it said that the sign of true intellect is the revaluation of each new speaker in the light of each new experience? I do humbly believe it was this very reviewer.

Note: I feel that it is most unlikely that we shall receive any comment from the manufacturer of the KARMA X speakers. It is understood that this equipment was made in H-V-N. Designed by you know who.

Nadine Amadio

Technics

If you want a frequency response with more dynamic range and more high-end extension, you'll want nothing less than metal tape. And for about $380 there are many metal tape decks to choose from. But if you want more than just metal, you'll want what most other comparably priced decks don't give you. The 3 heads and double Dolby† in Technics RS-M63.

The RS-M63's 3-head configuration lets you do what most other comparably priced decks don't: Monitor your recordings while you're recording. And, since our separate HPF record and playback heads are precisely gapped and enclosed in a single housing, you won't get azimuth error. What you will get is an extremely wide frequency response with CrO_2 tape and an incredibly high response with metal tape.

Wow and Flutter	Frequency Response	S/N
0.05% WRMS	20Hz-20kHz(metal) 20Hz-18kHz(FeCr/CrO_2) 20Hz-17kHz(normal)	67 dB Dolby in

As good as that sounds, double Dolby will make it sound even better, because there are separate Dolby circuits for recording and playback. So you can monitor your tapes with the full effects of Dolby Noise Reduction. That means a lot when it comes to accurate recordings.

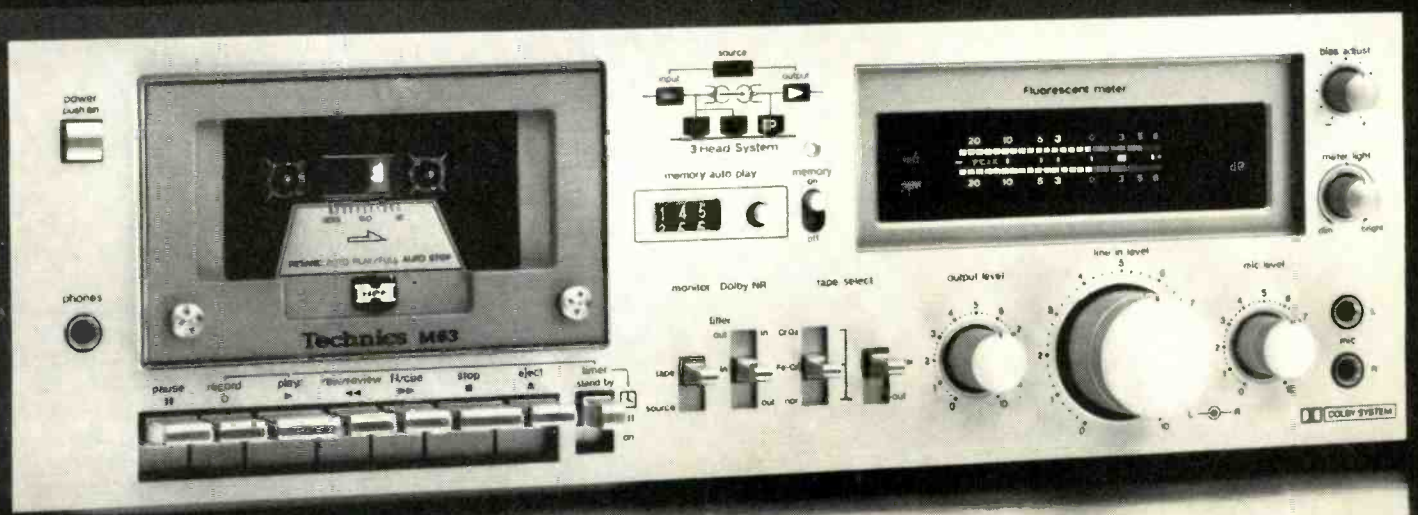
So do the RS-M63's fluorescent (FL) bar graph meters. Especially when it comes to dynamic range. Because with their device attack time of just 5-millionths of a second, they can respond to the most sudden musical transients.

To help you make the most of all this performance, the RS-M63 has a fine bias adjustment, so you can get the most out of all kinds of tape. And you'll spend more time listening to music and less time searching for it, because we include the memory features you need. Like auto-rewind, auto play and rewind auto play.

Technics RS-M63. The only deck to consider when you consider what you get for the price.

* Recommended price for Technics RS-M63, but actual price will be set by dealers.
† Dolby is a trademark of Dolby Laboratories.

Before you spend $380* on a metal tape deck, make sure it has 3 heads and double Dolby.



Enter No. 34 on Reader Service Card

Audio etc.

Edward Tatnall Canby

Recently I went to one of the most magnificent press events I have ever eaten at — pardon me, I should say listened to a Presentation of Information on New Audio Products at. Matter of fact, they got us all seated at the banquet tables after a session of bibulosity and then served nary a crumb until the entire Presentation was all over, at which point I was raving hungry, just watching those silent, white-coated catering people standing over their tables of smoking chafing dishes and heaping piles of ice, waiting . . . just waiting for the talk to end. Me too! Then — such a royal splurge. Unforgettable.

Do you think I'm not talking about audio? This is the happy way (for journalists) in which audio is born, folks, the way it first hits the big time sequence, long before you ever hear of it, maybe before the trade shows, the CES winter and summer, before the AES shows, the local dealer seminars, the hi-fi shows for the general public, and at last the actual sales rooms. It's the American way even if the sponsoring outfit is German or Scandinavian or Japanese or others various. The route to a man's heart goes via his ingesting apparatus and the same with Ms., don't you believe. Not being on any sort of reducing diet yet, I approve decidedly.

This is also, oddly enough, the way to a man's and a woman's thinking apparatus. Not many journalistic scoops have been composed on an empty stomach.

Now let me see, just what were the audio products on display that time? I find my memory momentarily a bit hazy. There were the shrimp, great, whopping shrimp with long tails. And the oysters, enormous, bumpy, opened with a blunt knife before your very eyes. And the smoked salmon and tender roast beef and Bardolino — NOW I remember; it was tape.

Of course! How could I forget. Thanks, tapemaker, for an extraordinary occasion. And great, whopping success to the updated lines of cassettes, also the ongoing reel-to-reel products, of an equivalent sophistication. In all truth, I was more impressed by the extraordinary expansion of this firm's tape business during recent years than by my second helping of oyster. And if I say nothing much about their TV cassettes, in both formats at various levels of excellence, it is because this doesn't wholly fit into audio, which is our business here.

Model of the Minute

Quite seriously, for a roving journalist the press conference can be immensely helpful. Most of us, of course, are busy taking notes on all the technical details being put forth and/or the sales plans in hand, and do this even though we are invariably furnished with a press kit containing the whole thing to take home with us. Plus generous samples when not too heavy to carry. But, food aside, there is much more to ponder. One looks for hints, for clues as to current thinking, in the very style of the Presentation — they are always, of course, very upbeat and full of confidence but, even so, one can find all sorts of meanings that do not come from the printed press release page. More important, I think, is that it takes many press conferences, and especially among rival concerns, to make a true picture of the larger state of things.

No — I do not for an instant mean to imply any "lack" in the usual Presentation we attend. This is a kind of ritual, obeying very strict and sophisticated forms of communication, almost an art form. There are accepted norms, useful and understood by all of us. If they sometimes border on exaggeration, in favor of the product of the moment, they very seldom involve deliberate untruths. Indeed, again and again I have been astonished at the depth and extent of technical detail offered to the untutored journalistic ear — I have had to summon up every bit of brain I had, time after time, to follow the arguments in favor of the brand X of the moment.

The rules are keenly drawn. One can expect to hear praise to the skies of the current development and it is always permissible to imply — no more — that indeed there really is no important competition. One does not often say so in explicit terms. That is, naming names. Or even by merely implying names. True, current advertising practice elsewhere is undergoing a wave of explicitness, particularly among the auto makers; but in audio we are perhaps more conscientious. I do not remember hearing A mention the inferiority of B or C or D or E, or whomever.

We fit the same. But we perform so much better.

When it comes to fitting any audio or video recorder, there's no apparent difference between Fuji and any other brand of cassettes: we all fit the same.

But there, the resemblance ends. Because tapes are manufactured to very different quality standards with different materials and technologies, Fuji's performance is unique.

Take video. Our VHS and Beta cassettes improve performance on any recorder. Providing sharper pictures. More lifelike color. And freedom from noise and distortion.

In audio, our premium FX-I, FX-II and low-noise FL set new standards for accurate sound reproduction. And extended response.

Our revolutionary new Fuji Metal Tape goes even further. With ultra-wide response. Dramatically-improved dynamic range and sound quality comparable to studio open reel recordings.

So, whatever you're recording—on whatever brand of recorder—discover how good your machine really is. With Fuji—the tape that helps it perform so much better.

FUJI TAPE

One brand fits all. Better.

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It just is not done. It should not be done. The function of a press conference, you see, is NOT to make comparisons a la Consumers Union. That is the art form of it and on the very few occasions where I have heard somewhat more direct downgrading of a rival product, even without actual names, I have sensed a definite negative reaction among the listeners. Rightly. You are expected to tout YOUR product, as skillfully as you are able. But you simply do not touch what is not yours.

The really successful press conference is that which persuades the waiting journalists wholeheartedly of the merits of the product on its own, without the slightest suggestion of the cast aspersion, "casting asparagus," as we used to call it, not even by implication. It is wholly a one-way discussion that we want and expect. If these formal structures are rightly followed, as they are remarkably often, then we journalists get what we want and need.

Comparisons, indeed, are very bad press. We are instantly suspicious. Maybe the product itself can be "rigged" to enhance its own value, and to an extent it often is—which is no more than a kind of acceptable drama that is easily seen through by those who are savvy when it is overdone. We take this with amused indulgence—it's OK, if they, the promoters, really feel it's something they must do. But any sort of direct comparison with a non-house product is something else. The whole fragile edifice of communication is destroyed—how can it be fair? Now we are outside the law, the accepted format; anything goes, but everything is suspect. No good! Even if true, it doesn't pay off. In fact, we are likely to smell an untruth when in plain fact there isn't any. Cynics that we are. So it is better to accept the etiquette that the situation demands and thereby retain the confidence of those all-important listeners.

The *ffrr* Was Flying

I remember, for instance, a time in the early years of hi-fi when the record wars were breaking out, the LP coming in and before that the "wide range" 78, notably London's *ffrr* (full frequency range recording) which appeared at first in the 78 format. Things got pretty hectic, along about that time, and some press conferences became, shall I say, rather strident. The ineffable rules began to slip, under stress. Invidious comparisons did get made. It was just then that I was entering our biz, and these were some of my first press "dos." Frankly, I was shocked. I remember one famous occasion when it was audibly proved that a certain domestic label's records were superior in sound to those of London in *ffrr*. I heard it. I didn't believe it. Sorry. This was simply NOT the way I wanted to hear a comparison of a kind which was very serious and important in that day.

I got so cynical, there, for awhile, that I went around making jokes—wasn't it funny that RCA records invariably sounded awful at Columbia demos, and, of course, precisely vice versa? This was largely rhetoric on my part, because it didn't really happen that way every time. But there were enough. It left a bad taste.

Perhaps you can get what I am driving at, which is that the formal (or informal) press conference is not a big lie and a publicity puff, in spite of its totally one-sided approach to reality. *Accentuate the positive!*—what stage character sang that? There is the art of it and the whole of it.

At an artfully managed conference, then, you can really size up the offerings, if you have a mind to and enough technical background and experience to make *your own* comparisons. Hence the real necessity is attending lots of press conferences, and particularly those offering similar products. I was thus especially glad to go to this recent big affair because I have attended a number of excellent presentations, on the positive side and remarkably well informed in a technical way, by other makers of cassettes. In each of these I was artfully persuaded in the best sense. I went away very much impressed with the positive values of what was being done. Now to these I added the present firm (and so did some hundreds of other perceptive journalists).

The "truth," then, is more than ever up to us. It is our business to assess each of these and to figure out for ourselves any unmentioned negatives that just might be around in one case or another. Whether we do this via direct instrument testing or by intelligent general evaluation is really beside the point. The ball is in our court; we have a large quantity of (positive) material in detail, and we must make what we may of it. A good system.

Knowledgeable Neophytes

Of course, one of the beauties of the press conference is that one may always simply quote. With ascription. *"The company says that—"* and down goes the press release, word for word. You don't even have to say "claims"—indeed, that might be unintentionally negative, not meaning to be. You are absolutely safe if you merely quote the printed or Xeroxed or Kodaked word. Thus, if you are an innocent new-

LUX

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Why settle for anything less than superb sound? Check the features and benefits on these super components in this series:

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- A ten-octave graphic equalizer with active filter components for minimum distortion and noise-free operation.

Visit your Lux dealer now for an opportunity to audition today's ultimate in high quality reproduction and purchase the components in the Laboratory Standard Series at considerably less than the ultimate in cost.

G-11 ten-octave graphic equalizer: ±6 or ±12dB booster or cut at each octave no more than 0.005% THD

T-12 FM Tuner: 10.7dBf (1.8μV) usable sensitivity, 14.1dBf (2.8μV) quieting sensitivity (IHF)

L-11 DC Integrated Amplifier: 100 watts per channel, minimum RMS, both channels driven at 8 ohms from 20-20,000Hz with no more than 0.02% THD.

C-12 Preamplifier: no more than 0.005% THD and 0.002% IM distortion, S/N better than 96dB, 10mV input (IHF-A weighted), 300mV phono overload.

M-12 Stereo Power Amplifier: 80 watts per channel, minimum RMS, both channels driven at 8 ohms from 20-20,000Hz with no more than 0.006% THD

(Also available but not shown B-12 Monaural DC Power Amplifier)

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comer to hi-fi wiles, you can be "authoritative" in an unassailable fashion without knowing a d—thing. After all, we have to start somewhere. This, too, we all can tolerate; it is one of the graces of the system.

Back to the question of nutriments, etc. It always amuses me to watch the various producers of press events juggling the physical parameters for best effect—when shall we have drinks, when food, when the actual Presentation (obligatory for the journalist who is not a freeloader). They differ; they try various ways. It's hard to know. And success in this respect is vital, needless to say. I have walked out of a number of press events in my life in sheer disgust—overly loud and much too long. *Our* fault in a sense, the journalists'. But in a more serious way, this is also a miscalculation on the part of the producers. Maybe we writers stood around waiting for so long that the drinks just piled up? At one affair a couple of years ago I arrived at 12 noon and we sat down to luncheon—followed by press material—at two. Frankly, several of us were less than attentive. (I wrote an article for this magazine on the widget, but I'm not telling you which.)

Then there are the dry Presentations. Nice, sober dinners with really excellent and informed material for us, low-key, quietly precise. But not a drop, unless coffee, tea or water. I hate to be worldly but it doesn't really work. Ours is a depraved society, no doubt, but we all have to get along and to the next event. Coffee helps but likker is quikker. I won't argue further — as always, it is the happy mean which works best and is so very hard to achieve.

I can only say that in general the easiest way to digest facts is on a reasonably full tummy, when the drink is wearing away and one is, above all, relaxed and comfortable and in a good but attentive mood! I am aware that, this being a national mag, some of you readers may yourselves be shocked at all this talk. But I am only being objective; these are the facts of our useful life as writers and I can only suggest that if you find a better way to Sell, go right ahead. As I say, most publicity firms ardently seek for the most workable, the optimum effectiveness, in terms of the two essentials, persuasion and factual communication. And this depends on many other tricky factors, you may be sure, including the nature of the product itself and the best way to present its values.

Data Banks

I might say that I really appreciate, as do we all, any reasonable and genuine alteration of the usual arrangements — providing it works. One such happy approach is the continuous press conference, with a Presentation and/or feed at intervals, and high-rank attendants on hand to give individual briefings whenever desired. One team, father and son, does this thing particularly well and with much gentility. Another approach, maybe the opposite, is the enormous and running cocktail party in some flossy top-of-the-world eatery — I remember some lovelies of this sort. And please do not think that such a big event is merely a noisy party. It is much more, and that by intention. These things cost money; they are designed for a cold-turkey purpose. The promoters know it, we journalists know it, and we do, in spite of all our noise on occasion, we do, indeed, play the rules very carefully.

Oh, yeah — forgot one important item. Just as the elite and wealthy used to take the waters at Saratoga each summer mainly to find out what the *other* elite were up to (Edna Ferber, *Saratoga Trunk*), so we in the hi-fi writing trade go to gossip, to retail the "in" info we have ourselves and to absorb the tidbits that others can offer. It's fair game! A good journalist picks up much factual background in this way — after all, we can't all know everything — and the better one is at his trade, the more easily can he integrate this new material (sometimes, to be sure, on the negative side!) with the large useful background of his general understanding. AND with the material of the press conference itself.

Ah yes. The question period. And the individual questions put to attending officials. Doesn't get us very far. You can go as far as you want in extra detail, within the set scope of the Presentation itself — did I say, for you outsiders, that the official talk and/or demonstration is always called the Presentation? — but if you pull any journalistic tricks on those guys, like the loaded questions they fire at the U.S. President, for instance, you will get nowhere at all. That, you see, is NOT what a hi-fi press conference is for. It is indeed an art form! The thing is set up with the utmost precision and delicacy and nothing, but *nothing*, is added on the spur of the moment. Unless by ghastly mistake. (And the guy can be fired quick-like for his indiscretion.)

So please remember that the shrimp and the oysters and the tender roast beef are important and dead-serious elements of our basic information system in this, our hi-fi world, part of the orchestration of the presentation of the production. Very, very useful and again, thanks.

If you don't have at least $1,000 to spend on an Audiovox Hi-Comp autosound system, read no further.

By Robert Harris, Technical Director

There are few things in this world that can take a driver out of the traffic jam or away from a gas line, better than great music, well reproduced.

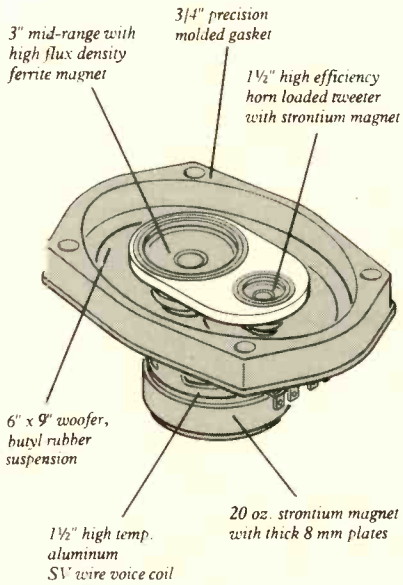
Audiovox understands this. That's why they engineered the Hi-Comp range of high fidelity stereo components designed to produce exemplary sound in automobiles.

A total range of exotic amplifiers/receivers.

Each model builds on the one before it until you reach the HCM-0010 – the "master system."

HCE-750 HiComp Semi-parametric graphic equalizer

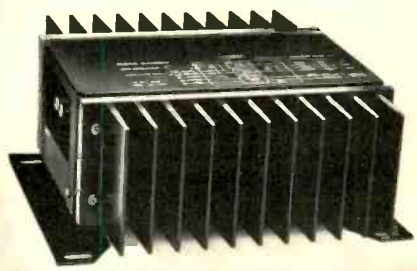
It's an electronically-tuned AM/FM multiplex receiver with a built-in auto-reverse cassette deck. The HCM-0010 has 12-station memory, LED display, built-in quartz clock and an automatic station seek. It also features a CrO_2 switch, Dolby®, FM muting, 4-way stereo balance controls, separate bass and treble controls and a Hard Permalloy tape head. Its looks are straight out of a stereo buff's music room.



HCS-362 HiComp 6" x 9" 3-way speaker system.

4 power-matched speaker systems.

The ultimate is the Hi-Comp 362 system: 6" x 9" three way speakers with 1½" Strontium horn tweeters, 3" mid-ranges, 20-ounce Strontium magnet woofers, 1½" heat proof aluminum voice coils, and a 70 to 18,000 Hz response range with crossovers at 2,900 and 9,000 Hz, and a power capacity of 70 watts. Hook these up to the HCM-0010 with the Hi-Comp power amplifier, *HCB-830, 120 watts RMS at less than 0.3% distortion*, and you've got enough sound to pop a moon roof.



HCB-830 HiComp 120 watt 4-channel power amplifier

Now for the equalizer.

Apart from a heavy-duty fader control or a dual slide-bar pre-amp, the only other Audiovox Hi-Comp component you might buy is the HCE-750 semi-parametric graphic equalizer with 5 slide-bar response controls and bi-amp capability.

You spend $1,000 and what do you get?

Probably the finest sound you've heard, *anywhere*. It takes money to get it. But it also takes a lot of specialized dedication. Audiovox only knows how to do just one thing: How to engineer the finest automobile sound systems you've ever heard.

For further information, write to: Robert Harris, Technical Director, Dept. AU , Audiovox, 150 Marcus Blvd. Hauppauge, New York 11787.

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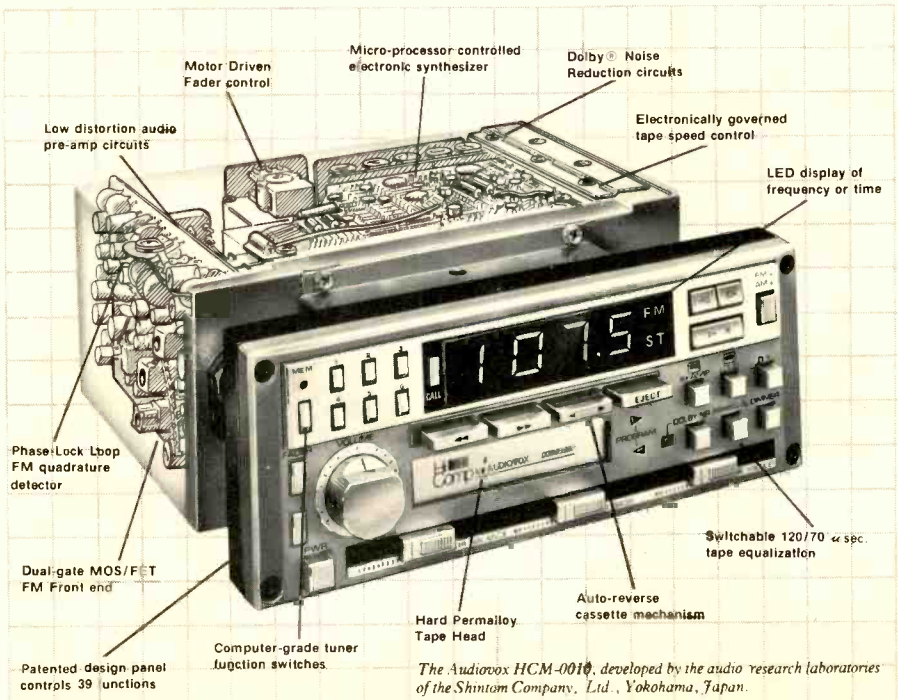


The Audiovox HCM-0010, developed by the audio research laboratories of the Shintom Company, Ltd., Yokohama, Japan.

Enter No. 2 on Reader Service Card

Tape guide

Herman Burstein

Pink Noise Revisited

Editor's Note: In the October, 1979 issue's "Tape Guide" column, there appeared an inaccurate answer to two questions on pink noise. The answer which appeared was not from the column's author, Herman Burstein, and this month's more accurate and complete answer is from Contributing Editor Howard Roberson, who first noticed the problem.

Q. What is pink noise? How is ⅓-octave pink noise used in testing equipment?

A. Let's first say that white noise, sometimes called flat noise, is characterized by having constant energy per Hz-bandwidth. In other words, white noise has the same energy in a one-Hz band at 100 Hz as it has in a one-Hz band at 1,000 Hz. Pink noise cannot be called "flat" noise: The energy in a one-Hz bandwidth falls off at the rate of 3 dB every time the frequency is doubled (up one octave). White noise has very much of an s-s-s sound, but pink noise — with the high-frequency energy reduced compared to the low — is much more sh-sh-sh in nature. Pink noise is usually generated by filtering the output of a white-noise generator. The output from the filter is broadband, however, usually covering 20 Hz to 20 kHz or more.

For most tests, the pink noise is not restricted to a ⅓-octave bandwidth. (Reverberation decay measurements are an exception.) For audio evaluation, the pink noise has two major advantages over white noise. First of all, its decreasing energy with higher frequencies is much more like music and better for testing some equipment such as loudspeaker systems, where the extra high-frequency energy in white noise could burn out tweeters.

The second advantage of pink noise is that it can be used with what are known as constant-percentage-bandwidth filters. The most popular of these are the octave and ⅓-octave filters and analyzers of various types. So, the pink noise is actually broadband: It's the analyzer filters which split it up into a series of ⅓-octave bands. If the equipment frequency response is flat, the output in each ⅓-octave band will be the same, and a scope display of all filter outputs would be a straight line. The basis for the results is this: The actual Hz bandwidth of the filters is increasing at the same rate as the noise power in each Hz bandwidth is decreasing. For example, the filter at 500 Hz will have twice the bandwidth as the filter at 250 Hz, but the pink noise power at 500 Hz will be half as much *per Hz*, and the result is the same noise power in the two bands.

Dubbing Dolbyized Cassettes

Q. I am planning to dub some of my friend's Dolbyized cassettes onto open-reel tapes. Will the recordings that I make from his cassettes be recorded in Dolbyized form or will they be just plain recordings? — Scott MacGregor, Atlanta, Ga.

A. If your friend's Dolbyized recordings are played back on his cassette deck with the Dolby switch "on," the playback signal will be flat (not Dolbyized). Therefore, your dubbings will also be flat.

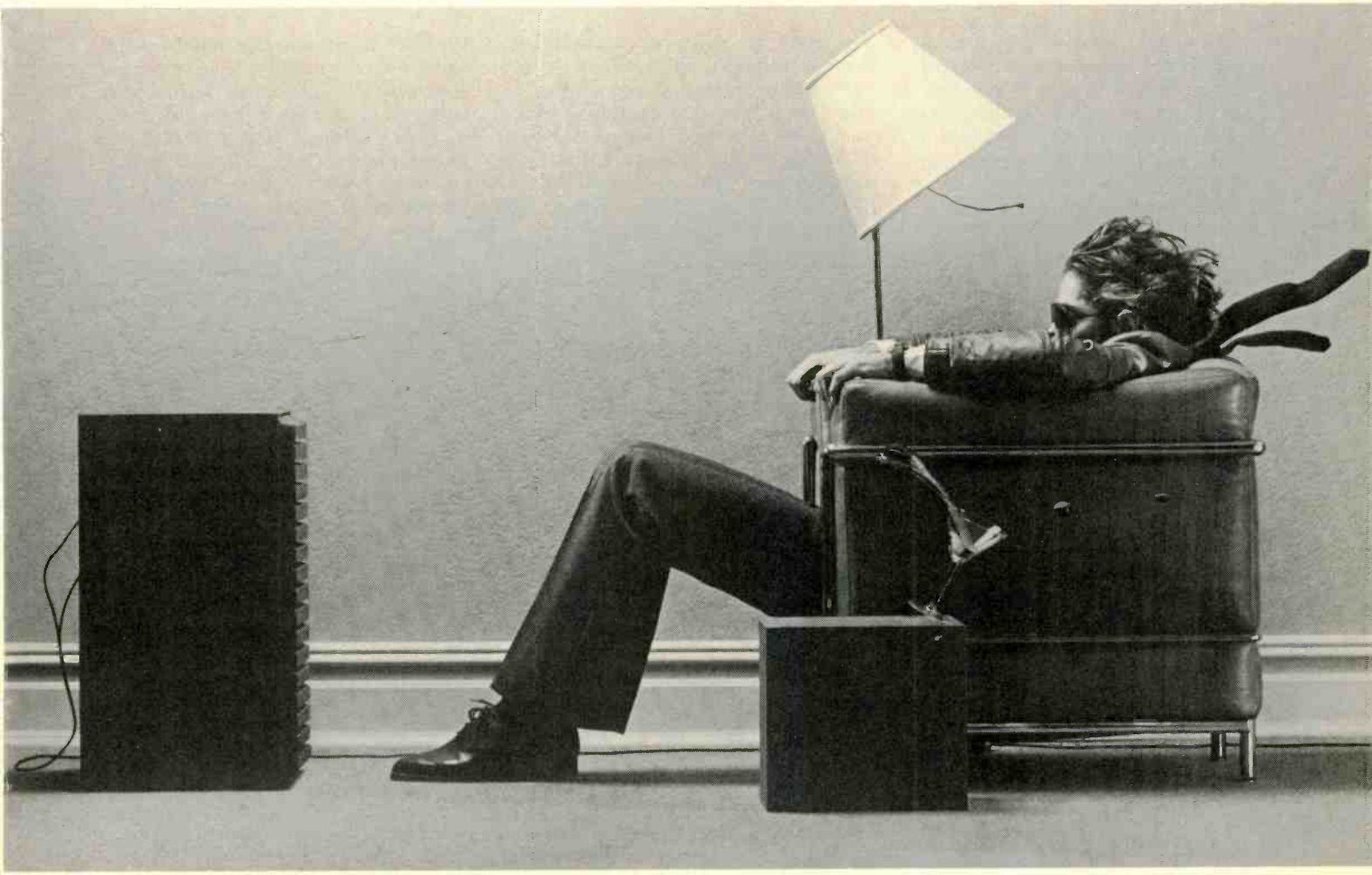
Variable Speed Ahead

Q. I would like to be able to adjust the speed of my tape recorder. I have done some experimenting with masking tape on the capstan, but this is a lot of trouble and requires quite a bit of trial and error to find the right variation in speed. How would you suggest that I go about achieving the control I desire? — Terry Black, Springfield, Ill.

A. Your objective is a difficult one for the user to achieve, although it seems not a difficult one for the manufacturer; after all, many turntables have adjustable speed, and so do a few tape decks. The most feasible course for you would appear to be to acquire a power supply with variable frequency and use this to power the motor. I doubt that such power supplies are available at your audio dealers, although you might inquire. Variable-frequency power supplies have been described in the popular electronic literature, and you can research this at your library.

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 1515 Broadway, New York, N.Y. 10036. All letters are answered. Please enclose a stamped, self-addressed envelope.

AFTER 500 PLAYS OUR HIGH FIDELITY TAPE STILL DELIVERS HIGH FIDELITY.



If your old favorites don't sound as good as they used to, the problem could be your recording tape.

Some tapes show their age more than others. And when a tape ages prematurely, the music on it does too.

What can happen is, the oxide particles that are bound onto tape loosen and fall off, taking some of your music with them.

At Maxell, we've developed a binding process that helps to prevent this. When oxide particles are bound onto our tape, they stay put. And so does your music.

So even after a Maxell recording is 500 plays old, you'll swear it's not a play over five.

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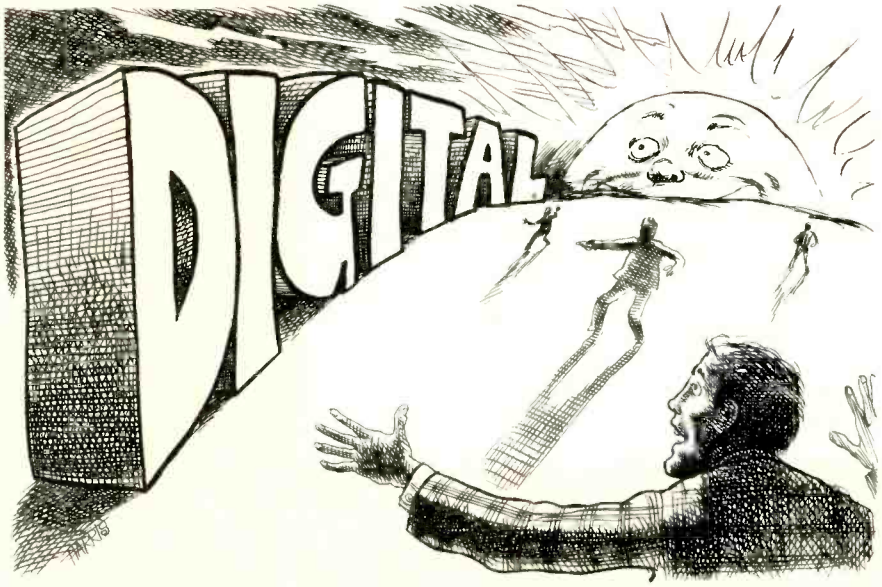
Behind the scenes

Bert Whyte

Last month I reported on what was new in digital recording technology at the 64th AES Convention in New York. While digital recording standards are still a most controversial and as yet unresolved problem, it was quite apparent at the Convention that this has not deterred a number of manufacturers, and I think it is now safe to say that digital recording hardware is generally available. Engineers who are aware of this, and who have embraced the digital doctrines, are now becoming concerned about the effects of the analog equipment in the rest of the recording chain. There is no question that having to leave the digital domain, enter the analog mode for a specific function, and then returning to digital causes a definite degradation of the original signal. Ideally, of course, the entire recording chain should be digital — from microphone preamplifier to monitor output. As reported last month, Sony has taken the first few small steps toward this goal with their digital "mini" mixer and digital reverberation unit. Strong rumors were circulating at the Convention that a major console manufacturer would offer a completely digital multi-input/output mixing console by the spring of 1981. If one's recording activities are of the "purist" minimum microphone variety, the Sony unit might be suitable at present, and it would be reasonable to expect small digital input consoles, either commercial or custom-built units, to appear in the near future. Since my personal recording philosophy is of the "purist persuasion," I am going to follow these developments very diligently.

As anyone who has attended the last half-dozen or so Conventions of the Audio Engineering Society can attest, while the exhibits emphasize the nuts and bolts equipment of professional recording, there are ever-growing displays and demonstrations of equipment that would be of interest to the high-end audiophile market as well. This cross-utilization of audio equipment can have a very salutory effect on both markets, and I hope this trend continues. Herewith, some interesting items from both camps that caught my eye (and ear) at the 64th Convention. . .

New microphones, especially from the redoubtable Georg Neumann Company, are always of interest. They have introduced the U89i condenser microphone, featuring a newly developed dual-membrane capsule which is said to be impervious to close-up high humidity effects (as from a vocalist's breath). The new unit resembles the familiar U87 but is actually about 20 percent smaller. It has a rotary switch which permits selection of omni, cardioid, figure of eight, hypercardioid, and wide-angle cardioid. A new amplifier allows up to 140 dB SPL, equivalent to the SPL right in front of a trumpet bell!



Sooner or Later

After five years of development, the new Cybersonics DM2002 disc-cutting lathe has reached the marketing stage, complete with prices. This compact (35½ in. W x 27½ in. D x 16 in. H) 250-pound lathe is in startling contrast to the massive Scully and Neumann lathes. The Cybersonic lathe features direct servo motor drive to the turntable, cutting lead screw, microscope lead screw, and head mount. The turntable motor is of the phase lock servo, quartz reference type. Their "Compu-Drive" automated cutting system is a composite analog and digital system. All signals are formatted in eight-bit words. The Cybersonic lathe can be fitted with most cutter heads, but it features the Ortofon DSS731 and DSS732 systems. An interesting note is that Ortofon will act as the distributor for the Cybersonic lathes in Europe. With its small size and light weight and the fact that multiple units can be electronically linked, the Cybersonic lathe would appear to be well suited for remote direct-to-disc recording. The cost of the DM2002 lathe with microscope and vacuum system is $47,700.00. Add another $40,000 or so for the Ortofon cutter head and amplifiers and you are ready for business. Cybersonics even has a fitted transport case for their lathe, so the enterprising direct-disc specialist can advertise, "Have lathe . . . will travel."

The Eumig company, an old-line Austrian firm with a solid reputation in the movie and slide-projection business, entered the cassette deck market about a year ago, and at the Convention they showed their latest offering, the very sophisticated FL-1000 cassette deck. This unit has all the usual "goodies" found on high-quality decks, plus some highly unusual facilities. In the Eumig demonstration room there was the somewhat startling sight of 10 of these decks all linked together through a computer, performing the function of an automated broadcasting station (with all associated transmitters, of course). The FL-1000 deck has a computer interface system that can be directly linked to almost any eight-bit computer system such as the Commodore Pet, Apple Two, and Radio Shack TRS-80. With a multi-machine control program, up to 15 FL-1000 decks can be individually controlled simultaneously or sequentially,

Breakthrough

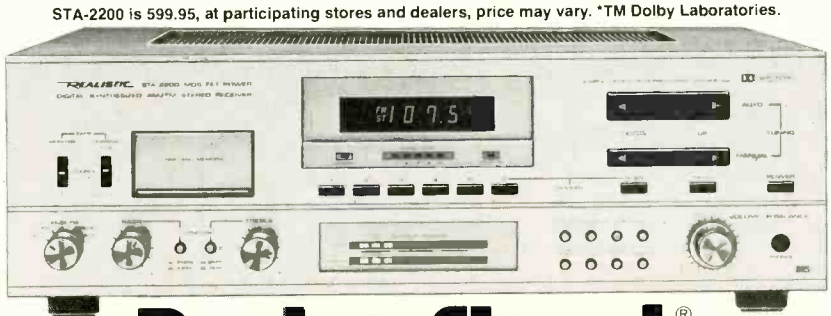
is a word that Realistic® uses very very very rarely. But nothing else describes our new STA-2200 all-digital receiver.

Could Radio Shack have scooped its peers (like Pioneer, Technics and Kenwood) in technology as well as features? Before you buy a conventional receiver that may be old-fashioned before 1980 is over, you can see what's really new at any of our stores. And decide for yourself!

The Computerized Tuner. Quartz-locked, microprocessor-controlled digital synthesis circuitry ends mechanical tuning errors and problems. No dial, no knob, no tuning meters. Instead, bright fluorescent digits display each station's frequency with absolute accuracy. Computer-type "feather-touch" tuning automatically scans up or down the FM and AM bands. Or you can select manual tuning. Store any six FM and any six AM stations in the microprocessor memory for instant recall. Even command the receiver to sample the stations in the memory, then touch-select the program of your choice. There's also battery back-up memory protection, Dolby* FM noise reduction, LED signal level indicators, and dual-sensitivity muting. And the display "off" is a quartz clock.

The High-Technology Amplifier. The Realistic STA-2200 uses a new generation of power transistors called MOSFETs. Their ultrahigh-speed operation brings you stunningly accurate sound reproduction through superior linearity, superior slew rate and inaudible TIM. They are more reliable than ordinary transistors and generate less heat. The amplifier features go on and on. 11-step bass and treble controls with turnovers for controlling ranges below 150 Hz and above 6 kHz. Tone control defeat. Hi-MPX filter. Monitoring and dubbing controls. And more. Power is 60 watts per channel into 8 ohms, 20-20,000 Hz, with no more than 0.02% THD. And one more thing: it's made by the same company that makes the breakthrough TRS-80™ microcomputer.

STA-2200 is 599.95, at participating stores and dealers, price may vary. *TM Dolby Laboratories.



Radio Shack®

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for any mode and any section of any tape! The computer interface of this unit employs an eight-bit parallel bus. The CPU integrated circuit in each deck is a Mostek MK3870. Each deck has an index program that, when tied in with the aforementioned computers and a CRT, permits up to 15 selections per cassette side to be programmed and played in any sequence under computer control. There are many other programs that can be developed for this deck, and it certainly is a fascinating taste of the future.

Speaking of computers, friend Clay Barclay was showing the latest additions to, and the ever-increasing versatility of, his unique Badap audio microcomputer. In addition to the RTA (real-time third-octave analysis) and RT/60 (reverberation time) functions I have mentioned in previous columns, Clay now has as accessories an Input Multiplexer which provides 32 channels of level display, simultaneous peak and average, and most fascinating of all, a Stereo Analyzer. This unit provides two simultaneous third-octave displays, with peak and average readings for both. The color of each display on the CRT is different. The unit may be set to show Left and Right, L+ R (lateral), and L-R (vertical). It has a Peak Accumulate feature which, in evaluating master tapes before cutting or during the recording of the master, shows in-phase information in one color and out-of-phase information in a contrasting color. Valuable information, to say the least! Also newly available is an inexpensive printer which will furnish an immediate hard copy read-out of the octave band data being displayed on the CRT screen.

Arms and the Mass

Technics has decided to set up a Recording and Broadcast Division, headed by that versatile old pro, Jim Parks. The division will eventually cover the full gamut of equipment used in these industries. One of the first fruits of this new set-up is the introduction of two very high-quality phono playback arms. One, the EPA-100, has been available in this country only as part of the SL-1000 turntable system (the SP-10 MK2 turntable, with black lava rock base, and the arm). I have been using this for some time, and it is really a superlative system. The EPA-100 arm is an S-shaped design with an arm pipe made of exotic titanium nitride. The gimbal suspension uses some 20 ruby ball bearings. Unique is a viscous/magnetic variable dynamic damping system which, when adjusted for the specific dynamic compliance of a given phono cartridge, reduces low-frequency arm resonances quite effectively, something on the order of 6 dB. The newest arm from Technics' R&B Division is the EPA-500. This arm has a base with a smooth helicoid mechanism for adjusting the height (and hence the VTA) on a dynamic basis. The arms are straight pipes of titanium nitride. Yes, the plural appellation is correct: The EPA-500 has five interchangeable arms which are meant to match with phono cartridges of a specific mass and dynamic compliance. Specifically, the arms are of the appropriate mass for very high compliance, high compliance, medium compliance, low compliance, and low compliance/high mass cartridges (as in some moving-coil designs). They fit into the gimbal suspension via a locking system, and electrical connections are gold "fingers." Each arm has its individual dynamic damping system, somewhat like that used on the EPA-100 and affording about the same reduction in low-frequency resonances. One of the benefits of this system of separate arms is that headshells are an integral part (non-interchangeable in the usual fashion) and thus headshell connector resonances are avoided. A good start for this new Technics division, and there are some very interesting new items waiting in the wings.

Well, it's on to the CES at Las Vegas, and from all reports it will be a very big show indeed!

The Eumig FL-1000: The world's only computer-compatible cassette deck; your best interface with the world of music.

Capturing the full richness of music on a cassette requires an extraordinary cassette deck. It takes extraordinarily wide frequency response. Incredibly smooth tape motion. And an undistorted dynamic range at least as great as that of your musical source. It takes the Eumig FL-1000.

You need the ability to use the latest metal-particle tapes, of course. And separate record and playback head elements that permit each to be designed specifically for its function and that let you monitor the actual recording as it is being made. You need the kind of innovative engineering that produced the exclusive Eumig Opto-Electronic capstan drive, which automatically corrects motor speed 15,000 times every second. And the fast, easy-to-use Computest® system to optimize record bias and Dolby* calibration for individual brands within each tape type. And you need extraordinary technical performance: a full-range 20-20,000Hz (±3dB) frequency response; a 0.035% (WRMS) wow/flutter rating; and a 70dB signal-to-noise ratio.

Thanks to its built-in microprocessor you can "punch in" the number of any location on the tape, at any time, and the FL-1000 will immediately advance or rewind to that exact spot, indicated on a 4-digit electronic readout so precise it can be used for automated broadcast stations. (Yes, the Eumig FL-1000 is a genuinely professional deck.)

A peak-reading fluorescent display shows the exact, instantaneous signal level being fed to the tape, and is equipped with switchable peak-hold, 6-dB attenuator, and 2-position dimmer functions. Mic/line and line/line mixing facilities, with master attenuator and cross-fader provisions are included, as are switchable reverb, mic. sensitivity, limiter, MPX filter, and timer-activation controls.

Above and beyond all these attractive features, however, the Eumig FL-1000 is the world's first — and only — cassette deck capable of directly interfacing with any of the popular 8-bit home microcomputers. Thanks to its digital read-write capabilities, the FL-1000 can index all the selections on a cassette for instant readout on your monitor screen and for automatic selection sequence. With another program you can sort all the recordings in your collection by artist, by title, or however you choose, to instantly identify the cassette you want and direct the FL-1000 to play any selection on it. And with such a computer you can completely program — as the professionals are already doing — the operations of up to 16 FL-1000's! The possibilities are endless.

See your Eumig dealer today for an introduction to the FL-1000. It will be the beginning of a very beautiful musical relationship.

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Audioclinic

Joseph Giovanelli

Edge-Wound Voice-Coils

Q. Several loudspeaker manufacturers make a point of stating that their speakers employ edge-wound ribbon voice-coils. What is the advantage of ribbon voice-coils over the ordinary round-wire voice-coil?—Name withheld.

A. One advantage of the edge-wound voice-coil is that it is light and thus does not add mass to the speaker system. Also, such a coil can radiate heat more efficiently.

Receiving Distant FM Signals

Q. Is there a device for FM/FM stereo which is analogous to devices for AM that make it possible for AM radios to receive signals up to 1,000 miles away? — Merritt E. Tilley, III, Syracuse, N.Y.

A. There is no such device for FM, and the reason is found in the differences between FM and AM propagation. AM signals, because of their relatively low transmitting frequencies (not because they are AM), can reflect back to earth and be heard at great distances. The ionosphere acts almost like a mirror. Note, however, that this action does not occur in daylight hours when the signals are absorbed rather than reflected back to earth. Such signals can be reflected to a given location at surprising strengths. This makes it possible for even relatively poorly designed AM radio sets to "hear" these signals, provided they are not located on channels adjacent to or shared by strong local stations.

The mechanism by which FM signals can *at times* be transmitted over greater than normal distances is different. Signals can be reflected from meteor showers, for instance, or from atmospheric dust. The latter is known as "tropospheric scatter" or "forward scatter." Meteor showers are not reliable; signals tend to fade in and out so rapidly that the program is really not usable. Tropospheric scatter can be quite effective, but to take full advantage of it calls for a really directional antenna, and a means of getting the exact antenna elevation as well as azimuth.

The most common reflections are those associated with the approach of a weather front. It often happens that warm air is trapped below a layer of colder air, making it impossible for the warm air to rise as it normally would. This creates a region in which there is a change of "optical density." Under these conditions, reflections must occur to the degree that this change of optical density occurs. Because Syracuse, where you live, is located on relatively flat terrain, you should, during spring and fall, *sometimes* hear signals from as far away as Michigan, Canada, etc. These signals will in some cases be so strong that you will wonder why you do not hear them all the time.

In general, FM signals are not reflected back to earth and if the receiving antenna is not in the line of sight of the transmitter, the signal will not be heard. These signals do not tend to follow the curvature of the earth; they travel out into space.

The most reliable method to use if you wish to hear a somewhat distant FM station is to raise your antenna. This means that your line of sight is now greater than it was with the antenna in its original position. Hence, you are now capable of receiving more distant signals.

It is also a good idea to have an antenna with directivity. One of the properties of such antennas is that they have gain (like an amplifier) over the conventional dipole antenna. Because the antenna favors one direction rather than "hearing" signals in a full circle, it tends to exclude signals which arrive at the antenna from other directions than that of the desired signals.

Given a good outdoor antenna which has good directivity, you should hear signals from as far as 150 miles away at any time, provided there are no major obstructions between you and the desired stations. You need to use a relatively "selective" tuner or receiver so that local signals will not wipe out "alternate channel," weaker signals.

Of course, any good antenna will strengthen local signals as well as the weaker, desired ones. Making the antenna directional, however, will tend to attenuate local signals unless their transmitters are located in the same direction as that of the desired, distant signal.

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

Very separate. Very together.

They're the Jensen Separates. An individual system of special high performance woofers, tweeters, and midrange drivers. And by separating them in your car, you'll come up with a very together sound.

Why separate them?

Because a car interior is acoustically very different from your living room. And in many cases a lot of the music may not even get to your ears.

Separating the drivers also opens up the chance to use bi-amplification. Which means better sound with better power level matching.

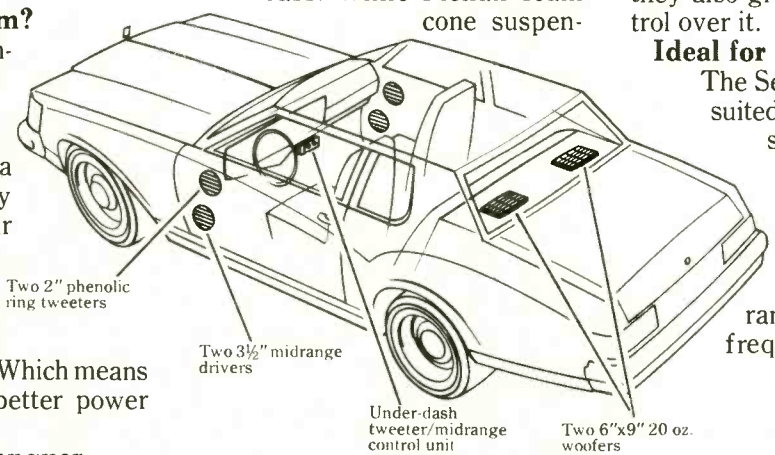
Divide and conquer.

We developed the Jensen Separates to deliver every last high, low and midrange signal your music contains. And to overcome any possible acoustic problem you may encounter.

Two individual 2″ phenolic ring tweeter units are designed to be mounted high in the front doors. That way, every bit of their 4,000-20,000 Hz high frequency signals travel straight to your ears. With no stops in between.

Two 3½″ midrange drivers also mount in the upper front doors. And what a difference they make.

In this position their subtle 1,000-4,000 Hz middle tones fill in the gaps between treble and bass. While Flexair foam cone suspension provides the extreme sensitivity needed for smoother sounding music.



For full, well-defined bass, a pair of 6″x9″ woofers mount in your car's rear deck. There they can take advantage of the trunk's air space to create their magic.

New 20 oz. magnet structures give these woofers extra power handling capabilities and high efficiency. While the Flexair foam suspension affords low distortion from 35 to 1,000 Hz.

The control unit.

It contains two independent midrange and tweeter level controls for each channel.

So not only do the Jensen Separates deliver all of your music, they also give you the final control over it.

Ideal for bi-amplification.

The Separates are perfectly suited for a bi-amplified car stereo system. The woofers would then receive only the bass signals from one amp. While the tweeters and midranges receive the high frequency signals from another amp.

It gives the system much better power distribution for higher power levels, clearer music and less distortion.

Their time has come.

Experience the Jensen Separates. And discover how very together music in your car can be.

JENSEN
SOUND LABORATORIES
AN ESMARK COMPANY

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Dear editor

Tape Clubbing

Dear Editor:

For many years I have enjoyed your very fine *Audio* magazine and am sure that a number of your readers would like to know that there is such a thing as a tape club still around, and has been ever since 1955.

We are not as big in size of membership as we have been in years past, but we have grown recently. Currently we have a membership of approximately 600 people, both blind and sighted.

Membership dues are $5.00 annually, and each member receives four quarterly magazines a year, plus a directory of members. If the member is blind, the dues are only $2.00 a year; instead of receiving the print edition of our publication, they receive the contents read on a cassette tape.

If anyone has questions about our club, please do not hesitate to write me and I will be glad to supply the answers.

Howard W. McClelland
Assistant Secretary
The Voicespondence Club
173 Highland Estates R2
Kutztown, Penna. 19530

Too Many Mikes Spoil the O.R.T.F.

Dear Editor:

Your July issue contains a letter from Lewis Smith, who speaks of making recordings using the O.R.T.F. mike configuration. However, he mentions use of three mikes. While I do not doubt the excellence of his results, the O.R.T.F. method specifies only two mikes.

On the subject of coincident microphone techniques, Charles Repka's article (November, 1978) examines the M-S system and includes diagrams for the necessary matrix. Thoughtful readers will realize such matrixing can be carried out using any high-quality audio mixer and one out-of-phase patch cord. Very briefly, the M signal (center) is assigned to both left and right equally. The S signal (sides) is also split and assigned equally to left and right, but with the phase reversed in one side. When combined with the M signal in a stereo mix, the S signal thus provides a sum to one side and a difference to the other. The amount of S added determines the width of the stereo image.

Doug Pomeroy
Brooklyn, N.Y.

Errata

In the January, 1980 Equipment Directory Addenda, the price of Dynaco's Model A-350 loudspeakers was listed incorrectly. The cost of these speakers is $780.00 per pair.

Facing the Music

Dear Editor:

I was thoroughly amused by Edward Tatnall Canby's fanciful and imaginative version of Mr. David Hagan's and my recording session of the Max Bruch **Concerto for Two Pianos.** In the November, 1979, issue he describes us as ". . . physically mild looking, with round amiable faces and close, long hair, near-double chins," vs. the Berlin Symphony whose members "cringe every time . . . demoralized, they hang back, they play sloppily."

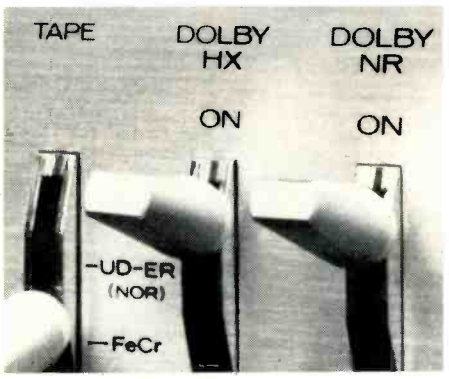
My mother would be so proud; I have terrified 80 Germans playing in precision!

This is also the first time I have ever had my physical appearance reviewed in a music magazine. It is only fair that I get a second chance (see photo).

Martin Berkofsky
Paris, France

DOLBY® HEADROOM EXTENSION: A Significant Advance in Cassette Recording

At higher frequencies, with even the best tape formulations, there are two major problems in cassette recording. The most familiar is hiss, background noise which is particularly annoying at higher frequencies. The other is tape saturation, the inability of tape to capture high frequencies at high levels. You may have noticed tape saturation as the dulling of highs on percussion, brass instruments, or other program material rich in high frequencies, as well as the distortion of closely-miked sibilant voices.



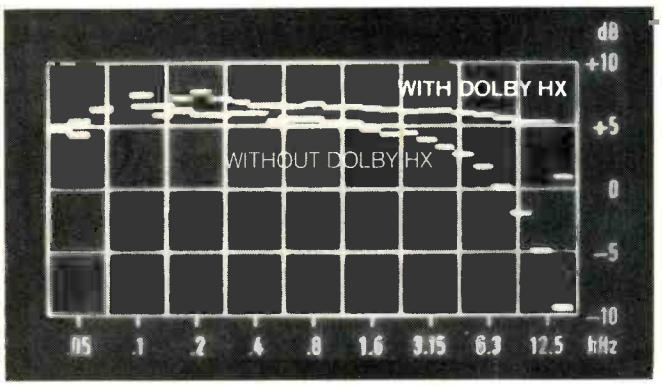


FIGURE 1. Pink noise recorded with and without Dolby HX on a low-cost iron oxide cassette tape, at an average level of −10 dB (referred to Dolby level).

For years Dolby B-type noise reduction has been an effective treatment for tape hiss as a serious problem in cassette recording. Now a new development from Dolby Laboratories significantly reduces high-frequency tape saturation as well.

Dolby HX

Dolby headroom extension, or Dolby HX for short, is new circuitry which works in conjunction with Dolby noise reduction in a recorder to improve significantly the usable dynamic range of any tape, particularly at high frequencies. As you can see from Figure 1, Dolby HX permits recording information at 10 kHz and above at a level on the order of 10 dB higher than is currently possible. In addition, as shown in Figure 2, there is a substantial reduction of the severe IM distortion that results when tape saturates. And finally, Dolby HX also optimizes performance at low and middle frequencies for minimum distortion, modulation noise, and drop-out effects.

How Dolby HX works

Dolby HX works by automatically varying a recorder's bias level in response to the changing high-frequency content of the music being recorded. At the same time, the recording equalization is automatically modified to prevent any change in frequency response. Therefore at each moment, Dolby HX provides just the right bias and equalization to optimize tape performance for the music, unlike the fixed bias and equalization of conventional decks which must compromise tape performance at least part of the time.

Much of the time on most music, the bias with Dolby HX is relatively high for best performance at low and mid frequencies. But when unusually high-level high frequencies of the type which would cause tape saturation come along, both bias and equalization pre-emphasis are momentarily lowered to increase the tape's high-frequency headroom far beyond the normal limit. Information about the high-frequency content of the music is derived from the recorder's Dolby noise reduction circuits, which are already programmed to scan the music in precisely the way required by Dolby HX*.

*Dolby HX is sufficiently complex to require engineering a deck from the outset for it; it is not practical to add it to an existing model.

What Dolby HX means to cassette recording

Dolby HX makes it possible to make more accurate recordings of difficult program material, and to make accurate recordings more easily. The improvement is realized on any tape type for which the recorder is set up, so that less-costly iron oxide tapes perform like the more exotic formulations, and the more exotic formulations are further improved.

Just as important, the improvement Dolby HX provides is inherent in the recording process, so no special playback processor beyond normal Dolby noise reduction is required.

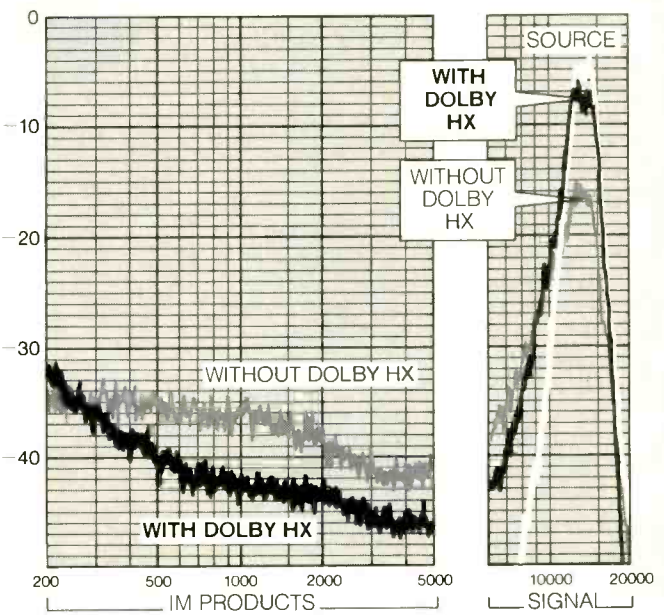


FIGURE 2. As well as increasing high frequency output, Dolby HX reduces IM distortion. *(The curves were obtained by first recording pink noise through a ⅓-octave filter centered at 12.5 kHz to simulate a musical signal such as a cymbal crash. The results were then played back and charted by a sweeping spectrum analyzer.)*

The difference will be heard when playing the tape on any deck. All decks equipped with Dolby noise reduction, and all Dolby encoded cassette recordings, will continue to be fully compatible with each other.

New cassette deck models incorporating both Dolby HX and Dolby noise reduction are on the way; watch for them over the next few months at your hi-fi dealer's. In the meantime, if you would like a complete technical description of how this new development works, please write us at the address below.

DOLBY LABORATORIES LICENSING CORP., 731 Sansome Street, San Francisco CA 94111, Telephone (415) 392-0300. Telex 34409.

Dolby®

what's new

Leigh Instruments Loudspeaker

The Leigh ECD is an egg-shaped acoustic suspension speaker that may be either hung from a wall bracket, suspended on the ceiling, or attached to a floor stand. Curved cabinet walls were used to eliminate diffraction problems and to reduce coloration caused by panel resonance. Two low-frequency equalization contours permit placement of the ECD close to or away from walls. The drivers are a 6½-in. woofer and 1-in. soft dome tweeter, both with separate automatic protection. Frequency response is 45 Hz to 22 kHz, ±3 dB, with a crossover frequency at 2 kHz. The oak-finished speaker is 15½ in. tall with an 11½-in. diameter, and it weighs approximately 10 lbs. Price: $425.00 per pair with 3 mounting systems.

Enter No. 100 on Reader Service Card

Electro-Voice Microphone

Model DO56 is a shock-mounted omnidirectional mike intended for hand-held broadcast and sound reinforcement applications. Its main acoustic cavity and the diaphragm/voice coil assembly are isolated, as an integral unit, from the case. This prevents capsule/case collisions and achieves isolation from handling and mike cable vibration noises. Frequency response extends to 18 kHz, and a slight emphasis in the 2 to 12 kHz range can enhance vocal qualities. Low frequency noise interference is reduced by the slow roll-off that occurs below 200 Hz, and "P-popping" protection is provided by a blast filter. The mike's case is of steel and aluminum, and its grille screen resists denting. Price: $100.00.

Enter No. 101 on Reader Service Card

Kenwood Tuner

Model KT-917 FM-stereo tuner incorporates a digital pulse-count detector for demodulation of the FM signal that is both theoretically and practically linear. The improvements are noted in distortion figures, specified at 0.05 percent in mono from 50 Hz to 10 kHz at wideband, and in the 90-dB(mono) and 84-dB (stereo) signal-to-noise ratios. Stereo separation, claimed to be 50 dB at wideband from 50 Hz to 10 kHz and 60 dB at 1 kHz, is achieved through a sample-and-hold MPX process in which pulse waveform peaks are sampled, held in a capacitor unit until the next peak from the PLL circuit occurs, and then averaged and adjusted up or down. Tuning accuracy is afforded by a "Distortion Detection Loop" circuit that automatically locks in on a station and lights up at its point of minimum distortion. Price: $1,000.00.

Enter No. 102 on Reader Service Card

Spies Laboratories Spectrum Analyzer

Model SA-91 spectrum analyzer may be used with any equalizer and features a single voltage-controlled filter that sweeps over the audio spectrum to obtain 1/9-octave resolution in 91 bands over a 20 Hz to 20 kHz range. The unit provides a composite video output for the display and will drive a television (with an r.f. modulator) or a video monitor. Microphone and line inputs are also offered. Price: $1,195.00.

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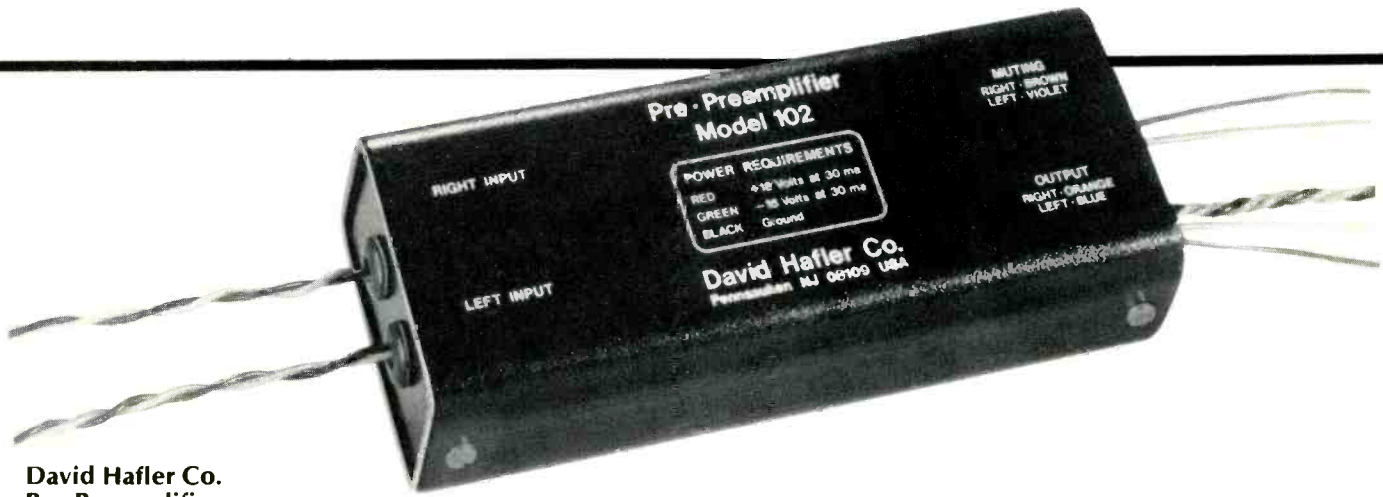

David Hafler Co.
Pre-Preamplifier

Model DH-102 pre-preamp for moving-coil cartridges can be built into the Hafler DH-101, its primary application, in less than an hour. It may also be adapted to other preamplifiers which provide 30 mA of well-filtered ±18 V of d.c. An external switch permits selection of either 20 or 34 dB of gain to accommodate various moving-coil cartridges. The DH-102 can handle peak signals with a 500 percent margin in high frequencies, and 10 times that in the mid-band range. Ultrasonic IM distortion is reduced to unmeasurable levels. Price: $74.95.

Enter No. 104 on Reader Service Card

Audio Control Equalizer

Model C-22 is a 10-band equalizer with an 18-dB per octave Tchebychev-type subsonic filter and bass summing circuits. The filter is designed to eliminate the boost of subsonic noise that occurs when low frequencies are increased, while the summing circuit "monos" bass for improved clarity and rumble reduction at frequencies not used psychoacoustically for stereo imaging. THD is less than 0.04 percent at 20 Hz to 20 kHz. Price: $229.00.

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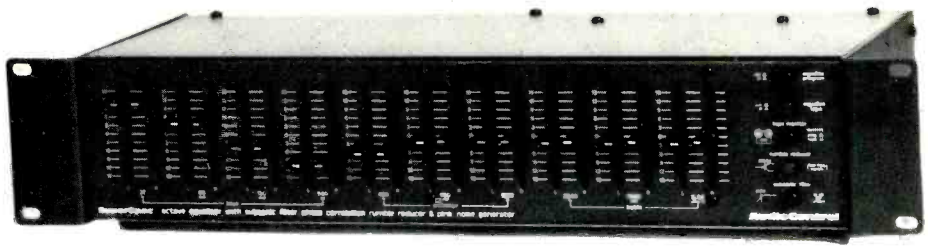

ReVox
Multi-Speed Deck

Model B77 open-reel tape deck is now available in four different speed configurations: 15/16 & 1⅞, 1⅞ & 3¾, 3¾ & 7½, or 7½ & 15 ips. Offered in both half-track and quarter-track formats, the B77 may also be ordered with an A-V head option which can record slide sync pulses. The versatile input-switching system allows selection of low- or high-impedance mikes and preamplified *AUX* or *Radio* sources; mono inputs can be recorded from either or both sources onto one or two tracks. Claimed wow and flutter is less than 0.08 percent at 7½ ips, while response is from 30 Hz to 20 kHz, +2,-3 dB, with S/N of -67 dB in half-track mode. Price: $1,499.00.

Enter No. 106 on Reader Service Card

Introducing The Itsy Bitsy Mitsubishi.

Mitsubishi has put big audio performance into a series of precise little packages.

Microcomponents.

Stereo components that are compact. But can hardly be called compacts.

They have the same high-performance characteristics as our regular size components. They have to. They're Mitsubishi.

The Micro FM tuner, for one. It's the teeniest tuner in the world. A mere 10⅝"x 2¾"x 9¾"big. However, few tuners can measure up to its standards. It has, among other things, a quartz-PLL synthesizer tuning system so sophisticated that it has absolutely no drift. Zilch.

We were no less frugal with features on our Micro Cassette Deck. It has an Automatic Spacing Pause System, Dual Capstan Drive, Separate 3-way Bias and Equalization Feather Touch Controls and of course, Dolby.® Yet measures only 10⅝"x 5½"x 9⅝".

For power, the Micro Amp is unbeatable at this size. The little "direct coupled" powerhouse puts out 70 watts per channel. Total harmonic distortion is only 0.01%. For 30 watts per channel, it's an infinitesimal 0.004%.

Our Micro Preamp is made to complement the amp. And faithfully conduct any signal source that goes through it. It has a built-in moving-coil head amplifier. With a signal-to-noise ratio of 77dB even for 100μV input and 0.005% THD, it obviously does the job better than components twice its size.

Small wonder the final touch was to finish them with Champagne Gold face plates.

The new Mitsubishi microcomponents.

Now bigger isn't better. Only bigger.

MITSUBISHI® AUDIO SYSTEMS

*Mitsubishi's Microcomponents. Micro FM Tuner, M-F01. Micro Cassette Deck, M-T01. Micro Amp, M-A01. Micro Preamp, M-P01. For the name of your nearest dealer, please call (800) 621-5199 (in Illinois, (800) 972-5855). For more information write Melco Sales, Inc., Dept. 40, 3010 East Victoria Street, Compton, California 90221. In Canada, contact: Melco Sales Canada, Markham, Ontario. *Dolby is a registered trademark of Dolby Laboratories.*

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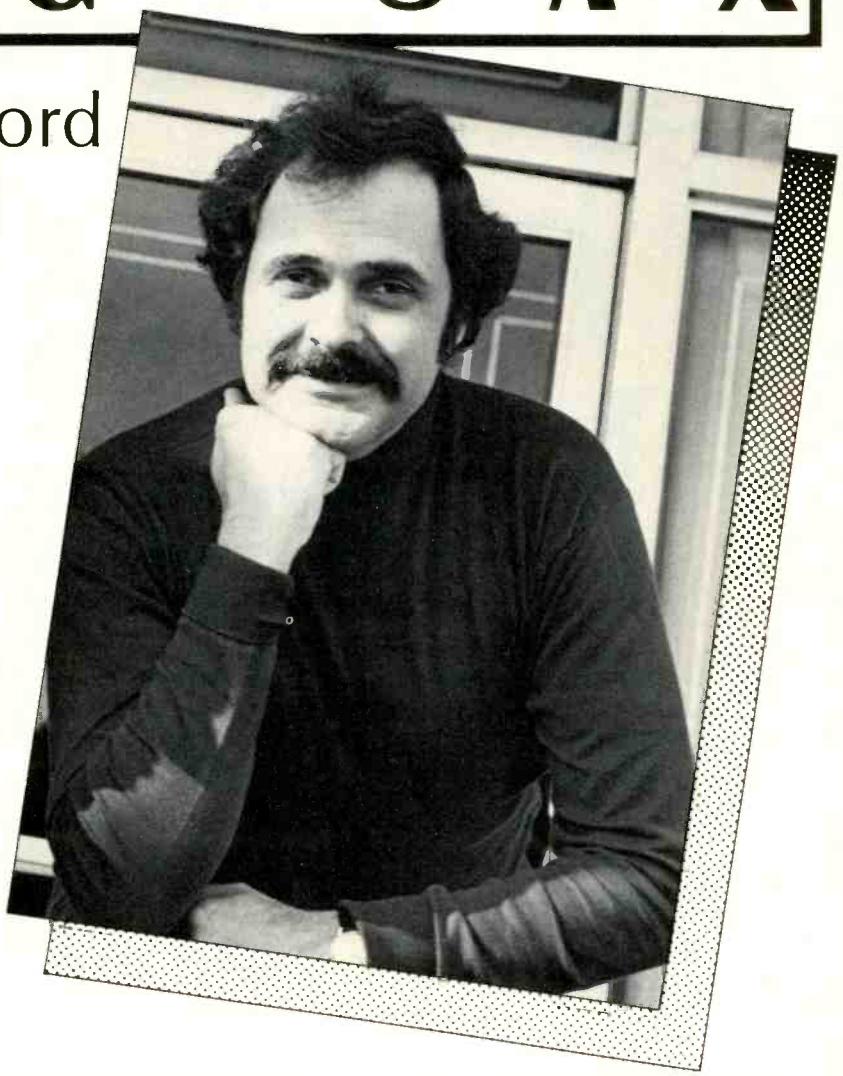
D O U G • S A X

On Current Record Technology and Music Systems Of the Future



The second in a series of interviews with the audio industry's innovators and thinkers.

Gary Stock

If you've listened to a Linda Ronstadt, Barbra Streisand, or Neil Diamond album lately, you have been hearing the work of Doug Sax without knowing it. As the mastering engineer on all of the recent albums of these performers, he is responsible for transforming the studio master tape into the metal molds that will be used to press every copy of the record. His custom mastering company, The Mastering Lab, is one of the most respected in the nation.

Sax is much better known, however, for having revived, in conjunction with his friend Lincoln Mayorga, the concept of the direct-to-disc record. Sax and Mayorga made the first experimental direct-disc recording in 1961 (at 78 rpm, by the way), and brought the concept to the marketplace in 1968 with their Sheffield Labs disc "Lincoln Mayorga and Distinguished Colleagues," the first commercially released direct-disc album and a milestone in recording technology. Mint copies are currently valued at $500 to $1,500. Sheffield has now released more than a dozen direct-to-disc recordings encompassing a broad range of musical tastes and ensemble sizes, and the company remains active in research into microphone design and disc-cutting technology. In our conversations with him, Sax held out two intriguing possibilities: Dbx encoded direct-to-disc recordings from Sheffield and an innovative cutting method, using copper rather than acetate master discs, with the potential to provide a 90-dB dynamic range and more from conventional analog LP records.

Late last year, Contributing Editor Gary Stock talked with Sax whose colorful, folksy, and certain-to-be-controversial comments on present-day record technology and audio's future follow.

Audio: One of the questions which comes to mind immediately when discussing the technology of making phonograph records is the question of the ultimate capabilities of the LP record. You are very much in a position to know what the limits of that technology are. How much in the way of dynamic range, for instance, can be put on a conventional phonograph record?

Sax: To begin with, there are two different statements on this point that are often confused. One is signal-to-noise ratio, and the other is dynamic range. A record made from a well-cut lacquer, well processed on excellent vinyl, would probably, in a static measurement of noise below a standard 5-centimeter cutting level, give you a signal-to-noise ratio something in the range of 65 dB, or maybe even a bit better. But that is only the noise compared to the standard cutting level. On several of

the Sheffield Lab records and on other recordings, one can find peak values above that cutting level of more than 16 dB. They are on the record and retrievable by many of the better phono cartridges available. That gives us a total of 65 *plus* 16, for a total dynamic range of 81 dB or so. That is the true dynamic capability of at least a few of the LPs being produced today.

With indifferent plastic or indifferent processing, however, that 65-dB signal-to-noise ratio can very quickly go to 55 dB, thus reducing the dynamic range by 10 dB as well.

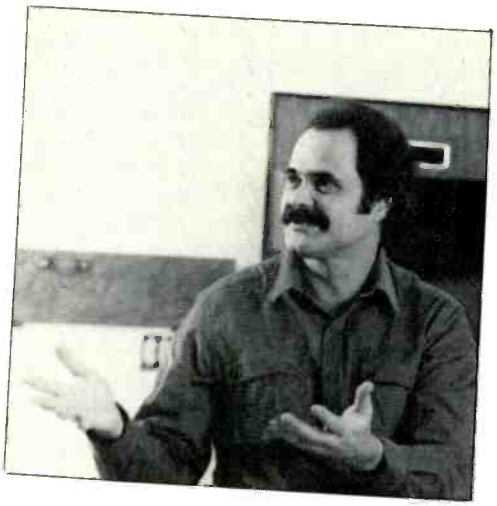
Audio: Where does most of the noise creep in, during the metal processing stages?

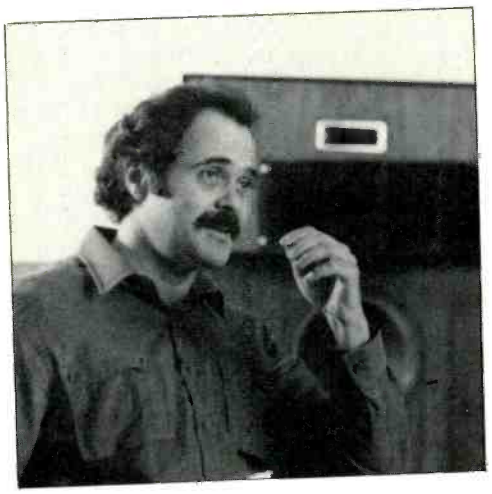
Sax: It's difficult to ascertain, since the metal mother never plays as quietly during tests as a vinyl pressing will. One big factor in recent years, though, is that the master lacquers on which a disc is cut are not nearly as good as they were five years ago. I've done tests on old lacquers where the signal-to-noise ratio versus a reference cutting level was 75 dB, and RCA did some experiments in the old days that indicated a 90-dB ultimate signal-to-noise ratio for the master lacquer itself. Now I find that it is possible to get much poorer lacquers, lacquers that are in fact audibly noisy, which was unheard of a few years ago.

One of the problems in record production is that when you generate noise in the lacquer, or indeed in any stage, it never goes away. If you pick some up in the lacquer, some in metal mothers and stampers of indifferent quality, some in the form of tape hiss from the master tape, and another type of noise from the vinyl itself, the public gets to listen to all four of those noises. None of them masks one another, although I'd like to say they do. All of them come through.

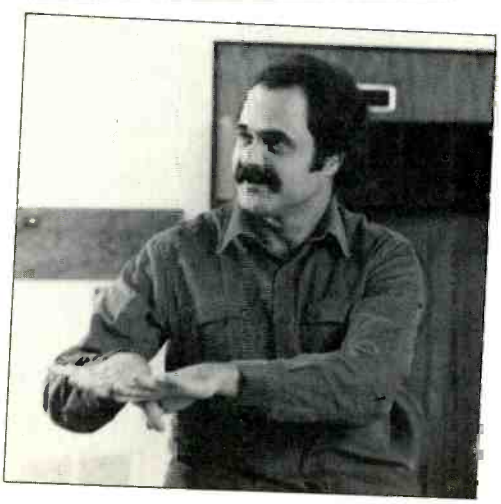
Audio: Setting aside for a moment questions about the various proposed revisions to the RIAA equalization curve for records, how high and how low can a record go, in terms of ultimate frequency range?

Sax: The cutting lathe is capable of putting a signal on the master disc that is flat from 8 Hz, in the case of the Neumann lathe, up to 25 kHz; incidentally, the low-frequency response from a disc is one area in which the disc can far exceed an analog tape recorder, in terms of linearity. When measuring tape machines, as you go down in frequency there are always a couple of irregularities — head bumps, they're called — below which the response drops off to nothing. But all of the disc-cutting systems I know enjoy flat response down to extremely low frequencies. Remember that we are talking about a magnet structure and a stylus in the cutting system, and they can move very slowly as well as very fast.





"Any cutting system can easily exceed the tracking abilities of any cartridge made."



Audio: What are the maximum lateral velocities that one will encounter on a record? How much level can be put on the disc? This, of course, relates not only to the cartridge's responsibility in tracking the groove, but also to how high the phono overload capability of the phono preamplifier must be.

Sax: I'm afraid I can't give you as simple an answer for that question. I will state this: Any cutting system I know of can easily exceed, both in the midrange and in the bass, the tracking abilities of any cartridge ever made. We can lay down much higher levels than we can pick up, as it were. There is an excellent analogy. If you talk about driving a car at a fixed speed down a road, and that road has increasingly tighter curves, there will come a point at which the car cannot traverse that road, assuming it maintains a constant speed. It will finally go out of control. The answer to your question, then, is simple. You can easily exceed your purpose in cutting a record at much higher levels than can possibly be tracked. Remember that the intent is that the majority of people with good systems should be able to play the record and get music from it. Exceed the limits, and you may be making a worse product, rather than a better one.

Audio: How about stereo separation? How much can the contemporary LP record achieve in that regard?

Sax: Well, again we have a situation where the abilities of the cutting lathe exceed anything that you could retrieve with the finest phono cartridge available. Stereo separation of more than 35 dB at 15 kHz has been measured using optical techniques, although you can't measure it directly with any cartridge. At least I've never heard of a cartridge with 35 dB of separation at that frequency.

Audio: So again we are talking about limits imposed by the playback equipment rather than the record. Are any of these limits significantly alterable, though, by any special recording or mastering technique, such as half-speed mastering or 45-rpm playing speed?

Sax: Half-speed mastering has much in theory going for it. The cutter's ability to get better separation, for instance, would be even further increased, although as we've discussed, the cutter's ability exceeds that of the

cartridge at either full or half speed. But my feeling on the question of significantly expanding those limits by some special technique is no, I cannot see it making that much difference.

Audio: Well, if we flip the question over, do you see anything that could be done on the playback side of things—in the cartridges, the tonearms, or the turntables, that would significantly expand the LP's sonic capabilities? New tip shapes, or radial-tracking arms, or other new hardware?

Sax: Actually, I am constantly amazed, because the one area in high fidelity that seems to have had a linear progression of advancements, without backtracking, is the phono cartridge. There are many cartridges today that retrieve, as far as I'm concerned, even the difficult musical information on the record incredibly well. I've never heard anyone say "That sounds good but if I take out my 15-year-old cartridge it will really sound better," although people do say "If I take out my old tube amplifier, it will sound better" all the time.

Audio: But if someone handed you an immense sum of money and asked you to do something to improve record playback technology, is there anything new that you would undertake? Any principle that has been overlooked or that you see as having great promise?

Sax: Perhaps a system with no record contact, optically read; but other than that, no. I don't sit and think in my heart of hearts "If I could only do this or that the sound would really get good." From the standpoint of playback systems, I'm at the other pole in my thinking. I'm amazed at what they do.

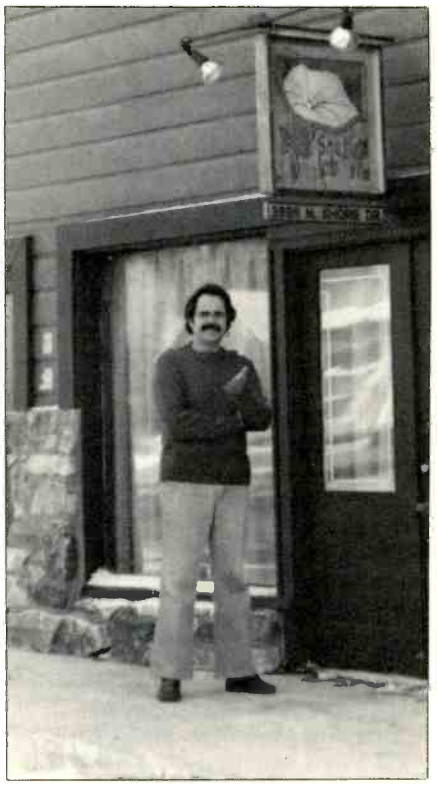
Audio: How about some electronic technique, like the dbx encoded disc approach, which uses a linear compression/expansion arrangement?

Sax: I find the dbx system a very provocative one. It promises an ideal that has not existed up to now—under good conditions, a virtually noiseless record. Properly used, it permits you to retrieve more clean information, with good dynamic range, and less noise.

Audio: Is Sheffield interested as a corporate entity in the dbx system?

Sax: As a matter of fact, yes. Right now our involvement with it is in the experimental stage. But, from my viewpoint as a manufacturer, I feel very tempted to take one of the four cutting lathes we have at Sheffield, sacrifice the 100,000 or so conventional discs that could be made from a direct-to-disc recording on it, and use it to make a direct disc with the dbx system. I would still, of course, have the masters from the other three lathes in conventional form.

Audio: You've gone on record in the past as having reservations about current digital recordings and recorders. What do you find wrong with digital, and what can be done to correct the problems?



Sax: Digital's virtues are instantly obvious, but its faults are much more subtle. Looking down the road, I believe that it is only a matter of time and effort before its problems are going to be fixed, but I consider them, at least in all of the extant digital recorders, fairly severe problems in terms of their effect on the musical energy. Many very fine minds, people who are not wrapped up in the manufacture of an existing digital recorder, say that the sampling rate is one crucial issue, and that it must be at least doubled. *(Editor's Note:* The sampling rate of a digital recorder defines the number of times per second the recorder measures and stores the level of the musical signal. In most contemporary recorders, the sampling rate, which is controlled by an internal "clock," is set at 44 to 50 kHz.)

Audio: Why will doubling the sampling rate be necessary?

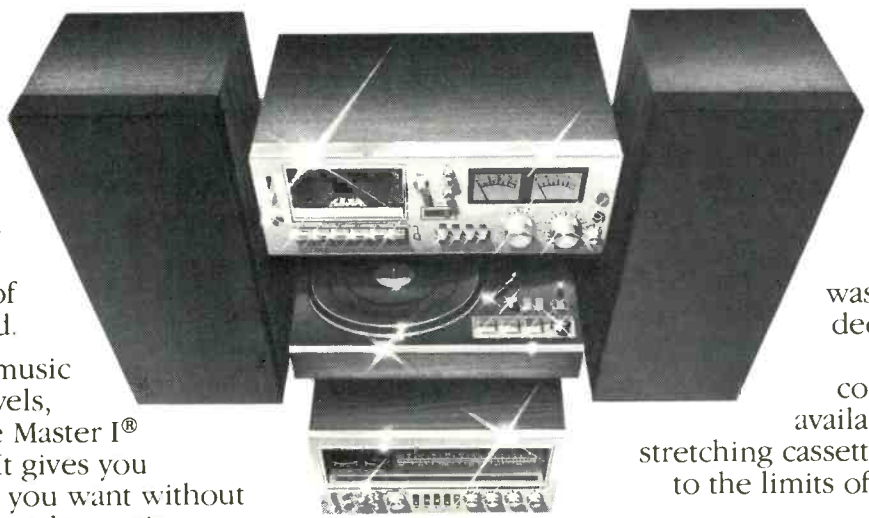
Sax: Because of the severe phase shift caused by the recorder's steep high-cut filters, for one, which are related to the choice of sampling rate, and because the recorder only looks at a

NOW THAT YOU'VE GOT THE COMPONENTS YOU WANT... GET THE ONE YOU NEED.

A SCOTCH® CASSETTE IS THE ONE COMPONENT THAT LETS YOU GET IT ALL OUT OF YOUR SYSTEM.

There isn't another cassette made that can give you better sound than Scotch. Rich, true, pure sound. The best your stereo can deliver.

Take Scotch Master® Series for example. Three premium cassettes with three different oxide formulations designed to bring out the best in the type of music you record.



If you record music at high sound levels, like rock, choose Master I® for normal bias. It gives you the volume level you want without the distortion some low noise tapes can induce.

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Master III® (FeCr) will give you outstanding clarity for any recording, plus a high-end brilliance that delivers truly remarkable sound on your car stereo. Every tape in the Scotch line is made with the same kind of care and precision that went into your other components, to give you all the performance your system can deliver.

SCOTCH METAFINE.® THE ULTIMATE COMPONENT.

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piece of the high-frequency tone, not all of it. It's interesting to note that Ampex, which is now making a digital preview system for disc cutters, is offering it in two forms—with a 50-kHz sampling rate and a 100-kHz sampling rate. The 100 kHz sounds better.

Audio: So the sampling rate of the recorders should go up, and the anti-aliasing filters must be changed. What audible effects do the drawbacks of the present recorders have?

Sax: I can't give you a detailed answer. If I hear something that sounds bad, I know that it sounds bad. Overall, I perceive on everything I've heard digital, things that are unnatural, things that are not there in real sound.

"Many of the speakers I see today wouldn't be helped by even a 2,000-watt amplifier because most cannot handle any substantial amount of power on top of their inefficiency."

I've found that when people talk about the faults of digital they say "Maybe it's factor X or maybe it's factor Y that I'm hearing," trying to come up with some explanation for their dissatisfaction, but their discontent with the sound precedes any technical understanding or opinion on it.

Digital recording right now is in exactly the same position as solid state was in 1958, when it first came out. There were immediate virtues, there was more power than ever before in a package a fraction of the size, but in the 20 years we have come from those first solid-state amplifiers, we have made enormous improvements. In the beginning, there were problems with solid state that brought new terms into the nomenclature, terms like crossover distortion and then later slew-rate limiting. The same is true of digital now, as we look for new terms and concepts to describe its sonic limitations. I am very enamored of digital recording's virtues, and I know the problems will be corrected. There is too much promise for them not to be corrected.

Audio: Turning more toward your view of audio's future, what would you like to see in a musical storage medium for the home? In other words, what should the gizmo that we put our music on look like?

Sax: I see several formats that I expect to become available to the public. One, which already exists, is a combined video recorder/digital processor that allows you to record digitally, play prerecorded tapes, or use it for recording television programs. It is very central in that regard.

Most of the electronics companies that have large production volume have some sort of video-disc system, and any of these can rather easily be converted to digital audio use. Among those discs I find the Philips Compact Disc a very viable animal, in terms of size, in terms of Philips' commercial clout and coverage. They have the muscle to put the idea out, and I think it's going to be a really potent product.

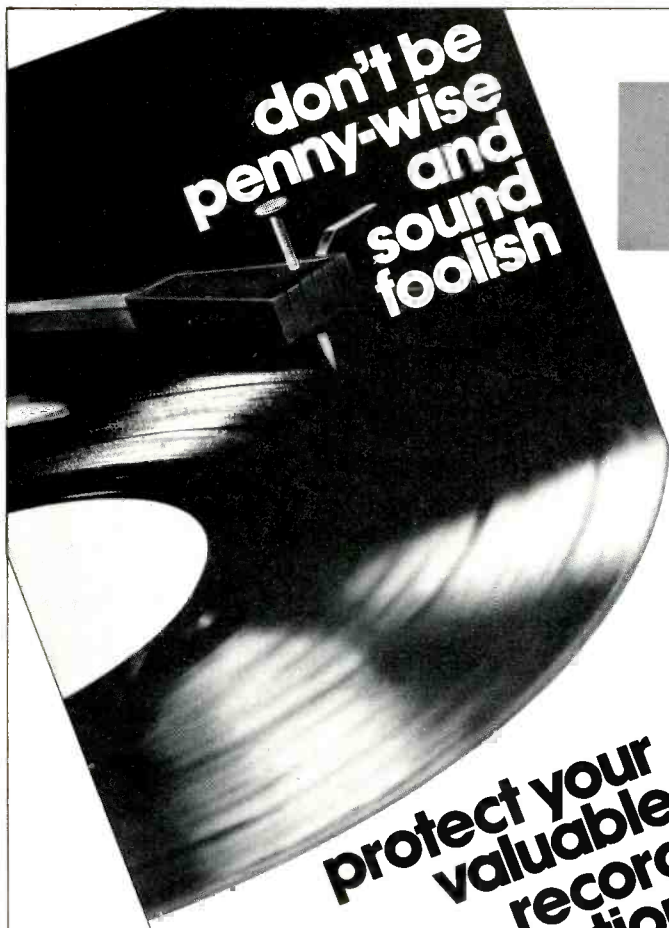
Audio: So you prefer separate audio and video players, and the small size of the Philips approach?

Sax: No. That I don't. What I like is the notion of something in a price range, of a size, that has broad appeal. The Philips player will be very price competitive, with digital's total absence of noise, and very space conserving in terms of both player and record collection. Philips, from the commercial standpoint, also has the labels — Deutsche Grammophon, Philips, Polydor, and American RSO — to make the catalog enticing. And they're all right in Philips' pocket, so to speak, with no need for licensing agreements. One other thing I see in the future, though, is a noise-encoded vinyl analog disc, like the dbx system we have discussed.

Audio: In the long term? Or just as an interim device?

Sax: Well, for the next 10 years at least, the main way you're going to buy your music is on a phonograph record, period. There are 500 million reasons why — and that is the estimated number of good-quality phonographs in the Western world and in Japan. It's fun to talk about the blue-sky distant future, but the fact of the matter is that digital discs will not be the dominant musical medium for at least 10 years.

Audio: Returning to our blue-sky discussion for a moment, though,



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would you care to comment on the characteristics of the music system we will be using in 25 years? Will it be a combined audio and video sort of thing?

Sax: Long range, I do see audio and video systems combined into a single grouping. We are going to take the broiler, and the grill, and the oven, and the range top and put them together, and call it a "stove." It's going to take a number of improvements in each of the elements. One thing that comes to mind immediately is the need for better television sound, and stereo audio for television. I have read that RCA is introducing a video disc next January, by the way, and that it will be mono, and not terribly healthy mono at that. That's headed backwards, and I believe it is a horrendous mistake.

Audio: On that same general subject, what do you think about the number of channels future music systems will have, and about the techniques that will be used to recapture the ambience and acoustic setting of the original performance? Do you see a return to four-channel, for instance?

Sax: In a word, no.

Audio: What direction, then? Widespread use of the kind of ambience synthesis systems that are popular today?

Sax: Yes, whether it is something recorded on the disc or something that you add on to your system, it will be some sort of addition to the sound of the front speakers. In my opinion, something synthesized from the two-channel recorded signal rather than anything that would need encoding and decoding.

Audio: What else will the system of the future have?

Sax: One area that I feel needs considerable improvement, where modern equipment has in some senses gone backwards, is in the ultimate dynamic capability of the speaker/amplifier combination. The advent of dynamic digital and direct-to-disc recordings has given the whole concept a push. The people who produce audiophile records have been striving for greater dynamic range, but frequently that range is well beyond the loudness capabilities of the extremely inefficient speakers in use today. In effect, the records are being limited by the playback equipment, and the loudest third of the recording is not being heard realistically.

Audio: So the systems of the future will have to have either much more powerful amplifiers or much more efficient speakers, correct?

Sax: Yes, but many of the speakers I see today wouldn't be helped by even a 2,000-watt amplifier because most of them cannot handle any substantial amount of power on top of their inefficiency!

Audio: They have a narrow dynamic window, then.

Sax: They are the limiting factor in many systems today. I hear records I've made played on these systems, and the openness of the quiet passages is there, but the dynamic portions are total chaos. The phono cartridge is performing well, the preamplifier is having no trouble at all; it's the tail end of the system — the amplifier and speakers — that is in permanent strangulation.

I've heard a number of large, hand-built speaker systems made by serious individuals, professionals, in their homes, and they sound remarkable, not so much because they play louder, but rather because they can play at the same average levels and still have the ability to reproduce the peaks without strain. When one of these becomes available, home music systems may then be able to realize for the first time what is truly on the disc. A

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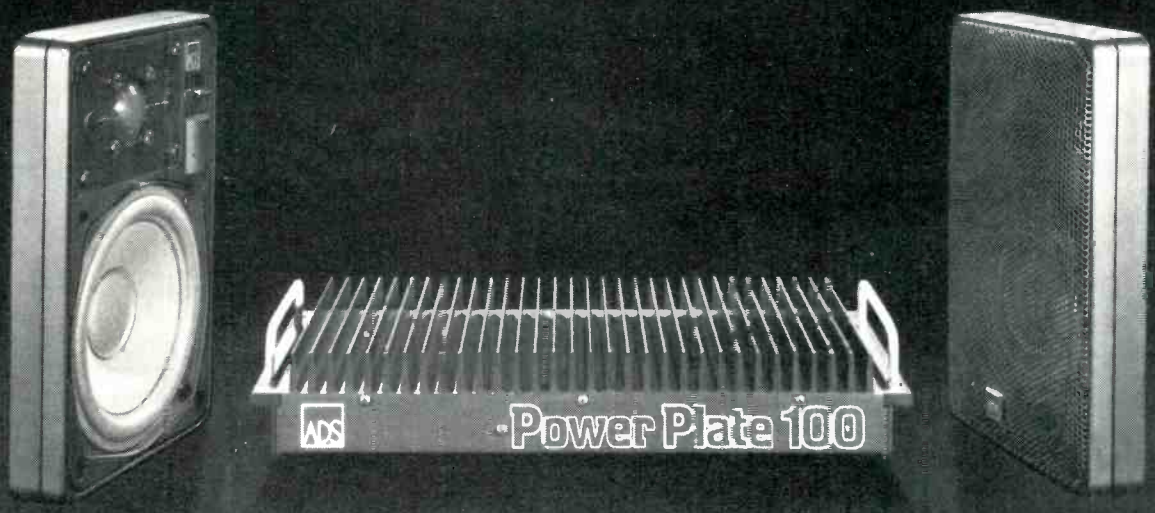

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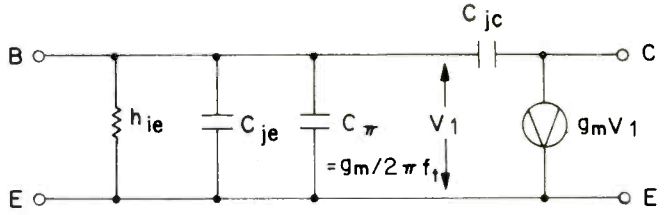

Fig. 9 — Simplified transistor model. Note that g_m, and thus C_π, are proportional to collector current.

discharge the capacitor by about 60 mV (as dictated by the exponential I_c vs. V_{be} transistor law). Although this voltage seems small, we must realize that the capacitance is on the order of microfarads when the transistor current is on the order of amperes for typical power transistor f_ts in the range of 1 to 4 MHz. It can be shown that if we try to turn off the transistor by pulling a constant current out of the base, the collector current of the transistor will decrease at a reasonably constant rate; i.e. it will slew off at so many amperes per second. This is a direct result of the integrating action of the charge-storage capacitance. Specifically, the current slew rate is given by the simple expression $ISR = 2\pi f_t I_b$, where I_b is the base current.

Now let's see how this phenomenon affects the performance of an output stage when program signals change quickly. In most amplifier designs, a very large current can be supplied by the drivers (usually emitter-followers) to turn on the output devices quickly in response to program demands. Unfortunately, the available turn-off current is limited to the amount of quiescent current flowing in the power transistor base-bleeder resistors (R5 and R6 in Fig. 4). There is thus a well-defined turn-off current slew rate associated with each of the output devices.

Suppose for the moment we are operating into a resistive load; the top transistor is "on" and the output voltage is positive but rapidly heading in a negative direction. The current into the load is decreasing rapidly; i.e., the rate-of-change of the output current is highly negative. If this rate-of-change exceeds the turn-off current slew rate for the top device, that device will go into current slew-rate limiting. Under these conditions the transistor's current is no longer a function of the signal, and it thus represents a source of distortion. The bottom transistor will, of course, tend to conduct more heavily to make up the difference, but the distortion will not be completely removed. This extra current conduction on the part of both transistors is referred to as "common-mode conduction," and is also responsible for increased output stage power dissipation (sometimes dangerously so) at high frequencies.

Because the opposite transistor makes up for most of the deficiency of the device being turned off, this current slewing phenomenon does not manifest itself as visual voltage slew-rate limiting at the amplifier output.

To see how serious this problem can be, let's assume 1-MHz f_t power transistors in Fig. 4. With about 8 mA of turn-off current available, the current slew rate for each device is about 0.05 A/μS, corresponding to a voltage time derivative of 0.4 V/μS into an 8-ohm load, or less than one watt at 20 kHz. Such an amplifier can thus be expected to generate substantial amounts of high-frequency intermodulation distortion at moderate power levels.

This problem can also be effectively dealt with, however. The most common solution is to use low-valued bleeder resistors (i.e., run the drivers fairly "hot") and faster output transistors. Assuming 4-MHz f_t devices for the design in Fig. 7, where about 30 mA is available for turn-off, we have a turn-off current slew rate of 0.75 A/μS, corresponding to a voltage time derivative of 6.0 V/μS into 8 ohms or 144 watts at 20 kHz.

The Case for A Large Feedback Factor

We've spent quite a bit of time so far examining many issues and arguments and are led to conclude that a large feedback factor and its attendant small open-loop bandwidth does not do any harm, given a design with the same gain crossover frequency as a low-feedback design. But what good does it do? Specifically, why should more feedback be applied at mid-band frequencies when the problem seems to be at high frequencies, and 20 to 30 dB at the high frequencies is probably sufficient given a fairly linear open-loop amplifier?

First, the weak but not unimportant argument: It costs nothing. In fact, in most designs it saves one or two resistors (R15 and R16 in Fig. 7).

The more convincing argument rests on the fact that negative feedback reduces the percentage of output stage distortion components at a given frequency by the same factor that it reduces gain at that frequency. The Class AB output stage is a major contributor to open-loop nonlinearity in good designs, and local degeneration cannot significantly reduce its distortion. Only overall negative feedback does a good job there.

Suppose an open-loop amplifier is handling a 1-kHz sine wave input and second harmonic distortion is being produced at 2 kHz in the output stage. When feedback is applied, the 2-kHz distortion product percentage (for the same output level) will be reduced by the same degree that feedback reduces the amplifier's gain at 2 kHz. Since feedback factor is often a function of frequency, we must remember that the feedback factor at the frequency of the distortion component (not the fundamental) is what is important. This rule is independent of the phase shift around the feedback loop; in the extreme case of positive feedback, distortion percentages would be increased by the same factor that the gain increases at a given frequency.

Because of this action, the additional loop gain at mid- and low frequencies in the high-feedback designs contributes an important distortion reduction — not so important for mid-band harmonic distortion, which can be expected to be low anyway, but rather for mid-band intermodulation products which result from two or more high-frequency signal components involved in high-frequency intermodulation distortion. Few people can be expected to hear the THD produced by signals much above 10 kHz (although THD is a good *indicator* of performance). Rather, it is the low-frequency intermodulation products which can detract from, say, a cymbal crash. These products, which may fall in the most sensitive portion of the audio spectrum and which may not be well-masked by other sounds, will be further reduced by the additional low-frequency feedback. The additional 10 to 40 dB of feedback in these designs can thus improve the sound of the high frequencies even though the additional feedback only occurs at lower frequencies.

Distortion produced in earlier stages will be reduced by a smaller factor by negative feedback action. However, because of the higher subsequent gain in high-feedback designs, these stages will typically be operating at a lower level and will thus tend to produce less distortion in the first place.

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Great American Aural Experience, LA, CA
Havens & Hardesty, Huntington Beach, CA
The High-End Shoppe, San Jose, CA
Jonas Miller Sound, Beverly Hills, CA
Middleton, White & Kemp, Anaheim, CA
Music & Sound, Woodlawn Hills, CA
Natural Sound, Solano Beach, CA
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Reference Audio, Gardenia, CA
The Stereo Shoppe, Pasadena, CA
Stereo Unlimited, La Mesa, CA
Audio Alternative, Ft. Collins, CO
Listen UP!, Denver CO
Audiocom, Old Greenwich, CT
Harbor Sound, New London, CT
Take 5 Audio, New Haven, CT
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The Stereo Shop, Boise, ID
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Audio Ltd., Champaign, IL
Audio Musicale, Belleville, IL
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Good Vibes Sound, Champaign, IL
Hi Fi Hutch, Mt. Prospect, IL
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Sounds Deluxe, Westmont, IL
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TIM Measurement

Although it's important to understand the origin of TIM and engineering techniques for avoiding it, it is equally important to be able to measure it objectively, preferably in a way that correlates well with subjective perception of TIM. Being able to measure an imperfection in this way is an important step toward eliminating it as an audible degradation.

Several techniques for measuring TIM have been proposed, but none has been standardized and general disagreement exists as to which is most satisfactory [5, 10, 11]. Incidentally, none of the tests makes any distinction between TIM and any other form of high-frequency intermodulation distortion (DIM).

One such technique is illustrated in Fig. 10 [10]. In order to highlight the transient nature of the distortion mechanism, this test combines a bandlimited square wave of 3.18 kHz with a 15-kHz sinusoid. The peak-to-peak amplitude of the latter is one-fourth that of the square wave. The resulting intermodulation products are then measured on a spectrum analyzer and their rms sum is compared to the 15-kHz rms level to arrive at a distortion percentage. The bottom waveform in Fig. 10 illustrates that the high-frequency sinusoid is completely blotted out during gross slewing. Such gross behavior is unusual in practice, and the more likely culprit is low-level, sub-slewing TIM which cannot be visually discerned. Practical disadvantages of this test include expensive instrumentation and a time-consuming procedure requiring the measurement and root-mean-square addition of six or more distortion products.

Although some feel that such a specialized signal is necessary to exercise amplifier TIM mechanisms [1, 3], others have more recently shown that ordinary high-frequency harmonic distortion measurements (THD) are just as good if not better [5]. This seems reasonable, because any nonlinearity which produces TIM also must produce harmonic distortion. A high-frequency sinusoid (like 20 kHz) also produces a significant rate-of-change for a large percentage of the time, so that an amplifier's TIM mechanisms are clearly exercised. Because the smaller peak time derivatives produced by a 20-kHz sinusoid are somewhat more in line with those produced by real music than those of the sine-square test, better subjective correlation may result. However, much more work needs to be done to determine which test, among these or others, yields the best overall *subjective* correlation.

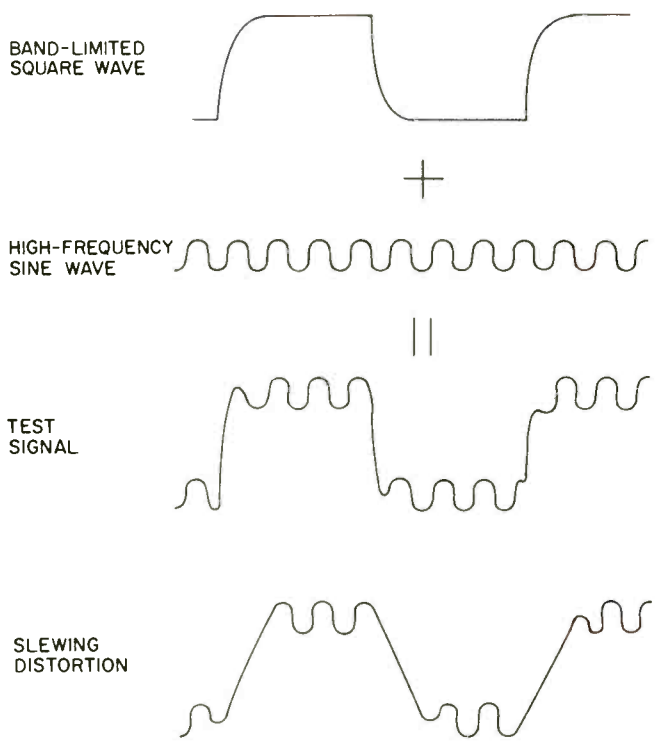

Fig. 10 — A TIM test signal and what it looks like when an amplifier is slew-rate limiting.

That high-frequency THD is a reasonably dependable indicator of TIM performance is good news, since the FTC requires that all amplifier specifications must quote a maximum THD figure for the full rated frequency range (usually 20 Hz to 20 kHz) at rated power. TIM should be completely inaudible for units with 20-kHz THD figures below about 0.02 percent. However, the reader is cautioned that THD figures as high as 0.1 percent may still yield inaudible TIM under some circumstances. Until more work is done, these numbers can only be considered ballpark figures.

Conclusion

To summarize, TIM is simply a form of high-frequency intermodulation distortion which is induced by a signal's rate-of-change rather than amplitude alone. It can be excited by continuous signals, such as sine waves or square waves, or by noncontinuous signals like music. Because it is induced by a signal's time derivative, an amplifier's slew rate is the single most important design parameter, while the small-signal parameters of feedback factor and open-loop bandwidth are, by themselves, irrelevent to the avoidance of TIM. These small-signal parameters also have no direct influence on slew rate. Since there is no need for open-loop bandwidth to exceed program bandwidth, deliberate program bandlimiting is in most cases unnecessary. It goes without saying, however, that good open-loop linearity is very important, especially at high frequencies.

Another important observation is that recorded music is simply not as "fast" as some would have us believe. The inevitable pre-emphasis/de-emphasis process places significant limitations on the power bandwidth, and thus the relative rate-of-change, of the reproduced signals. As a consequence, most reasonably designed amplifiers may not be producing as much audible TIM as we might think, especially at reasonable listening levels. Audible TIM certainly does exist, but its omnipotence has probably been exaggerated somewhat. It is also important to realize that some amplifier designers were routinely providing good slew rates and low values of high-frequency distortion (hence low TIM) long before the term TIM became popular.

Although our discussion has concentrated on power amplifiers, it should be kept in mind that, with the exception of the power output stage, the mechanisms which generate DIM and TIM in power amplifiers also exist in low-level circuits, such as in preamplifiers. This is particularly true in circuits employing operational amplifiers. Many of these devices have a rather limited maximum gain crossover frequency (on the order of 1 MHz), and open-loop linearity is not always carefully controlled. In particular, slew rate is often inadequate, especially in unity-gain compensated circuits. Externally compensated devices with carefully chosen compensation to match the selected closed-loop gain should be used for best results. Some of the FET op amps, providing unity-gain crossovers in excess of 3 MHz and slew rates above 5 V/ μ S, are capable of superb performance.

By far the most important conclusion is that we can "have our cake and eat it too"; we can take full advantage of the distortion-reducing properties of negative feedback without increased risk of generating TIM.

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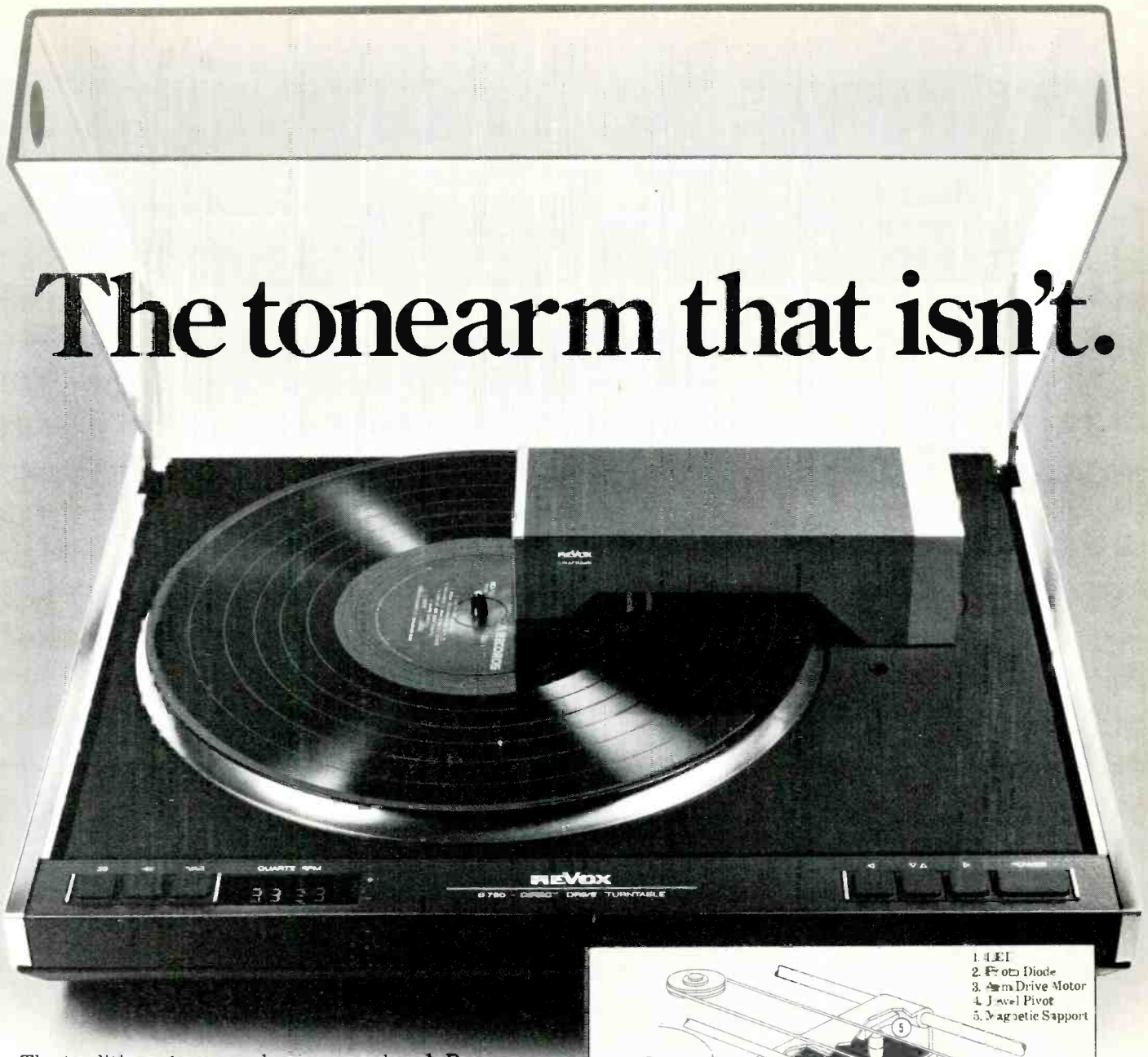

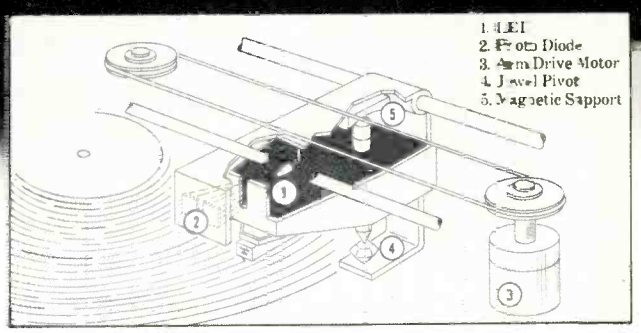

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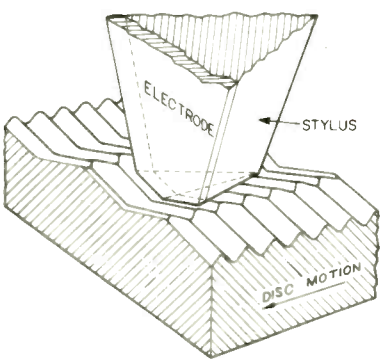
RCA Shows SelectaVision Video Disc

Gary Stock

The work began in the early Sixties, just after the completion of color television's technical development. RCA's engineers asked "What next?" and an answer came down from the corporate heavens: "Make us a machine that puts sight and sound on a record and pulls it back out again. A machine that holds comedy and tragedy and documentary and reruns of the Lucy Show. Give us Patton at Bastogne, Ruth at Yankee stadium, Louis at Versailles, and Harlow in her boudoir. Make it cheap enough to put in every living room in America, easy enough for a child to operate, and as simple to manufacture as cookies. Give us wide screen, full color, plug-in reality. Call it a video disc player."

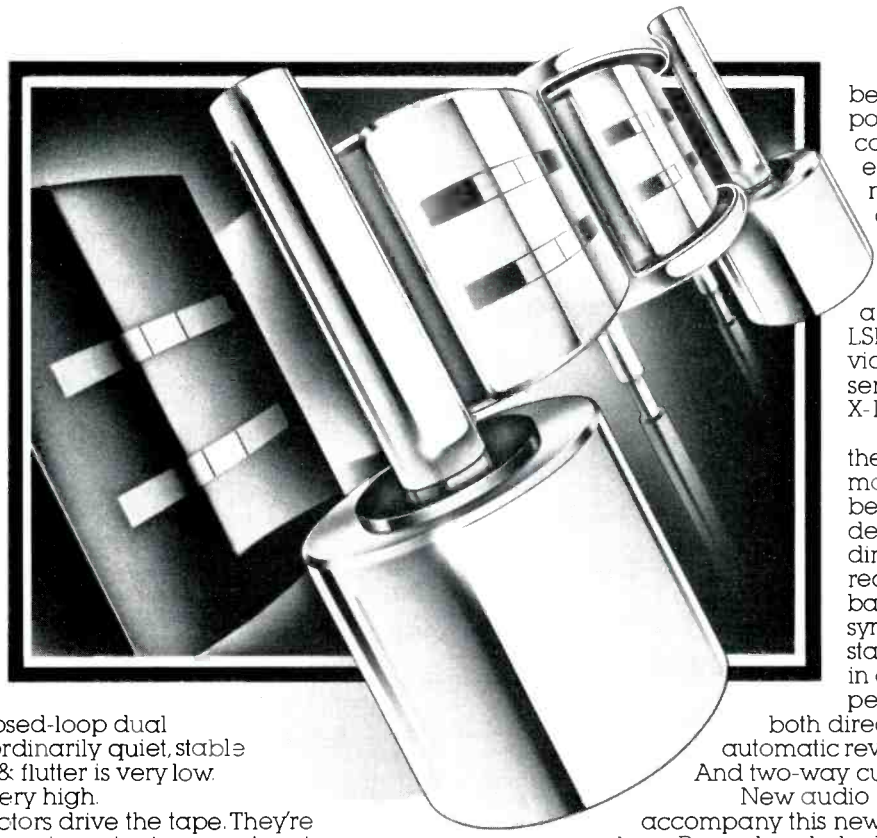
On December 7 of last year, RCA announced that its engineers were ready to deliver. The company will introduce their long-awaited SelectaVision video disc system, the result of one of the most extended and expensive electronic development projects in history, in January of 1981. And, according to RCA, it will arrive like gangbusters, with a 300-title catalog chock full of feature films and special programs produced by the likes of Don Kirshner and Walt Disney Productions, an immense advertising budget, and a very attractive price — $500 for the player and $10 to $17 for each of the discs. Most importantly, SelectaVision will be available in the mass quantities necessary to have a major impact on the thinking and buying habits of the average American, some 200,000 players in the first year or so, with a corresponding supply of programming and immediate, fully national distribution. This is in sharp contrast to the city-by-city introductions and limited production volume of Philips-backed Magnavox and its MagnaVision video disc player, RCA's only current competitor in the field.

Although RCA developed prototype players using three different pick-up methods in the course of SelectaVision's development, the player that will be marketed next year is a mechanically simple capacitance system, designed with moderate cost and straightforward operating features as its primary goals. It employs a diamond-tipped stylus to read the pattern of ripples in the extremely narrow groove of a 12-inch diameter disc that rotates at 450 rpm (see accompanying figure). The keel-shaped stylus tip, which has a metallic strip attached to its stern during manufacture, acts as one plate of the capacitor; the disc, which is made of an electrically conductive vinyl material, acts as the other plate. The changes in capacitance caused by the groove ripples modulate a carrier frequency, thus generating the combined audio and video signal information fed to the television set. In order to provide the incredible information density necessary in a videodisc, both the stylus and the groove are far smaller than in an analog phonograph record. Thirty-eight of the SelectaVision disc's 2.6-micrometer-wide grooves could nestle side-by-side in a single LP groove, and 50 of its stylus tips could march on the edge of a dollar bill. The stylus assembly is user replaced at intervals of about 300 hours, and is attached to a short, tangential-tracking arm inside the player. Tracking force is a mere 70 milligrams.



The disc itself has a maximum playing time of one hour per side, thus two hours per disc, and comes enclosed in what is called a caddy. This is a square, album-style cover that protects the surface from dust and scratches and prevents the disc's thin coating of lubricant from being scraped off (see figure). Inserting the entire caddy into the player's front slot extracts the disc and places it on the internal platter; inserting it again returns the disc to the caddy for storage. The user therefore never touches the disc surface.

TEAC TODAY: THE X-SERIES.



You're looking at four new machines that have more in common with data recorders than audio recorders. Together they are called the X-Series. And they bring a totally new kind of technology to the open reel format.

Each X-Series transport is an instrumentation mechanism. For 15 years, this TEAC design has stood the grueling test of time in computer installations where dependability is worth millions.

The basic configuration is closed-loop dual capstan. It's extraordinarily quiet, stable and precise. Wow & flutter is very low. Speed accuracy very high.

Three DC motors drive the tape. They're used to keep changes in motor temperature to a minimum under different loads so constant torque is maintained.

Our Magnefloat flywheel assembly, a completely new concept, uses magnetics rather than mechanics to eliminate problem-causing springs and pressure plates. Axial variations between the tape and capstans are prevented so proper tracking is assured. The result is highly accurate audio reproduction even after years of hard use.

The X-Series transport maintains ideal tape-to-head contact. Audible drop-outs, level and frequency losses are absolutely minimized. Frequency response is wide and flat. And signal articulation is unusually clear.

The brain behind the transport is our LSI control chip. It eliminates the need for mechanical relays so transport control is faster, more positive and reliable. The LSI also lets us provide full motion-sensing in the X-10 and X-10R.

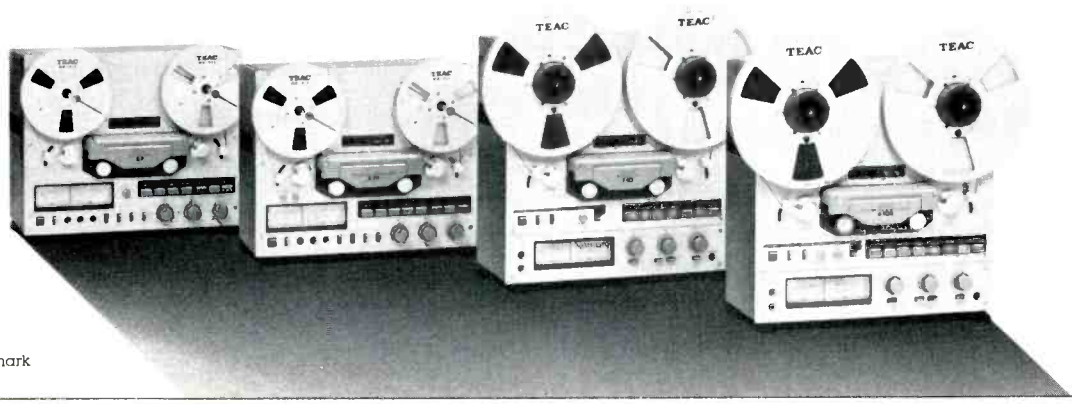
Within the X-Series, machines have been specifically designed for bi-directional record and playback. Perfectly symmetrical head stacks (6 heads in all) assure top performance in both directions. There's automatic reverse and repeat. And two-way cue monitoring.

New audio electronics accompany this new transport technology. Record and playback amplifiers are quieter and completely free of audible distortion. The sound is cleaner, more faithful to the source. The fidelity is unsurpassed.

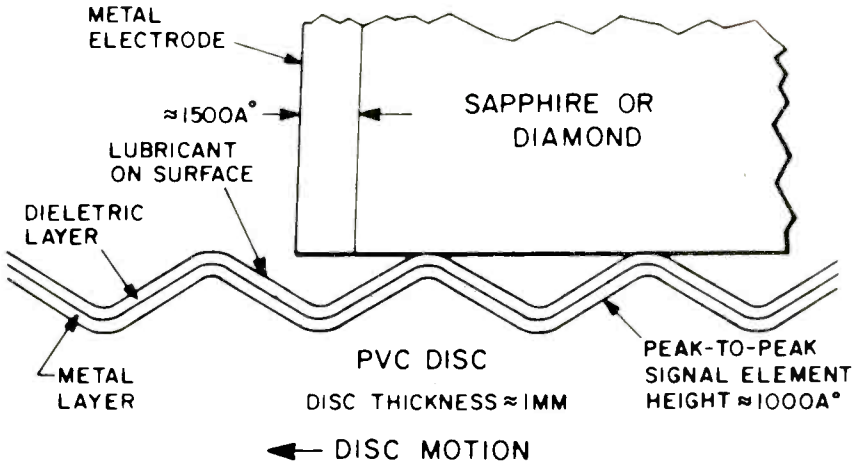
An option previously available only on our professional recorders can now be added to any X-Series machine. Called dbx I,* this noise elimination system adds 30dB to the already high S/N and over 10dB of headroom to give you master-quality recordings.

If your audio perception is critical, your listening standards high, audition an X-Series recorder. The performance is flawless. The sound peerless.

TEAC®



*dbx is a trademark of dbx, Inc.



The implications of the video disc as a concept are vast. Indeed, it is likely to have a greater impact on our society than any single device since television. At the very least, the music, film, and network-television industries will be dramatically changed by the new alternatives video discs will open up. The most immediate effect, in the view of many observers, will be to change the production and distribution patterns for motion pictures. As is done with phonograph records now, buyers would take video discs home to enjoy rather than seeing them in a theater. Producers of avant-garde or other special-interest films could market them directly to the public, rather than having to convince promoters, theater owners, and others of their films' mass-market appeal. But there will be many other changes, too. High-quality serialized dramatic, sports, and documentary programs that cannot hope to garner the huge audiences necessary to keep a television series on the air could be produced on disc and sold to subscribers as video disc "magazines." Audio-only music recordings of the type we listen to today may eventually be supplemented or replaced by video discs containing as-yet-unimagined couplings of music and visual image, multimedia "experiences" of which Disney's "Fantasia" was perhaps an elementary example. Instructional programs on everything from disco dance steps to auto repair may also be put on disc. RCA predicts that by 1990 as many as half of all American homes will have video disc players, and that the total market will approach 7.5 *billion* dollars, bigger than the current television and record industries combined. If any electronic product qualifies as The Next Big Thing, it is the video disc.

Understandably, the world's electronics giants — Holland's Philips, Germany's Telefunken, Japan's Matsushita and Mitsubishi, America's RCA, and many other smaller companies all see the video disc as a product with mind-boggling profit potential, particularly if a single company can, by force of marketing skill, set the accepted technical standard and derive royalties from the others. Many of these firms have been working full-bore on video disc projects for a decade or longer, and we are now observing the last stages of technical preparation before several video disc systems burst upon us simultaneously in the next few years (see the accompanying timetable). This will then initiate, in the opinion of many industry experts, a marketing struggle of titanic proportions, with several well-financed companies spending megabucks to convince the American buyer of the superiority of their disc system.

In an effort to attract the largest possible audience, each company has in the final stages of their player's design made a set of compromises corresponding to what it perceives as the American public's interests and priorities. Philips/Magnavox has assembled an exceptionally versatile player using wear-free optical technology and a miniature laser element to read the disc. It has the capacity to store thousands of frames of "still" information on a single disc and its features in-

The Video Disc Box Score

Company	Player Format	Announced Intentions
General Electric	Not yet chosen.	Decision on system by spring '80, at last report.
JVC	Electrode-contact grooveless capacitance system with 12-in. disc.	Projected introduction in 4th quarter '80.
Magnavox	Laser-read optical system with 12-in. disc.	Regional introductions in 4th quarter '78; full national distribution in 4th quarter '80.
Matsushita (Panasonic)	Stylus-and-groove mechanical system with 12-in. disc.	Announcement pending; reputed introduction by 1st quarter '81.
Mitsubishi	Laser-read optical system with 12-in. disc.	Prototypes only shown.
Pioneer	Laser-read optical system with 12-in. disc (compatible with Magnavox).	Projected introduction in 2nd quarter '80.
RCA	Stylus-and groove capacitance system with 12-in. disc.	Projected introduction in 1st quarter '81.
Sony	Laser-read optical system with 12-in. disc (some prototypes shown compatible with Magnavox).	Prototypes only shown.
Sylvania	Not yet chosen.	Decision on system by '81, at last report.
Teac	Laser-read optical system with 12-in. disc.	Prototypes only shown.
Teldec (Telefunken-Decca)	Stylus-and-groove mechanical system.	Prototypes only shown.

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"Because of their high performance, Altec speakers are usually combined with advanced professional electronics. The sound with Plus Series receivers more than compares to that standard."

Bill Fowler, President
Altec Corporation

"Tested with ESS speakers with their great reserves of performance, Sanyo receivers proved their excellence in every respect."

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ESS Inc.

"Sanyo's Plus receiver is extremely clean...and with efficient speakers like ours, the dynamic headroom compares to systems costing thousands more."

Gene Czerwinski, President
Cerwin-Vega!

"We're amazed, after testing the Plus 75 with our high power speakers, there was no overload distortion at levels close to 100 watts per channel."

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Ultralinear Loudspeakers

We asked these four speaker manufacturers to put our new PLUS 75 receiver through their most demanding tests. Judging by the results, it's pretty obvious that the PLUS 75 passed with flying colors.

In developing the PLUS 75, we listened to prototypes connected to every possible type of speaker. And we didn't stop refining the design until the receiver sounded great with any good speaker you might want to use.

Then we added a whole set of features that you won't find anywhere else. Like Digital Plus™ frequency display. Sampling Quartz Locked tuning. Built-in moving coil cartridge pre-preamplifiers. Unique Triple Turnover tone controls.

We ended up with a receiver so advanced that we think it'll outclass anything else you might be considering. Some of the world's best speaker manufacturers seem to agree.

We think you will, too.

PLUS 75 with integrated DC amp. 75 watts min. RMS into 8 ohms, 80 watts into 4 ohms, 20 Hz to 20,000 Hz, no more than 0.03% total harmonic distortion. Slew rate 80 V/μsec; Phono Signal-to-Noise Ratio 97dB (Moving Magnet), 70dB (Moving Coil); FM sensitivity 10.8dBf.

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clude slow motion, numbered-frame search, and a full-range stereo audio section. But it is also rather expensive at $775 for the player and up to $25 for the discs, and not compatible with a digital audio-only adaptor (Philips has developed the Compact Disc system for digital audio use. See "Digital Recording: State of the Market," *Audio*, December '79). Sony's, Teac's, Mitsubishi's, and Pioneer's disc systems are all fairly similar, although some incorporate or can be connected to digital audio adaptors. JVC may opt to separate their capacitive-system player into several discrete units — a basic player, a digital audio adaptor, and a Trick Play unit for slow-motion, search, and freeze-frame functions — thus reducing the cost of the initial investment while maintaining versatility. Matsushita (Panasonic) has adopted a relatively simple stylus-and-groove "mechanical" system in their Visc-o-pac player, thus sacrificing random access and still-frame capabilities, and limiting disc and stylus lifespan somewhat, in order to maintain a projected retail price under $500. Their player will have a stereo wide-band audio section, however, and an optional digital audio adaptor.

RCA has made perhaps the most difficult of compromises in the design of its player. Its capacitive pick-up system will limit the life of both disc and stylus, and rule out, at least as presently envisioned, any slow-motion, still-frame, or numbered random-access capability. The player that will be introduced in 1981 also has a mono sound section. Of even more significance to audiophiles, RCA plans no involvement for the next several years in a digital audio adaptor, although there is a possibility that some other firm could offer it as an aftermarket accessory.

There is little doubt that RCA is assembling an extremely powerful marketing effort for SelectaVision; many believe them to be on the inside track in the video disc race, with a good chance of setting the *initial* U.S. standard for video disc. But as the level of consumer sophistication about video disc systems and the diversity of uses to which they are put both grow, the demand for a disc player with broader capabilities and fewer drawbacks may also grow. If that occurs, the virtues of a wear-free optical system with the capacity for still-information storage will be even more appealing. In fact, many observers believe that optical players will immediately dominate the industrial and commercial information-storage field, and then cross over into the consumer market several years later as production economies reduce their cost. This would leave limited-function stylus-and-groove players like SelectaVision as forerunners in the race of advancing technology, like the 4-track cartridge and the V-cord video cassette. The question now, at least for the informed consumer, is: Shall we change horses in midstream or pay a slightly higher price for an ultimately stronger animal?

Flash Flash Flash

As we go to press, CBS and RCA have announced that CBS has obtained worldwide license from RCA to manufacture and distribute video discs using the SelectaVision system. The initial CBS contribution will be in development of mastering technology at the Stamford Center and in production processing at the Records facility in Milford.

DON'T BELIEVE EVERY DIGITAL READOUT YOU READ.

When you tune to 102.7, you want to stay tuned to 102.7.

Toshiba has solved the problem of mistuning by eliminating the need for a center channel tuning meter. Instead, digital frequency synthesis uses a carefully selected quartz crystal to produce a stable reference frequency. In plain English, this system constantly corrects tuning errors. The result is the lowest possible distortion and absolutely no drift. Toshiba was the first to utilize this system in a receiver, and now we're using it again in our SA-850 receiver.

Digital frequency synthesis not only makes us accurate, it also makes us more convenient.

1. Behind this digital readout is a conventional tuning system. It requires a center channel tuning meter and manual tuning.

2. Behind this digital readout is a quartz-locked tuning system. More accurate, but it still requires a center channel tuning meter. And it still requires manual tuning.

3. Behind this digital readout is the Toshiba quartz PLL digital frequency-synthesized tuning system. A totally electronic system that's never subject to manual mistuning. Accurate to 0.0025%.

No unnecessary parts.

We've eliminated the center channel tuning meter, FM/AM dial scale and tuning knob. So you can tune automatically or manually with the ease of pushbutton selection. You get LED digital readout and 5 LED signal strength indicators.

You'll thank us for the memory and scan.

Actually, you'll thank digital frequency synthesis. Because only with this process can you store 6 FM and 6 AM stations for instant recall tuning at the touch of a memory button.

And in the automatic FM mode, digital frequency synthesis allows the tuner to scan until it stops at the next listenable station. FM stereo S/N ratio is 68 dB. FM selectivity is a high 80 dB. Frequency response is 20 to 15,000 Hz + 0.2 – 0.8 dB.

But there's more to this receiver than just a superb tuning system.

Power you'll respect.

We're talking about 50 watts rms per channel into 8 ohms from 20-20,000 Hz.

This is provided by full complementary direct-coupled power amplifiers. And couple that with an ultra-low THD of 0.03%.

A preamp you'll appreciate.

Along with provisions for attaching two tape decks, we give you full monitoring controls. Plus duplication switching between the decks.

Our special subsonic filter switch helps eliminate low-frequency warp distortion.

And our receiver looks as good as it sounds. With a sleek slide-away cover that conceals a full range of controls, including tone/defeat switch and a dual speaker selector.

The Toshiba SA-850 digital frequency-synthesized receiver.

The next time you're looking at receivers, don't believe every digital readout you read.

Except ours.

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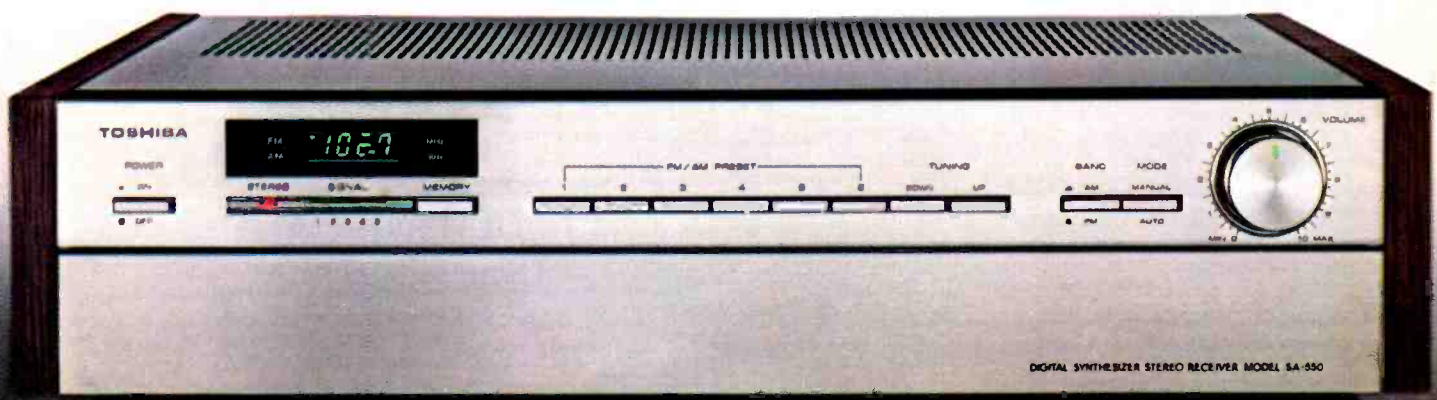

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Selection of Capacitors for Optimum Performance—Part II

PICKING CAPACITORS

Walter G. Jung and Richard Marsh*

A somewhat lesser known performance parameter of capacitors called dielectric absorption (DA) is also a major contributor to sonic problems. Actually, in spite of the fact that DA is not generally understood, it may well be more important than DF.

This phenomenon is really a reluctance on the part of the capacitor dielectric to give up the electrons that it has stored within itself whenever the capacitor is discharged. Then, when the shorting mechanism is removed, these electrons that remained in the dielectric will, in time, accumulate on an electrode and cause a "recovery voltage" gradient to appear across the capacitor terminals. This has been referred to as a capacitor's "memory" of what was just previously applied. The recovery voltage, divided by the initial charging voltage, and expressed as a percent figure, is called the "percentage dielectric absorption" (% DA).

Conversely, there is also a reluctance on the part of the dielectric to accept all of the energy presented to it with a uniformity of speed. These factors may be understood by regarding the capacitor model of Fig. B2. The effect of DA is represented by the capacitor C2, with a series resistance, R_{DA}. The total capacitance seen externally is C = C1+C2. Variation of the relative size of C2 and C1, and R_{DA}, represents the equivalent of real capacitors, with varying degrees of DA. (Note that this model suggests that the externally perceived effects of DA might be controllable to some degree by manipulation of the relative impedances controlling charge and discharge of the real capacitance. Experimental evidence discussed later tends to support this contention.)

In addition to the "bound" electron phenomenon, a secondary factor in the magnitude of recovery voltage values is that of "free" electrons in random movement in the dielectric. These free electrons take finite time to move from the dielectric to the electrode, and therefore contribute to this recovery voltage.

Dielectric absorption becomes a critical factor in circuits which are highly dependent upon speed of response. As the a.c. signal goes to zero (as in a short circuit) the trapped or bound electrons within the dielectric do not follow as fast. These electrons take a finite time to move from the dielectric to the electrode. As capacitors are typically used in audio circuitry, we could translate these defects into loss of accuracy in reproducing the fine inner detail of music, as well as the music's dynamic structure.

It is quite illuminating to consider what effect a phenomenon such as DA will have on an a.c. signal consisting largely of transients (such as audio) might have. For example, when an a.c. voltage is applied, there is a tendency for the dielectric absorption phenomenon to *oppose* this change in polarity.

When music is the a.c. signal, the sonic degradation is one of compression or a restriction of the dynamic range. Also, a loss of detail results, and the sharpness is noticeably dulled. With dielectric types which have high DA, there is a definite "grundge" or hashy distortion added to the signal.

It is quite important to describe the sonic thumbprint that DA contributes to subjective audio. The effects of DF and DA can be perceived differently. DF is primarily a contributor to phase and amplitude modulation; DA reduces or compresses dynamic range. This it does by not returning the energy applied all at once. With signal applied to a capacitor with DA present, the amplitude is reduced by the percent DA. When this energy does get returned (later), it is unrelated to the music and sounds like noise or "garbage" being added; the noise floor is also raised. High-frequency and/or transient signals are audibly compressed the most. Signals that look like tail pulses (a lot of transient music information is of this nature) are blunted or blurred in their sound. "Dulling," "loss of dynamics," "added garbage or hash," and "an inability to hear further into the music" have been subjective terms used to describe the DA effect in capacitors.

All *polar* dielectrics have relatively high DA; the best examples of this pattern are tantalum and aluminum electrolytics, which can have DAs as high as several percent. There is also a general correlation between dielectric constant and DA, with the high K dielectric types being worst in terms of DA (we would like to thank T. Von Kampen of TRW Capacitors for

making this point to us). For example, regarding Table BI, ceramics and both the Al and Ta oxides have high values for K, and also show correspondingly high values for DA.

Glass and mica dielectics have intermediate values for K, and also intermediate levels of DA. They are nowhere nearly as bad as ceramics or the Al and Ta oxides, but neither are they as good as the films.

Interestingly, it should be noted that there is also a general correlation between low values for DF and low DA, particularly among the film dielectrics. However, a low DF does not always go hand in hand with a low DA, and the glass and mica dielectrics are good examples of this fact. Both of these dielectrics have excellent properties with regard to DF, and also low capacitive variations with regard to frequency and temperature. Unfortunately, however, these excellent properties (which make these types highly desirable for such applications as resonant circuits and equalizers) are not realized concurrently with low DA. So, these types are therefore not ultimately as desirable for high-performance audio.

The film dielectrics, which are non-polar, are a different story with regard to DA and DF. All types listed in Table BI have relatively low values (3 or less) for K, and good to excellent performance with regard to DF and DA. Among the film dielectrics there can be found a direct correlation between K and DA, and even the relatively worst film dielectric (polyester) has a DA of less than 1 percent. The best of them, Teflon, has a DA on the order of 0.01 or 0.02 percent, while polypropylene and polystyrene are nearly as good.

Testing Capacitor DA

Measurement of the DA of a capacitor is a rather involved procedure when it is done in accordance with MIL-C-19978D [28]. This standard is widely used and referenced by the capacitor industry, and unless you test a particular type according to the MIL-C-19978D format, you are not likely to get comparable results (even though the relative quality relationship may still hold between different dielectrics).

The procedure outlined in this specification calls for a five-minute capacitor charging time, a five-second discharge, then a one-minute open circuit, after which the recovery voltage is read. The percentage of DA is defined as the ratio of recovery to charging voltages, times 100.

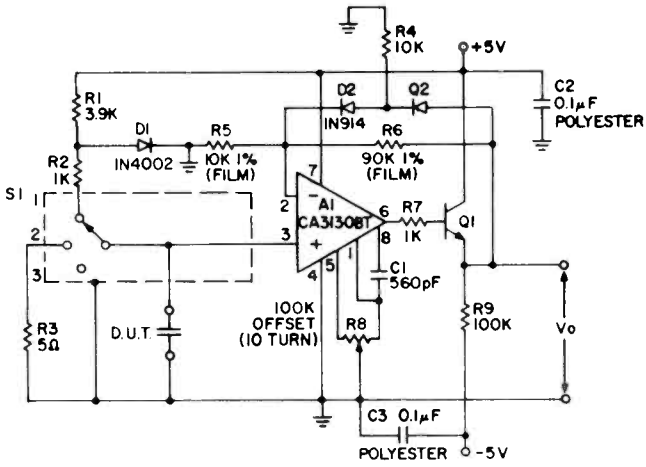
It should be understood that this is quite a stringent test, with regard to both the capacitor and the instrumentation. It takes an excellent dielectric to show small recovery voltages after a full charge, a five-second discharge, and a one-minute open circuit. It also takes some special low-current voltmeter techniques to read this voltage without introducing serious errors.

To simulate a MIL-C-19978D type of test, we built the circuit of Fig. 11, which reads the recovered voltage (Vo) via a bench DVM. The capacitor being tested (D.U.T.) is charged to 0.6 V. This level might seem low, but was chosen because it represented a typical peak signal level, particularly for lower level circuits. (A slightly higher charging voltage would make measurements easier and more applicable to higher peak signal voltages, should this be desired.) A MOS FET input amplifier is used, the CA3160BT. This is done because only a few pA of bias current are allowable in the D.U.T. circuit; if the current were higher the D.U.T. voltage would vary, by being charged by this bias current, and not be distinguishable from the true DA-produced voltage. In the circuit here, the 3160 bias current begins to limit the accuracy of readings below about 0.1 percent DA.

Fig. 11 — Dielectric absorption test circuit.

Test Procedure
1) Charge D.U.T. to 0.6 V for 5 minutes (S1, pos. 1).
2) Discharge D.U.T. for 5 seconds (S1, pos. 2).
3) Open S1 (pos. 3); after 1 minute, read Vo.
4) Calculate DA in percent, as DA (%) = Vo (16.7), where 16.7 is a scalor or constant unique to this test circuit.

Notes
1) Use clip-on heat sink for A1.
2) Trim offset for Vo = 0.0000 V prior to testing.
3) Use high-quality insulation to S1 and D.U.T. socket.
4) Q1, Q2=2N5089.



Two series of tests were run with this setup, as outlined in Table II. The first test compares four similar value capacitors with different dielectrics to see the differences in DA. As can be noted, both aluminum and tantalum electrolytics are very poor, with tantalum sample being slightly worse than the aluminum. This might be expected from their relative Ks.

The metalized polyester unit is far better than either electrolytic, measuring less than 0.15 percent. This may be quite good for polyester types, as typical specification data avail-

Table II — Dielectric absorption tests (after MIL-C-19978D).

Test 1		
Device	**V_o (V)**	**DA (%)**
1) 4.7 μF/50 V Al	0.082	1.4
2) 6.8 μF/35 V Ta	0.170	2.8
3) 4.7 μF/250 V Metalized polyester	0.008	0.13
4) 5 μF/200 V Metalized polypropylene	0.001	0.017
Polypropylene foil	0.002	0.033
Test 2		
Device	**V_o (V)**	**DA (%)**
1) 100 μF/3 V Ta	0.230	3.8
2) 100 μF/20 V Ta	0.095	1.6
3) 50 μF/10 V NP Al	0.065	1
4) μF/3 V Ta series, back to back	0.200	3.3
5) 6 μF/15 V NP Ta	0.148	2.5
6) 220 μF/35 V Al	0.086	1.4

able do not always show comparably low figures. The metalized polypropylene unit is extremely good in terms of DA with a measured figure which compares quite well with the manufacturer's data. The polypropylene foil unit is not quite as good, but is still excellent.

For both units 3 and 4 (or any other comparably low percentage DA type) the particular test conditions chosen are very sensitive to millivolt or sub-millivolt errors. This is simply because 0.1 percent of 0.6 V is only 600 μV— a voltage easily lost or obscured without very careful construction and calibration of the setup. Higher charging voltages (say 10 V) would ease this burden considerably, but we do not as yet know that such a test level can always be directly correlated to lower levels.

Test 2 examined a number of higher value aluminum and tantalum electrolytics. Comparison of units 1 and 2 shows that a higher voltage rated unit of the same value will tend to have a lower relative DA. This is an interesting point, as this

"Tuning" typically used audio circuits with quality capacitors

Since we would otherwise be endlessly asked "How can I improve my brand X preamp or power amp using the improved capacitor types recommended in this article?" it seems appropriate to make some comments as to the methods which would be typically used. First, readers should understand that we are not equipped to answer individual requests for consultation in these areas. If you cannot translate our general comments into the specific steps appropriate to modify your particular gear, please ask a more technically knowledgeable friend for some help. One should not attempt these changes without some prior experience in electronics and familiarity with the components used. Please be advised that if you choose to do so, you make such changes at your own risk, which is to say we cannot be responsible for any accidental damage you may incur. You should also be aware that the alteration of some equipment may result in invalidating a warranty and may also influence its potential resale value.

Since the minimum number of equipment blocks an audio system can be assembled with is two, preamp and power amp, we will discuss these two items as generally used. The basic ideas can be translated to any audio equipment using capacitors, which of course includes everything.

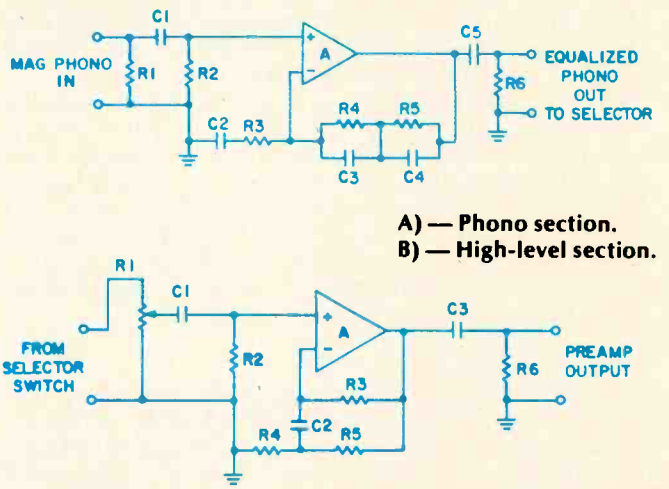
Figure B5 shows a block diagram of how a typical solid-state preamp is often realized. In the phono section of B5A, it can be noted that the signal path contains six capacitors, *all* of which can potentially degrade the signal's quality. The amplifier circuit is shown generally as a gain block A, which can be an op amp or discrete circuitry, and the comments on optimum capacitor usage apply to *any* active devices used (even those not yet invented!).

C1 is typically used to block d.c. from the cartridge, and is often a small electrolytic in the 1- to 10- μF range. It might better be a film unit such as a 2.2 μF, with a 0.01- μF polystyrene shunt. An interesting point here is that low bias current op-amp inputs (such as FET units like the TL071 or LF356) remove the requirement for C1 altogether, and the amplifier can be directly coupled to the cartridge. This, of course, will not be possible with the classic type of two-transistor topology, due to the inherent bias restrictions.

C2 is typically a large electrolytic, in the range of 10 to 100 μF or more, the large value necessary for extended bass response. This function can be optimized by selecting a low ESR type, using a back-to-back connection, and shunting with a film. The complete composite of Fig. 17B is useful.

C3 and C4 are the RIAA equalization capacitances and are very critical to fidelity as well as basic frequency response. If the network values are those appropriate for accuracy of the three RIAA time constants (see S. Lipshitz's article "On RIAA Equalization Networks," *Jour. of the Audio Eng. Soc.*, Vol. 27, No. 6, p. 458, June 1979), C3 and C4 should be realized with film types such as polystyrenes or polypropylenes (best) or at the least, polyesters. It is probably ill-advised to use a ceramic unit for equalization if quality results are to be expected. C5 is a simple output blocking capacitor and can be a composite such as Fig. 17B for best wideband response (or a large-value film type if the input impedance of the next stage is high).

Fig. B5 — Capacitor "tune up" in typically used preamp circuits.



A) — Phono section.
B) — High-level section.

The above comments can also be adapted to address tube-type phono sections, such as the Dynaco PAS series. In such cases, cathode bypasses (when used) are analogous to C2 and can be low ESR electrolytics, with film shunts. Interstage coupling caps should be the best-quality films, such as polypropylenes or polystyrenes, of appropriate voltage ratings. The output cap C6 cannot normally be an electrolytic because of d.c. leakage caused by the high bias voltages, so a composite film type such as several 5- to 10- μF units, shunted by a small polypropylene or polystyrene, is useful. This will be similar to Fig. 17A, but less the electrolytic. Be sure to use an adequate voltage rating and consider surges.

A point worth making is that it may be useful to minimize the grid resistances in tube circuits, while *increasing* coupling capacitance. This will tend to minimize the DA effects, by loading the capacitor as generally described with 17C. This idea also applies to the output capacitors used with cathode followers as well.

The high level preamp section of Fig B5B is typical of many modern solid-state preamps. C1 and C2 block the d.c. levels associated with the active devices used. If electrolytics are used, they should be low ESR types, with film shunts.

Depending upon the actual circuitry employed, C1 or C2 (or both) may even possibly be eliminated. For example, an LF357 op amp is often seen used for this amplification function, in which case its very low bias currents eliminate the need for C1 and C2, that is they can be jumpered out. Any residual offset of the IC used will still be blocked by C3, the output coupling cap. C3 would be selected, as was true for

same consideration for selection criteria is also true with regard to DF. It means that wherever possible, if you must use an electrolytic, use *the highest practical voltage rating*. This applies to either aluminum or tantalum units. Units like number 1 should be avoided at all costs!

Unit three is a 50-μF non-polar aluminum electrolytic of a type often seen in solid-state audio circuits. As can be noted it has a somewhat lower DA. Apparently, a back-to-back connection tends to reduce the DA of a single unit. For example, unit 4, actually a series pair of two units like number 1, shows less DA than a single. This tends to say that non-polar units or non-polar connected conventional electrolytics will be better in DA relative to a conventional polar cap. However, this difference is largely academic we feel, since if you want really high-quality sound, you cannot tolerate more than a small fraction of a percent DA. Obviously this rules out all but the best of the film dielectrics. Unit 6 is an example of one of the better quality aluminum electrolytics (see also Fig. 7).

While studying the DA problem in tantalum and aluminum electrolytics, we also bench-tested a large number of various units in a much simpler, unbuffered test setup. The basic procedure was to charge a cap to 5 V for 10 seconds, discharge it (through a 1K) for 10 seconds, then open circuit it, and read the recovery voltage after 30 seconds. With this technique we could grade the various units into relative DA categories. The best would read less than 5 mV (or 0.1 per-

C6 in the phono section (a non-polar composite, such as Fig. 17B).

Not shown here are tone control functions which, if used, would couple into the feedback path of the amplifier. Comments similar to those on the RIAA equalization capacitors apply to tone control capacitors as well. Since relatively high values will often be employed, polypropylenes will likely be effective here.

Power Amplifiers

In solid-state power amplifiers as are typically used today, the capacitor numbers are reduced due to the more simple function required.

A typical power amp signal path is as shown in Fig. B6. The amplifier circuit itself is direct coupled to the speaker to eliminate a huge blocking capacitor and to simplify biasing. C1 serves as an input coupling capacitor of 1 to 10 μF in value, while C2 may be 100 to 1000 μF. Both of these capacitors should be optimized similar to the method described for the preamp. C2 usually must be an electrolytic, but should be an optimized composite type. In some cases, depending upon the value of R2, C1 might possibly be a film (only) unit, but with typical input impedances of 10-50K, it will usually need to be 10 μF or more for adequate LF response.

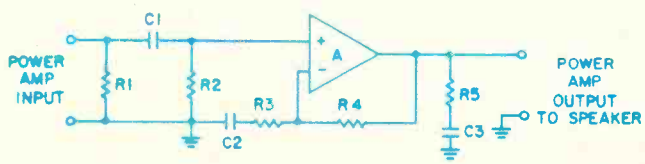
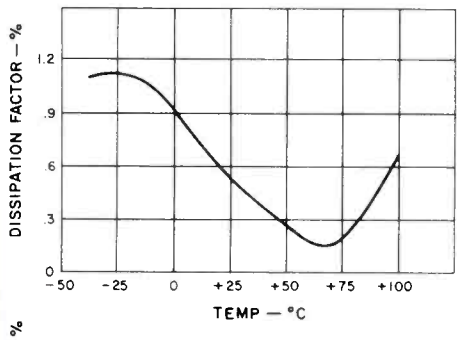


Fig. B6 — Capacitor "tune up" in typically used power amplifier circuits.

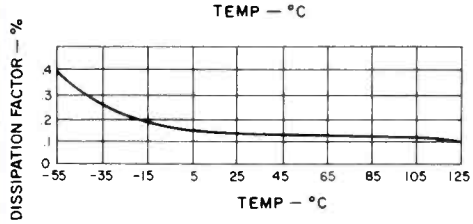
C3 and R5 form an output compensation network for the power devices, and C3 may in some cases be a ceramic disc. An equivalent value film unit is likely to be profitable here as a substitution.

In summarizing these comments, it is perhaps important to underscore the point that capacitors as used in the audio signal path can be optimized mostly independent of the circuit topology or devices used. This is simply to say that while our generalized guidelines have addressed more popular examples of circuit types, good-quality capacitors go well in other circuits also; crossover networks are an example of passive circuits, an equalizer could be a good example of active ones. Both functions have performance basic to capacitors. In making such changes as outlined above, a logical approach is to upgrade all the poorer quality capacitors first, for example the ceramic capacitors if used, and in particular those in the signal path.

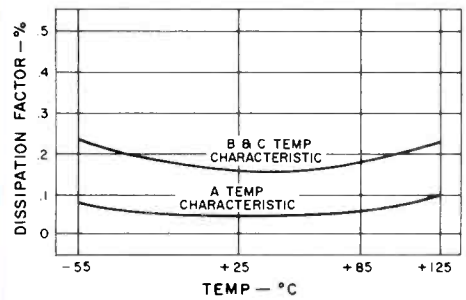
Fig. 12 — Dissipation factor vs. temperature, various dielectrics.



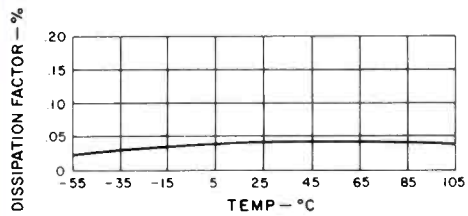
12A — Metalized polyester, courtesy Seacor, Inc.



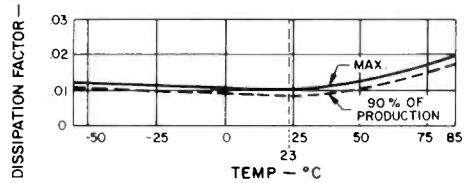
12B — Metalized polycarbonate, courtesy Union Carbide.



12C — Parylene (characteristics A,B, and C), courtesy Union Carbide.



12D— Metalized polypropylene, courtesy TRW.



12E — Polystyrene, courtesy PFC, Inc.

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Table III—Capacitor dielectric comparison.

Dielectric	Glass	Mica	Polyester	Metalized Polyester	Polycarbonate	Metalized Polycarbonate	Parylene	Polypropylene	Metalized Polypropylene	Polystyrene	Teflon
Parameter/ Characteristics											
DF, %	0.1	0.1	0.3-1.0	0.3-1.0	0.1-0.3	0.1-0.3	0.1	0.01-0.03	0.03-0.1	0.01-0.03	0.01-0.03
DA, %	≅5	≅5	0.3-1.0	0.3-1.0	0.1-0.3	0.1-0.3	<0.1	<0.1	<0.1	<0.1	<0.1
IR, 25°C	High	Med./High	Med/High	Med/High	High	High	Very High	Very High	High	Very High	Very High
ΔDF/freq.	Very Low	Very Low	Medium	Medium	Medium	Low	Low	Very Low	Very Low	Very Low	Very Low
ΔC/freq.	Very Low	Very Low	Medium	Med/High	Medium	Low	Low	Very Low	Very Low	Very Low	Very Low
ΔDF/temp.	Low	Low	Med/High	Med/High	Medium	Medium	Low	Very Low	Very Low	Very Low	Very Low
ΔC/temp.	Low	Low	High, Non-Linear		Med/Low	Med/Low	Low,Linear	Med/Low	Med/Low	Low,Linear	Low,linear
Stability	Excellent	Excellent	Poor	Poor	Good	Good	Excellent	Excellent	Excellent	Excellent	Excellent
Tolerances Available, %	1-10	1-10	5-20	5-20	1-20	1-20	0.5-10	1-20	1-20	0.5-10	0.5-10
Range of Values	1-10,000 pF	1-10,000 pF	0.001-10 μF	0.1-50 μF	0.001-5 μF	0.01-50 μF	0.001-1 μF	0.001-5 μF	0.01-50 μF	10 pF-5 μF	0.001-5 μF
Relative Size Of Higher Values	Large	Large	Medium	Small	Medium	Small	Large	Large	Large/Med	Large	Large
Relative Cost	High	Medium	Lowest	Low	Medium	Med/High	High	High	High	High/Low	Highest

Notes: The outstanding performers among those listed are in the shaded areas. Highest performance is obtained from polycarbonate and those listed to its right.

cent) for this test, the worst over 20 mV (0.4 percent). Obviously, this simple test does not compare *directly* with the Fig. 11 test results, but it still can grade units *relatively*. And we would invariably find that lower DA units would sound better in an audio circuit. However, the clincher is that no electrolytic known to us, aluminum or tantalum, sounds like a wire in even so simple an application as a coupling cap. Once you try some of these tests for yourself in a good audio system, one free of masking, you may begin to abhor capacitors and seek means to eliminate them where at all possible. And, indeed, where it is possible this is perhaps the most effective method of eliminating these distortions. However, it is not always practical to eliminate capacitors, therefore ways to minimize their degrading of the signal are valuable and will be discussed.

Performance Comparison of Various Dielectrics

At this point we are ready to survey the various capacitor dielectrics with regard to their parameters relevant to audio. This we will do for all dielectrics mentioned thus far, with the exception of ceramic and the electrolytics, since for the highest-quality audio these dielectrics should not be used if at all possible. Where an electrolytic type is a must because of a time constant or filter criteria, some qualified recommendations can be made for aluminum types which make them quite useful; this will be covered at the end.

Table III is a summary of the various dielectrics most useful for consideration, with typical specifications listed for each major performance parameter (left column). These specs are really *ranges*, as are typically available from average suppliers, and are not meant to represent a given type or series in specific terms. They are, however, broadly representative of what is generally available. For a given electrical parameter, the dielectric type (or types) which are outstanding are noted by shaded areas.

While Table III summarizes comparative data in discrete form, Figs. 12 through 16 illustrate graphically a selection of these different characteristics.

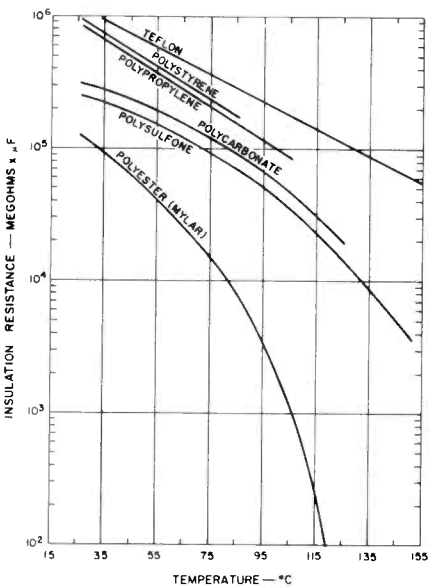
Dissipation factor of the various dielectrics is usually given at 25° C, but there is always some temperature dependence. Figure 12 shows that polyester is the worst of the films in this regard, but the better ones show very flat DF change with temperature.

Insulation resistance (Rp) has not been strongly addressed in this discussion, because it is not often a critical parameter in audio (at least from a *distortion* point of view). Figure 13 is an excellent summary of how the dielectrics compare for Rp. As can be noted, all show decreases in Rp with increasing temperature.

While DF is an important parameter for capacitors, it is also important that DF remain low for different frequencies. However, in many dielectrics there is substantial frequency dependence exhibited by DF, as shown in Fig. 14. The better dielectrics in this regard are parylene, polystyrene, polypropylene, and Teflon (not shown). A related parameter is capacitance variation with frequency, shown in Fig. 15. Again, parylene, polystyrene, polypropylene, and Teflon (not shown) are best in this regard. These variations are due to the variation in K versus frequency for the different materials.

Film capacitors are generally quite good with regard to capacitance variation with temperature, as is shown by Fig. 16. The better a capacitor in this regard, the more stable a tuned circuit based on it will be when undergoing changes in temperature. Of the films, polyester is the poorest, followed by polycarbonate. The lowest TC is exhibited by polystyrene.

Fig. 13 — Insulation resistance vs. temperature, various dielectrics, courtesy F-Dyne Electronics.



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One should view TC minimization with some caution with regard to audio use, as in certain dielectrics optimization techniques which minimize TC raise DA. A good example of this factor is the characteristic "B & C" parylene dielectrics, which have nominally 0 TCs, but a DA several times that of characteristic A parylene, which has a 0.1 percent DA but a TC of -200 ppM/°C. For audio use, the A characteristic would be preferred, since you can't "compensate" for zero DA, whereas for TC you can (where necessary). One should, incidentally, check for a possible compromise in DA for any "0 TC" capacitor; they often occur, and we do not mean to imply the DA compromise is peculiar to parylene.

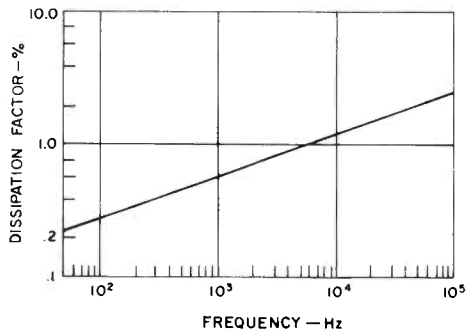
The remaining parameters of Table III are not illustrated by graphical data, but also deserve comment. For example, the available tolerances and range of values can strongly influence the selection of a capacitor, aside from the electrical specs. Generally, very tight tolerances are available in most films, to below 1 percent on special order. The range of values is a difficulty, though, particularly when large sizes are needed.

Most film capacitors are readily available, many off the shelf, in sizes up to 1 μF. Above 1 μF they become very hard to obtain, and almost non-existent for some dielectrics, such as polystyrene.

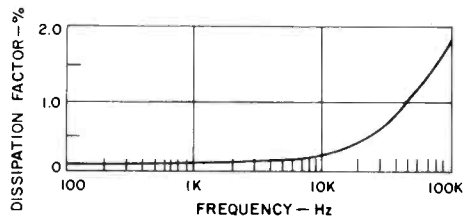
In the larger values, any film capacitor will be quite large, relatively speaking. So, to make use of the excellent electrical properties and ultimate sound quality, we must be prepared to accommodate a largish capacitor when 1 μF or more is needed. A factor which can help minimize the final size is the metalized dielectric. Most film capacitors (except polystyrene) are available in metalized types, as opposed to the foil-wound variety. The metalized dielectric uses a very thin metalized layer for the electrode and thus conserves space. A danger area of metalized caps is the lead attachment, which

Fig. 14 — Dissipation factor vs. frequency, various dielectrics.

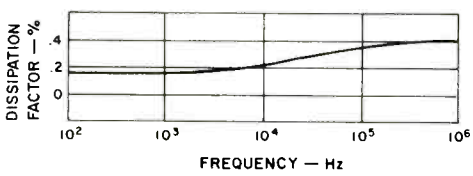
14 A — Metalized polyester, courtesy Seacor, Inc.



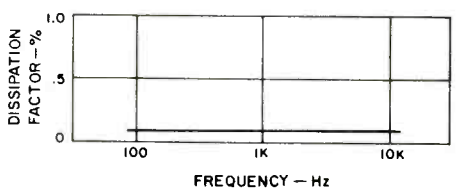
14B — Metalized polycarbonate, courtesy Union Carbide.



14C — Parylene, courtesy Union Carbide.



14D — Polystyrene, courtesy Midwec.



14E — Metalized polypropylene, courtesy Seacor, Inc.

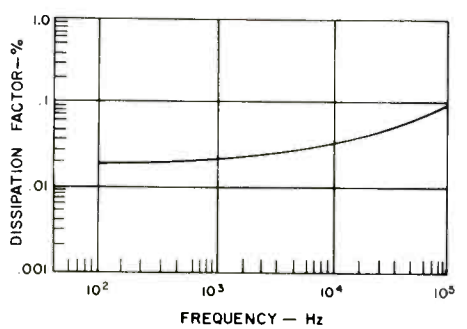
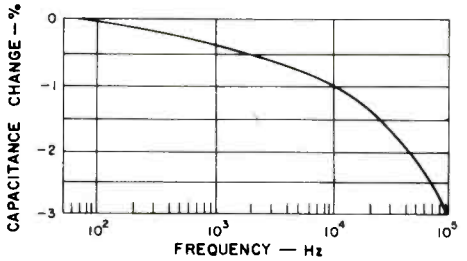
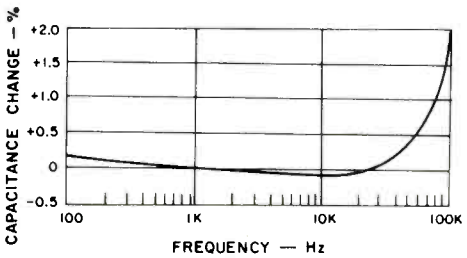


Fig. 15 — Capacitance vs. frequency, various dielectrics.

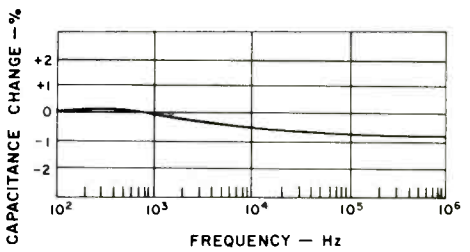
15A — Metalized polyester, courtesy Seacor, Inc.



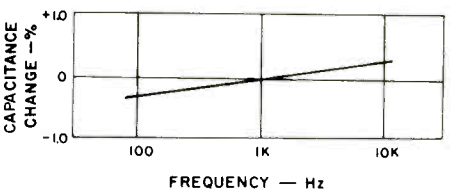
15B — Metalized polycarbonate, courtesy Union Carbide.



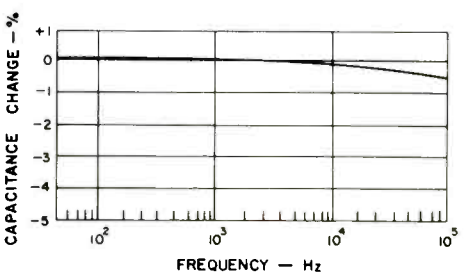
15C — Parylene, courtesy Union Carbide.

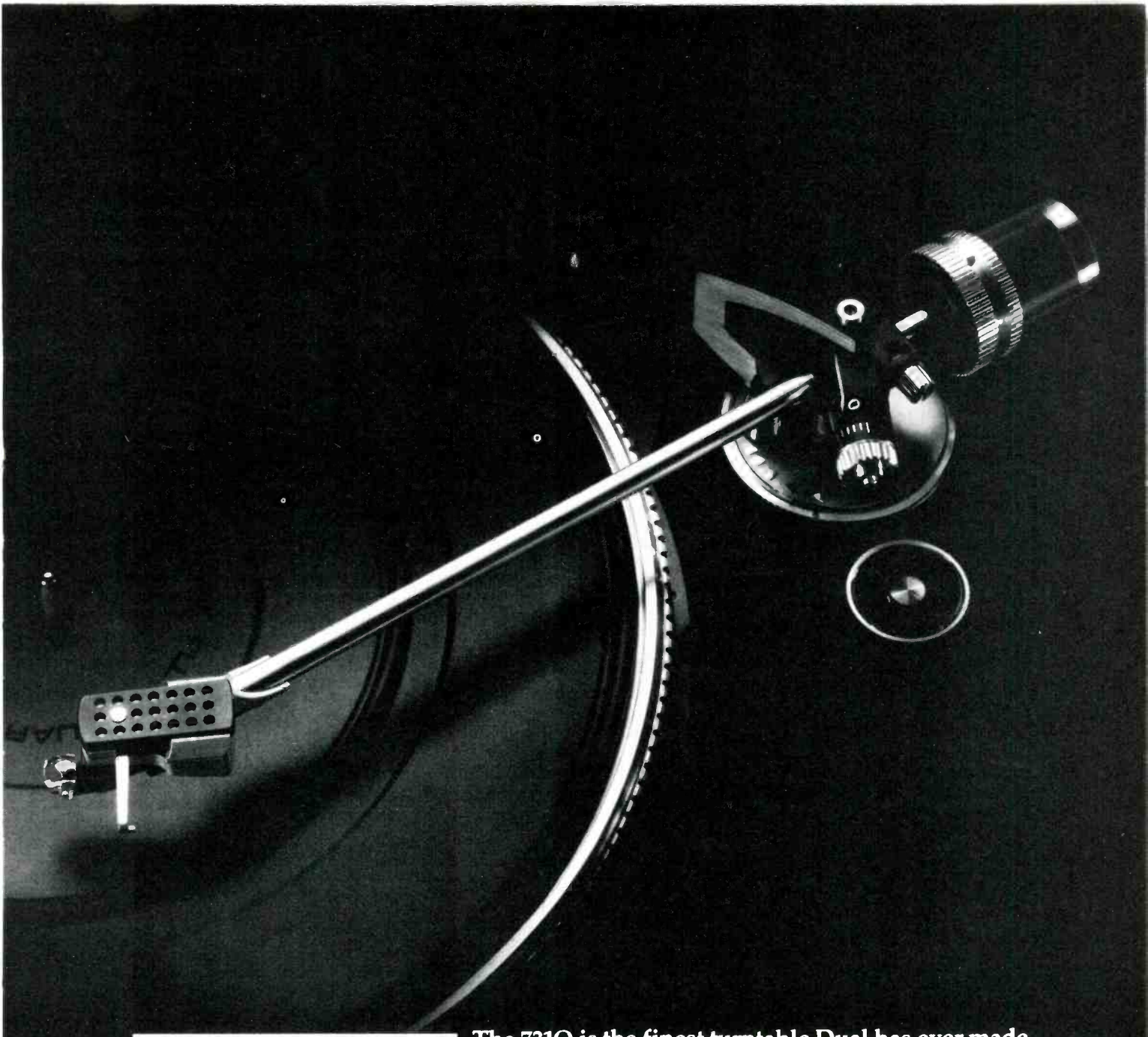


15D — Polystyrene, courtesy Midwec.



15E — Metalized polypropylene, courtesy Seacor, Inc.





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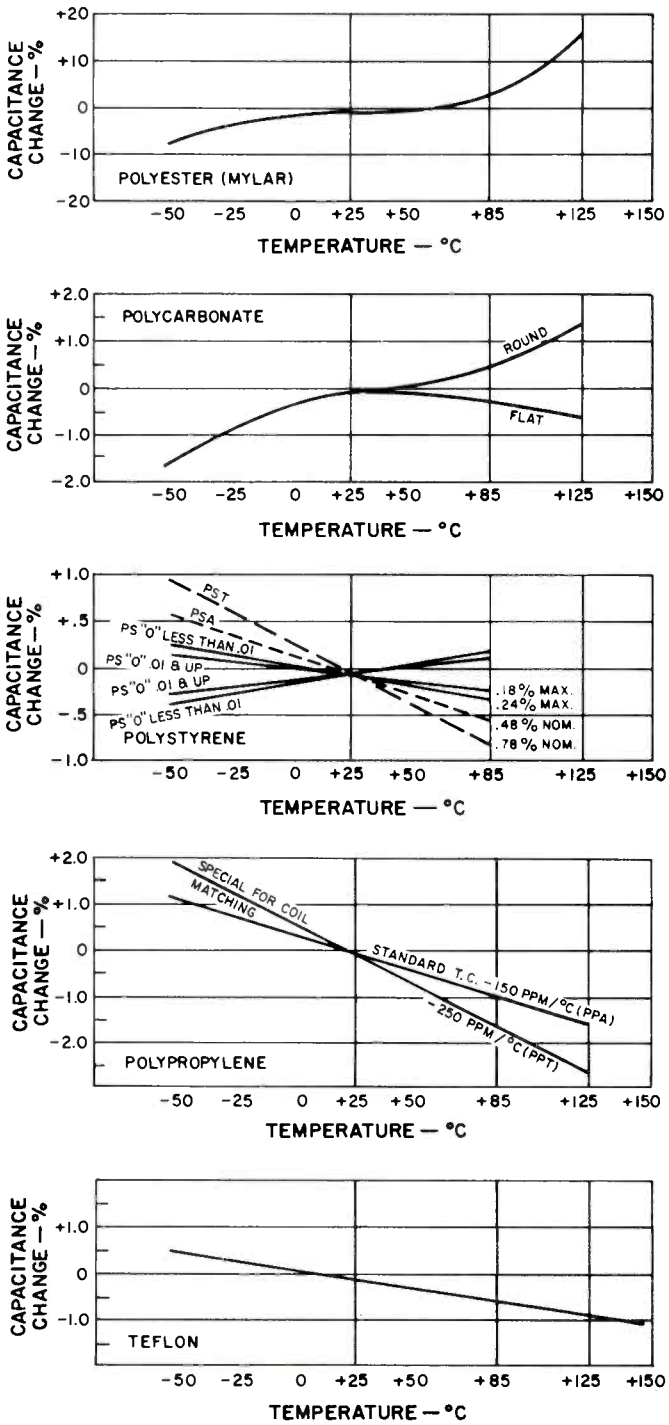
Dual

is tricky. If it is not done adequately, a high (or worse, intermittent) Rs can occur. As a result, metalized caps will usually show somewhat higher levels of DF than a foil unit. However, they can still be of excellent quality, and the best advice here is simply to thoroughly check a given type before use.

The final "parameter" of Table III is the relative cost of the various dielectrics. A statement that is unquestionably true here is that you do get what you pay for — the "super dielectric" films will cost you more money for a given value. For example, a small-quantity of price for a 5-μF polypropylene will be on the order of $8.00, whereas a 5-μF aluminum electrolytic will cost about 20 cents.

Fig. 16 — Capacitance vs. temperature, various dielectrics, courtesy F-Dyne Electronics.



This kind of comparison is a sobering one, and the authors would be foolish to think it will not scare many off. However, we should not attempt to kid ourselves that "cheaper is better," as it simply is not *if you want the best quality.* As time progresses and more become aware of the advantages of these excellent capacitors, we hope volume usage will help their price reduction. Where it is inevitable that a cap be used, we should be prepared to pay more for the quality unit necessary. If this seems like a harsh, unrelenting statement, the final summation should give you better perspective for why we feel the true audiophile must be prepared to bite the bullet with regard to capacitors.

Summary

If we have done a good job on this article, a glance at Table III and considerations of the distortion discussions should allow the reader to easily select a good capacitor. For reasons of practicality and other rationalizations, there are the inevitable trade-offs. However, here is the way we see it.

Up to values of about 10,000 pF, polystyrene is the best all-around choice, as it has reasonable size and is readily available in many sizes, with tight tolerances available. Above 10,000 pF, and up to 0.1 μF, it still can be used but is much harder to obtain.

Above, 0.1-μF polypropylene (or metalized polypropylene) is the dielectric of choice, as it has nearly the same relative qualities of DF and DA as polystyrene. Tight tolerances are available (but will be special order), and you can get capacitors up to 10 μF or more.

Teflon may well be the best dielectric of all for audio, but is produced in limited volume and is generally not practical. Parylene is an excellent dielectric also, but limited in electrical size (1 μF or less) and not widely available. Polycarbonate is perhaps the next best all-around choice behind these and is generally available in a wide range of values.

Polyester types are the most widely available for all the films and are already widely used in many audio circuits. There is no doubt that this is due to the generally low cost of these capacitors, but convenience and low cost should not be primary selection criteria to a critical audiophile. *Polyester capacitors can be readily heard in good systems,* with defects similar to those described for tantalum but, of course, reduced in magnitude.

In our opinion, polyester capacitors should be very carefully applied in an audiophile's system, and any system using them in the signal path may potentially benefit by the substitution of (equal value, voltage and tolerance) polypropylenes or polycarbonates. We have done this ourselves on different items of equipment, tube and transistor, with always the same result — a stunning upgrade in sound quality. Further, we have observed others do similar things, either completely independently or at our direction, with the same type of results.

It is not surprising to us that this type of reaction occurs, since one *single* polyester or electrolytic (or other polar type) can be heard, and a typical update to an old preamp or amp might replace a dozen or more! If you did nothing more than take an old (stock) Dynaco PAS preamp and change the capacitors to polypropylenes, you can be literally astounded at the results. All of this is available at moderate cost to anyone who can solder, and you need not send your amp off to the specialty audio shop either! (Capacitor sources are listed in the appendices.)

More Specific Recommendations

Beyond the above described substitutions (which are basically of a one-to-one variety), we'd also like to show how to use aluminum electrolytics effectively, so as to minimize their sound degradation.

Sansui is breaking up a very successful relationship. The TU-717 has a new mate: The AU-719.

Sansui has just introduced an exciting new integrated amplifier, the AU-719. It represents the very latest developments in audio and electronics technology. It is so good, in fact, that it has replaced its rave-reviewed, best-selling predecessor as the partner of the TU-717 tuner.

The TU-717's performance has been extravagantly praised by professional critics and knowledgeable consumers alike. With advanced features like switchable IF bandwidth and specs like 81dB signal-to-noise ratio and 0.06% THD, it's only natural.

We expect the tuner's new mate to receive a tremendous reception and set industry amplifier standards for a long time to come. Here's why.

INTRODUCING DD/DC

What particularly distinguishes the new AU-719 amp is Sansui's patent-pending DD/DC (Diamond Differential/DC) circuitry that provides the extremely high drive current needed to reduce THD by adding large amounts of negative feedback without compromising slew rate or adding TIM.

Slew rate refers to an amplifier's ability to respond to rapidly changing musical signals. The slew rate of the AU-719 is an astounding 170V/μ Sec.

MAGNIFICENT MUSIC

Many modern amplifiers have extremely low total harmonic distortion specs. And that's important. But THD is measured with steady test signals and is not really representative of an amp's ability to deal with music. Sansui alone, with it's DD/DC technology, is able to provide both low THD and lowest TIM simultaneously. Instead of the harsh metallic sound you sometimes get on a conventional amp when the musical signals are complex, with the AU-719 you hear only magnificent music.

THD is less than 0.015% at full rated power of 90w/channel, min. RMS, both channels into 8 ohms from 10 - 20,000 Hz. Overall frequency response is awesome: DC - 400,000 Hz, +0, −3dB. Hum and noise are a super-silent −100dB on aux and −88dB on phono. The phono equalizer, which adheres to the standard RIAA curve within ±0.2dB from 20 - 20,000 Hz, also uses our unique DD/DC circuit for record reproduction that's second-to-none.

CONTROL YOURSELF

The unit is equipped with a full complement of versatile controls and connections to create the system and sound that's right for you, including two phono and two tape inputs, defeatable tone controls with switchable center frequencies, deck-to-deck tape dubbing and a very convenient 20 dB muting switch.

Audition the new AU-719 and matching TU-717 at your authorized Sansui dealer. We think it will be the start of a very successful relationship.

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Sansui

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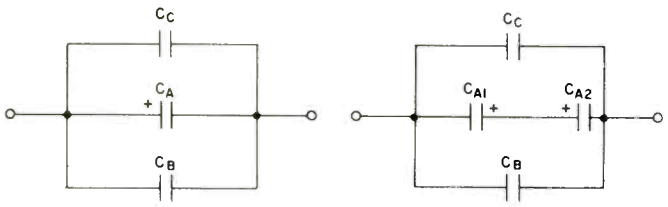
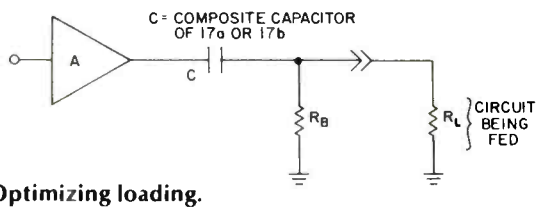
Fig. 17 — Using aluminum electrolytics with film shunts.



A) — Defined polarity. **B) — Arbitrary polarity.**

C_A=330 μF/50 V or 220 μF/35 V aluminum electrolytic (Panasonic), see text.
C_B=5 μF/200 V 20 percent polypropylene (TRW X363UW, Seacor 125 or Electro-Cube W950) or 4.7 μF/250 V 10 percent metalized polyester (Transcap).
C_C= 0.47 μF polypropylene (Transcap).



C) — Optimizing loading.

Notes
1) R_L is net input resistance of next stage load.
2) R_B is local bleeder or shunt resistance, adjusted to minimize leakage and load impedance.

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In Fig. 17 are shown two types of connections which might need to employ higher capacity value, 100 μF or more. The trick is to select a low Rs electrolytic, such as one of the two specifically mentioned for C_A (see Fig. 7 again). Either of them may be considered overkill from a time constant standpoint, as 50 μF may be all that is necessary. But, the high value and voltage listed will minimize Rs, and the relatively high voltage also minimizes DA. At the higher frequencies where the electrolytic becomes inductive, the film shunt carries the signal and minimizes the audible degradation.

Figure 17A is used where the capacitor will always see a defined polarity and can thus be correctly polarized. Figure 17B uses two of the specified types to form a low Rs, low DA non-polar electrolytic. For the film cap C_B, use a polypropylene if at all possible; if not, use a polyester. In either case, a smaller polypropylene shunt C_C helps even further. Optionally, an even smaller polypropylene or polystyrene (in addition) in the range 0.01 to 0.1 μF may be useful in some circumstances.

Figure 17C illustrates how the composite capacitors of 17A or 17B would be best applied as a coupling capacitor (d.c. blocking) within an actual circuit typical of such use. The load resistance which the capacitor must feed into is comprised of R_L (which may be the input resistance of, say, a power amp) plus the local bleeder resistance, R_B. The net load resistance will be R_B and R_L, added in parallel fashion.

For two reasons, this impedance should be minimized. First, and most obvious, a low impedance is necessary to bleed off any d.c. leakage of the large electrolytics (which can for certain conditions be on the order of 1 μA or more). Selecting a load resistance of 10K or less will, for example, reduce the leakage-induced d.c. offset at the output to 10 mV or less for a leakage of 1 μA.

The second reason is to minimize the audible effects of whatever DA may exist in the capacitors actually used for C_A and C_B. A low load (and source) resistance presented to a coupling capacitor tends to minimize sonic deterioration.

In a single blind listening test using such various capacitor dielectric types as mica, polyester, tantalum, and polypropylene, it was found that a simple coupling capacitor can degrade sound quality quite strongly if the load impedance is high. In this test R_L was 50K and R_B was varied from infinity down to 1K, and the source impedance for C was 1K.

A tantalum capacitor (Table II, Test 2, sample 1) feeding the 50K load distorted the sound very strongly, with severe hashy sound and loss of detail. However, the same capacitor under 1K load conditions improved in sound quality appreciably (it did not become transparent, but it did improve). The other dielectrics mentioned followed similar patterns: Poor performance into the higher impedance, improvement in clarity with the lower impedance. However, even the best dielectric on hand in a usable size (5-μF polypropylenes) sounded much better into a lower impedance load.

Of course, one cannot lower load resistance arbitrarily from this general viewpoint, as low-frequency response will suffer sooner or later. But the evidence of these tests and also the general pattern of bench tests for DA (which show reduced recovery voltage for low R_L) indicate that it is worthwhile to lower load resistance (within allowable bounds) to minimize DA effects. This factor can very logically explain points of disagreement on whether or not capacitors really do sound bad, as it tends to say they sound bad (within a given dielectric type) to the degree that the DA is allowed to manifest itself. Minimizing load resistance tends to optimize the circuit in terms of suppressing the DA. General procedural guidelines for "tuning" typical audio circuits with capacitor improvements are described in the sidebar.

Interestingly enough, there is very strong indication to us that in many situations the *power supply electrolytics* also need the same careful attention as do signal path units. The general rule of selection is the same: Use a low Rs unit and bypass it with a film (such as in Fig. 17A). While the degree to which this problem may be apparent is surely related to the circuit topology, it is certainly worth consideration in all instances of amplifier circuits, tubes or transistors.

For those readers unfamiliar with the "sound" of capacitors or this general subject area, much of the above might sound like mad ravings to some degree or another. We'd like to leave some implication of what we feel the magnitude of this problem really is.

After we had gone through all of the above exercises and exorcised our complete system of unnecessary or poor-quality capacitors, the total degree of improvement was greater than any other improvement measure ever employed. With no capacitors (or *clean* capacitors), you begin to hear the music in a new light, one which is much more like the sound of the real thing. In fact, you will be able to differentiate subtleties you never before even realized *existed*. Your system simply becomes a new system, in terms of resolution and definition. The "solid-state sound" we've all heard discussed may be largely due to lousy electrolytics — which by and large never got used in the signal path in the tube days.

Acknowledgements

The authors would like to acknowledge private discussions with John Curl and J. Peter Moncrieff on the subject of capacitors in audio circuits and how they might influence subjective testing. W.J. would like to acknowledge the contributions of Dave White on capacitor problems, and thank him for participating in listening tests. We also found the discussions by Dow [32] to be particularly useful in relating the phenomenon of DA to audio circuit behavior.

In addition, we would like to thank those manufacturers who have allowed use of their data in this article. Technical information as well as price and delivery data can be obtained by writing manufacturers direct (see appendix), mentioning this article.

Appendix I — Capacitor manufacturer index.

Code for types, A= aluminum electrolytic; F= film, and T= tantalum electrolytic.

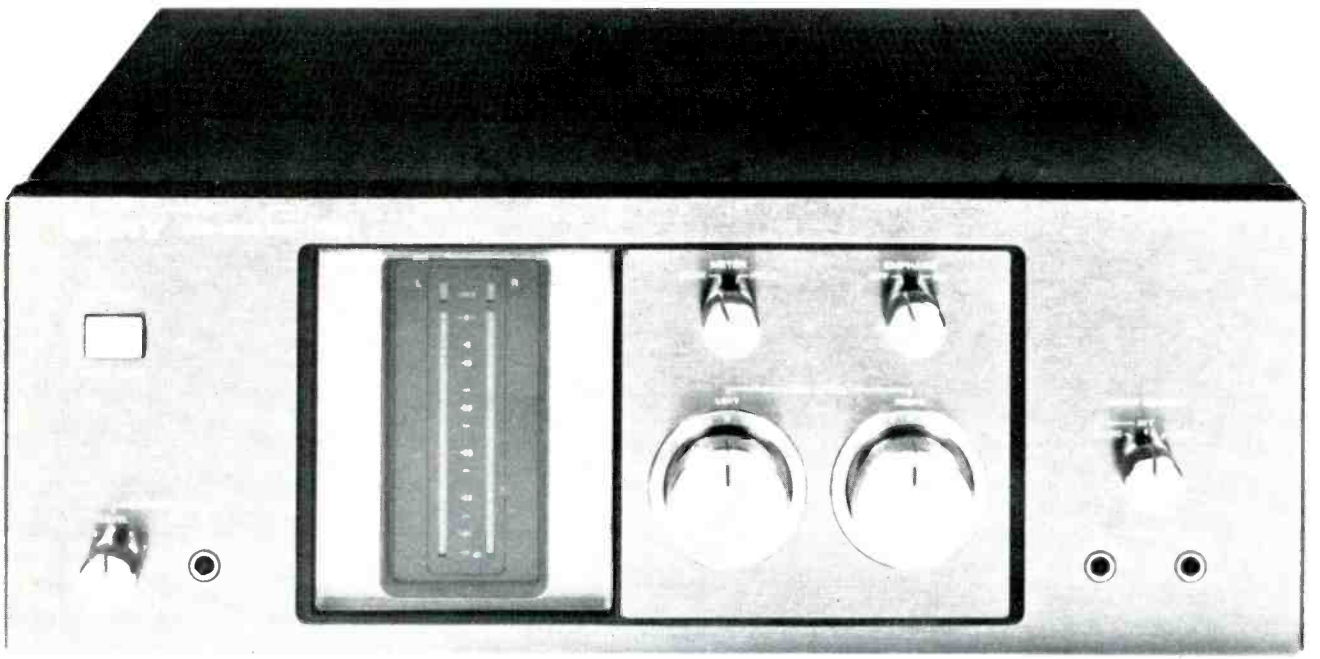
Company	Types
Custom Electronics, Inc. Browne St. Oneonta, N.Y. 13820 607/432-3880	F
Elpac Capacitors 3131 S. Standard Ave. Santa Ana, Calif. 92705 714/979-4440	F
Electro-Cube, Inc. 1710 So. Del Mar Ave. San Gabriel, Calif. 91776 213/283-0511	F
F-Dyne Electronics 449 Howard Ave. Bridgeport, Conn. 06605	F
Mallory Capacitor Co. 4760 Kentucky Ave. Indianapolis, Ind. 46241 317/856-3731	A,F,T
Mepco/Electra Columbia Rd. Morristown, N.J. 07960 201/539-2000	A,F
Mial 165 Franklin Ave. Nutley, N.J. 07110 201/667-1600	F
Midwec Box 417 Scotts Bluff, Neb. 69361 308/632-4127	F
Nichicon (America) Corp. 6435 No. Proesel Ave. Chicago, Ill. 60645 312/679-6530	A,F
Panasonic Electronic Components Div. One Panasonic Way Secaucus, N.J. 07094 201/348-7000	A,F,T
Precision Film Capacitors 100 Community Drive Great Neck, N.Y. 11022 516/487-9320	F
Sangamo Capacitors Box 128 Pickens, S.C. 29671 803/878-6311	A
Seacor, Inc. 123 Woodland Ave. Westwood, N.J. 07675 201/666-5600	F
Siemens Corp. 186 Wood Ave. Iselin, N.J. 08830	A,F,T
Sprague Electric Co. 449 Marshall St. North Adams, Mass. 01247 413/664-4411	A,F,T
Transcap Capacitors Box 2536 El Cajon, Calif. 92021 714/449-6650	F
TRW Capacitors 301 West "O" St. Ogallala, Neb. 69153 308/284-3611	F
Union Carbide/Kemet Box 5928 Greenville, S.C. 29606 803/963-6300	F,T
West-Cap Capacitors 2201 E. Elvira Rd. Tucson, Ariz. 85706 602/294-2646	F

Appendix II — Distributors with shelf stock of audio grade capacitors.

Digi-Key P.O. Box 677 Thief River Falls, Minn. 56701 800/346-5144	Hanifin Electronics P.O. Box 188 Bridgeport, Penna. 19405 800/523-0334	Mouser Electronics 11511 Woodside Ave. Lakeside, Calif. 92040 714/449-2222	National Capacitor Supply 11731 Markon Drive Garden Grove, Calif. 92641 800/854-2451	Old Colony Sound P.O. Box 243 Peterborough, N.H. 03458

Equipment profiles

Sony
Model PCM-1 Audio Unit



Manufacturer's Specifications
Number of Channels: Two.
Modulation System: PCM using standard NTSC TV signals.
Sampling Frequency: 44.056 kHz.
Recording Density: 1.726 Mbit/S.
Code: 94 bits/horizontal; 16 bits for CRC (Cyclic Redundancy Check) circuit.
Data: 13 bits x 2 channels.
Quantization: 3 polygonal line quantization, 13 bits (equivalent to 14 bits).
Dynamic Range: Record/playback, more than 85 dB.
Harmonic Distortion: Less than 0.03 percent.
Frequency Response: 2 Hz to 20 kHz, ±1 dB.
Input Sensitivities: Mike, 0.3 mV minimum; line, 0.095 V minimum; video, 1 V p-p normal.
Output Levels: Line, 0.435 V normal; video, 1 V p-p normal.
Power Requirements: 120 V, 60 Hz, 60 W.
Dimensions: 17 in. (43.18 cm) W x 6¾ in. (17.15 cm) H x 17 in. (43.18 cm) D.
Weight: 41 lbs., 13 oz. (19 kg).
Price: $4,400.00.

To paraphrase a well-known philosopher, I have seen (heard) the future of audio and it is digital! After a great deal of anticipation, I was finally loaned a sample of the world's first and, as of this writing, *only* consumer-type digital audio recording adapter; I then spent a couple of weeks putting it through its paces and, at the same time, learning a bit about digital audio tape recording. Calling the PCM-1 an *adapter* is, perhaps, a bit misleading if not demeaning. One doesn't normally think of adapters as products that sell for more than most high-end audio components, but there is really no other word to properly describe the function of the PCM-1.

As most readers of *Audio* surely realize by now, the PCM-1 is really an elaborate form of signal processor, one which must be used in conjunction with a suitable video cassette deck. In that connection, a somewhat amusing story must be told. Naturally, Sony advises users to employ the Sony Betamax video tape deck to obtain "best results" with the PCM-1. They were kind enough to supply a portable version of Betamax, the Model SL-3000, to use with the PCM-1. I quickly discovered that this portable model had no separate provisions for connecting the required "video in" and "video out" cables supplied with the PCM-1. Access to these terminals on the SL-3000 was *only* via an elaborate multiple-pin connector intended for Sony's video cameras, and the appropriate cable was not supplied.

For reasons which will become obvious in a moment, I remained undaunted and simply hauled out my JVC video portable which employs the competing VHS video taping format. Of course, it worked perfectly with the PCM-1, as would *any* video cassette recorder that can handle a standard NTSC video signal, for that is what one is actually dealing with when using this PCM-1 unit.

As for the PCM-1 unit itself, externally at least, it is a deceptively simple-looking box. On the front panel are a *Power On/Off* button at the upper left, a headphone jack and associated level control at the lower left, two large record level controls to the right of center, a pair of mike jacks at the lower right, an input selector switch for mike/mike attenuator/line inputs above the mike jacks, and a pair of switches above the level controls. One of these switches selects peak or peak-hold functions for the vertically oriented LED meter displays, while the other introduces or cancels a 50-micro-

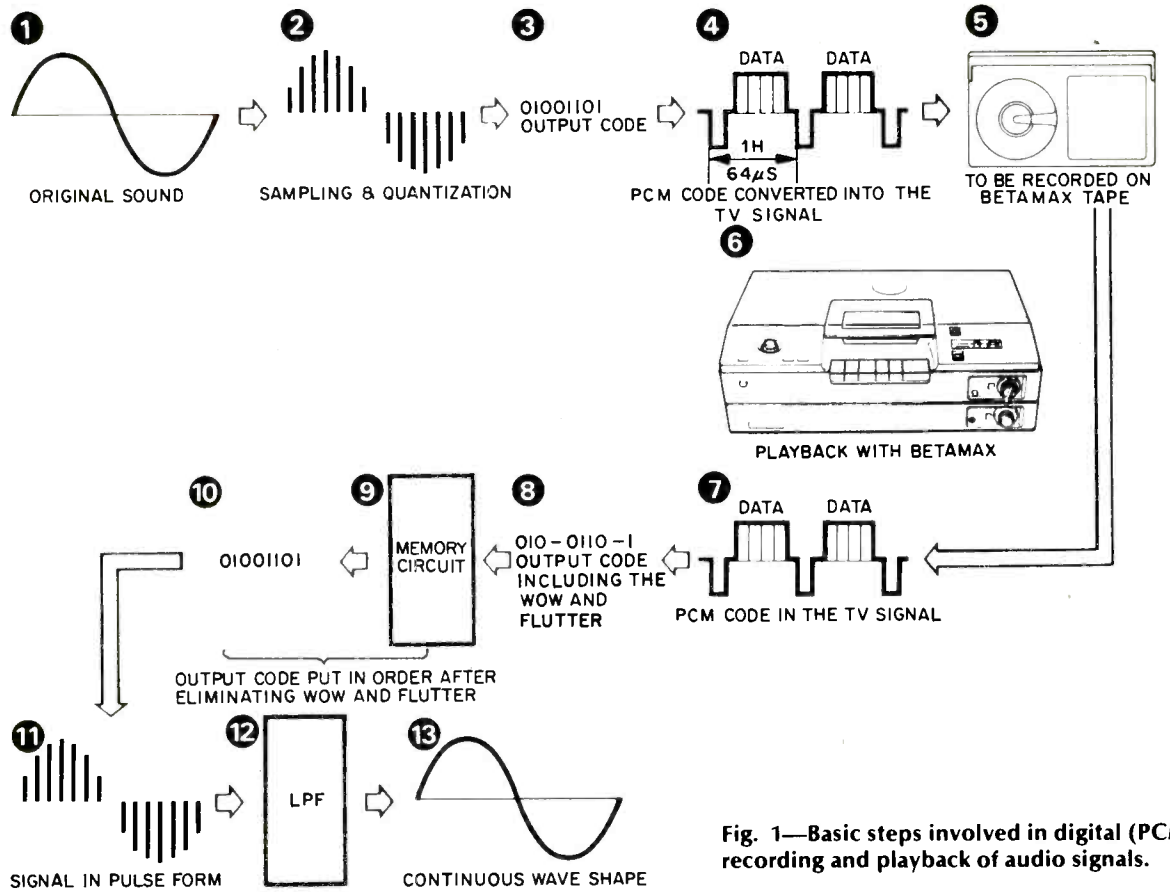


Fig. 1—Basic steps involved in digital (PCM) recording and playback of audio signals.

second pre-emphasis/de-emphasis circuit. The purpose of this pre-emphasis/de-emphasis will be described later, when we discuss the circuit features of the PCM-1.

The LED metering system, consisting of two rows of vertically arranged LEDs, covers a wide range from -60 dB to 0 dB. Unlike conventional analog recorders, the 0-dB mark is the absolute maximum level which can be recorded, and any attempt to record at higher levels results in severe distortion. For this reason, "clipping" indicator lights are provided at the top of the meter scale. Normally, these LEDs should never be permitted to light. While the 0-dB maximum restriction takes a bit of getting used to for those of us who have traditionally allowed meters on analog recorders to exceed that limit, it in no way restricts the tremendous amount of dynamic range which can be accommodated by this digital recording system.

The rear panel of the PCM-1 is equipped with line-in and line-out terminals in the form of phono tip jacks as well as XLR-3 Cannon-type connectors, so that professional mike mixers and professional line amplifiers can be connected. Video output and video input jacks enable the user to interface with the required VCR, while a convenience a.c. outlet supplies up to 300 watts of a.c. power for any auxiliary equipment.

The system employed in the PCM-1 is probably familiar to most readers, but a brief review may be helpful to those who are not acquainted with digital recording principles. The diagram of Fig. 1, supplied in Sony's excellent technical information manual, breaks down the process into 13 steps, beginning with the desired audio waveform to be recorded, its sampling and quantization, conversion to binary code data and to a standard video signal format, storage on video tape, playback of the video signal via a memory circuit (to smooth out any and all wow and flutter), reconversion to a signal in pulse-quantified form, and low-pass filtering to recreate the original continuous audio waveshape.

Circuit Description

The block diagram of Fig. 2 illustrates the basic circuit elements employed during audio recording using the PCM-1, while Fig. 3 shows the circuit elements employed during playback. Referring to Fig. 2, line or microphone input audio signals are first amplified either by a differential mike amplifier or by a line input buffer amplifier. After suitable attenuation by means of the record level controls, a line amplifier amplifies the audio signals, applies pre-emphasis if desired, and applies "dither" oscillations or noise. In order to quantize analog signals with the least significant bit in a PCM system, the playback signals will take on a stepped configuration and harmonic distortion would be generated when signal levels are low. However, if a certain kind of noise is superimposed on the signals, the THD is converted into random noise which bears no relationship to harmonics of the audio signal. The noise thus applied is called "dither," and the PCM noise level is almost always determined by it. In the PCM-1's dither generator, zener diode noise is passed through a low-cut filter and amplified, while its level is made uniform by an a.g.c. circuit.

The pre-emphasis is designed to reduce the amount of dither noise and enhance S/N ratio still further by boosting high-frequency response during recording and lowering it during playback. Time constants used are 50 μS and 15 μS, and S/N is improved when using the emphasis circuits by about 7 additional dB. Incidentally, while emphasis must be

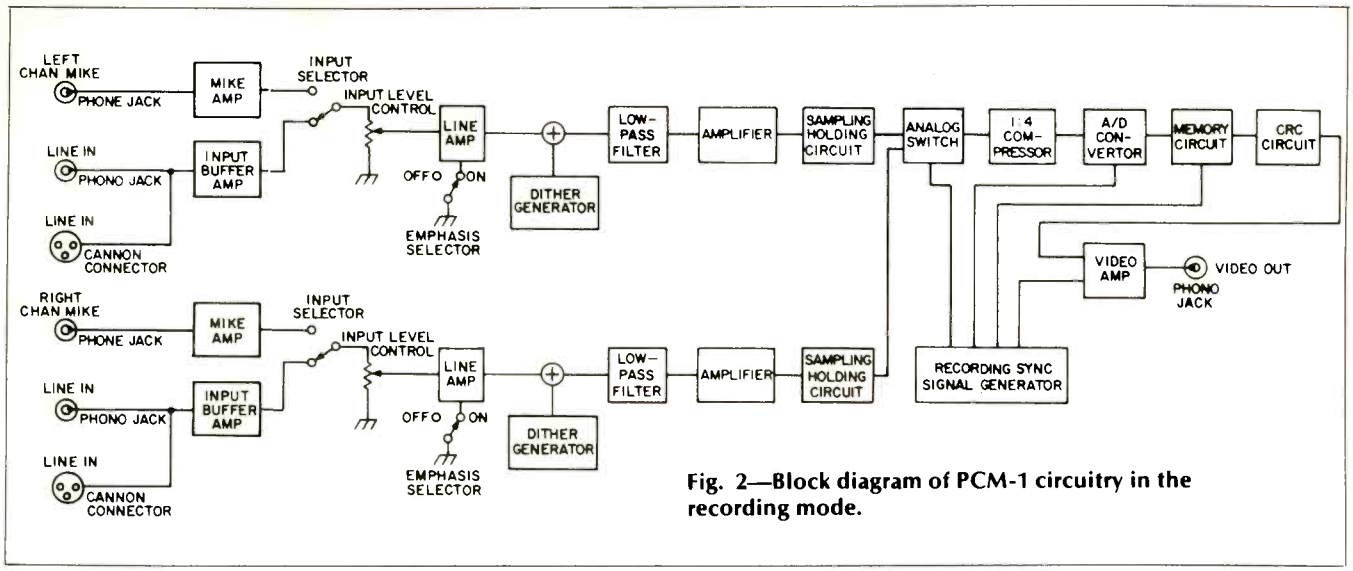


Fig. 2—Block diagram of PCM-1 circuitry in the recording mode.

selected (if desired) during recording, the front panel switch can be left in either position during playback, since de-emphasis is applied automatically by sensing circuits within the unit, when required.

Because of the relatively low sampling rate employed in the PCM-1, it is necessary to attenuate any audio signals above 20 kHz and that is the purpose of the low-pass filters shown in both the record block diagram (Fig. 2) and the playback diagram (Fig. 3). In order to sample a continuous stream of analog signals, it is necessary to sample them in an extremely short time. The circuit that performs this function is known as a "sample and hold" circuit. A CMOS analog switch is used to apply the left-channel and right-channel signals alternately to the analog-to-digital (A/D) converter. By employing a 4:1 compressor in the record chain and a 1:4 expander in the playback signal chain, the PCM-1 provides the equivalent dynamic range of a 14-bit system while in reality employing only a 12-bit code. The task of converting the signals into digital signals is performed by the A/D converter, while the reverse task during playback is performed by the D/A converter shown in Fig. 3. In the PCM-1 left- and right-channel signals are combined (in the analog switch) into a series of pulses on a time-sharing basis. A single complex IC is used for the A/D and D/A conversion.

The PCM-1 is designed so that dropout errors in the data recorded on the tape can be corrected and will not become part of the reproduced sound signal. An interpolation circuit substitutes the average value of samples before and after the code error when incorrect codes occur. Digital signals derived from the A/D converter are fed to the memory circuit. In this circuit the continuous stream of PCM signals are compressed since it is not possible to record data during the horizontal and vertical sync and blanking periods of the standard TV signal.

The CRC circuit stands for Cyclic Redundancy Check and is used in connection with error detection and correction codes. The circuit applies a 16-bit redundancy code to a single horizontal sync period in order to detect data errors when they are produced during playback by dropouts in the tape. Next, the video amplifier mixes the digital signals with standard TV sync signals (vertical and horizontal) which are produced by the recording sync signal generator. Video output is approximately 0.7 volts p-p, at 75 ohms impedance. The recording sync signal generator divides down a quartz-controlled oscillation at 14.068 MHz to provide the precise frequencies required in the A/D converter, memory circuits, etc. and also generates the aforementioned TV sync signals.

In playback, the sync separator circuit shown in Fig. 3

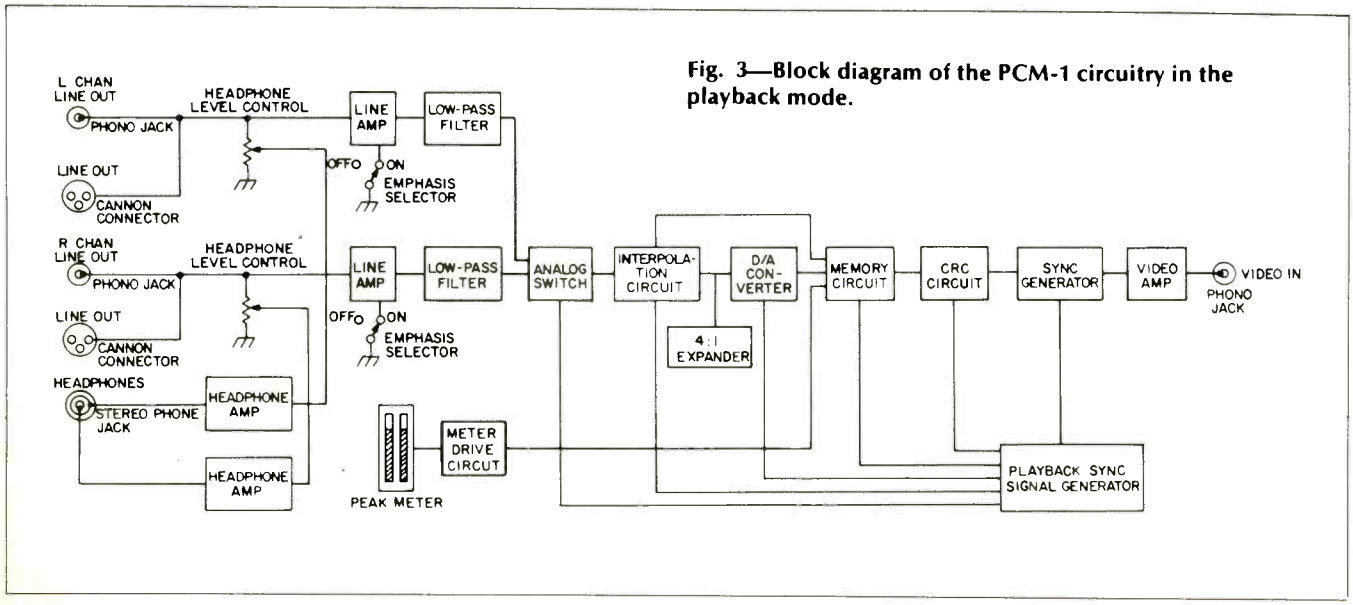


Fig. 3—Block diagram of the PCM-1 circuitry in the playback mode.

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To make a speaker that produces accurate sound is not simple. It requires painstaking attention to detail, precise craftsmanship, and advanced technology.

And that's where Yamaha comes in. We build all our speakers with the utmost precision in every detail.

As the premier examples of Yamaha loudspeaker craftsmanship, read what goes into the two speakers shown, the NS-690II and the NS-1000M. Then you'll understand why Yamaha loudspeakers sound better. Even before you hear them.

Precision Yamaha crafted cabinetry – **(1)** The walls on these, and all Yamaha speaker cabinets, are sturdily braced and crossbraced at every possible stress point. **(2)** The corner seam craftsmanship is so fine that it looks like the cabinet is made from one continuous piece of wood.

The back panels on these speakers are flush-mounted for maximum air volume within the cabinet. **(3)** Inside, a ¾" felt lining "decouples" the cabinet from the drivers to achieve acoustic isolation of the woofer from the cabinet. **(4)** Thick glass-wool also aids in damping the woofer for maximum performance.

Lift one of these Yamaha speakers. It's uncommonly heavy and sturdy. **(5)** We even glue and screw the woofer cutout from the baffle to the inside rear panel for greater cabinet rigidity.

Now knock on the cabinet. It will sound as solid and substantial as it is.

Precision Yamaha Drivers – **(6)** The drivers are mounted on computer-cut baffle boards with exacting, critical tolerances to insure precision fit. All Yamaha speakers are acoustic suspension design, and this precise fit is critical for an airtight seal and optimum woofer recovery.

The drivers on these, and all Yamaha speakers, are flush-mounted on the baffle board to avoid unwanted diffraction of the sound waves. **(7)** This is especially important because all our tweeters and mid-high range drivers are the maximum-dispersion dome type for the most natural reproduction of voice and instruments.

(8) We use chrome-plated machine screws (rather than wood screws) with two washers (regular and lock) to insure an unyielding mounting.

(9) The speaker frames shown are die cast rather than stamped. That's so they won't twist and alter the voice coil alignment during assembly and use.

Other Precision extras – All terminals are quick connect, screw-mounted assemblies.

(10) The wire leads are carefully soldered, not clipped.

All our speakers use full LRC crossover networks. These crossover networks are among the most advanced available.

Precision that stands alone – There's more. Much more. But, there is another fact of Yamaha loudspeaker construction that simply stands alone in the industry. Each component used in the two Yamaha speakers shown is manufactured by Yamaha. From the hefty die-cast speaker frames to the unique, ultra-low mass beryllium dome diaphragm. That's a statement no other manufacturer can make.

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Look before you listen. You'll be convinced that Yamaha loudspeakers sound better than the rest. Even before you turn them on. Then ask for a personal demonstration of these and other Yamaha loudspeakers at your Yamaha Audio Specialty Dealer, listed in the Yellow Pages. Or write us: Yamaha, Audio Div., P.O. Box 6600, Buena Park, CA 90622.

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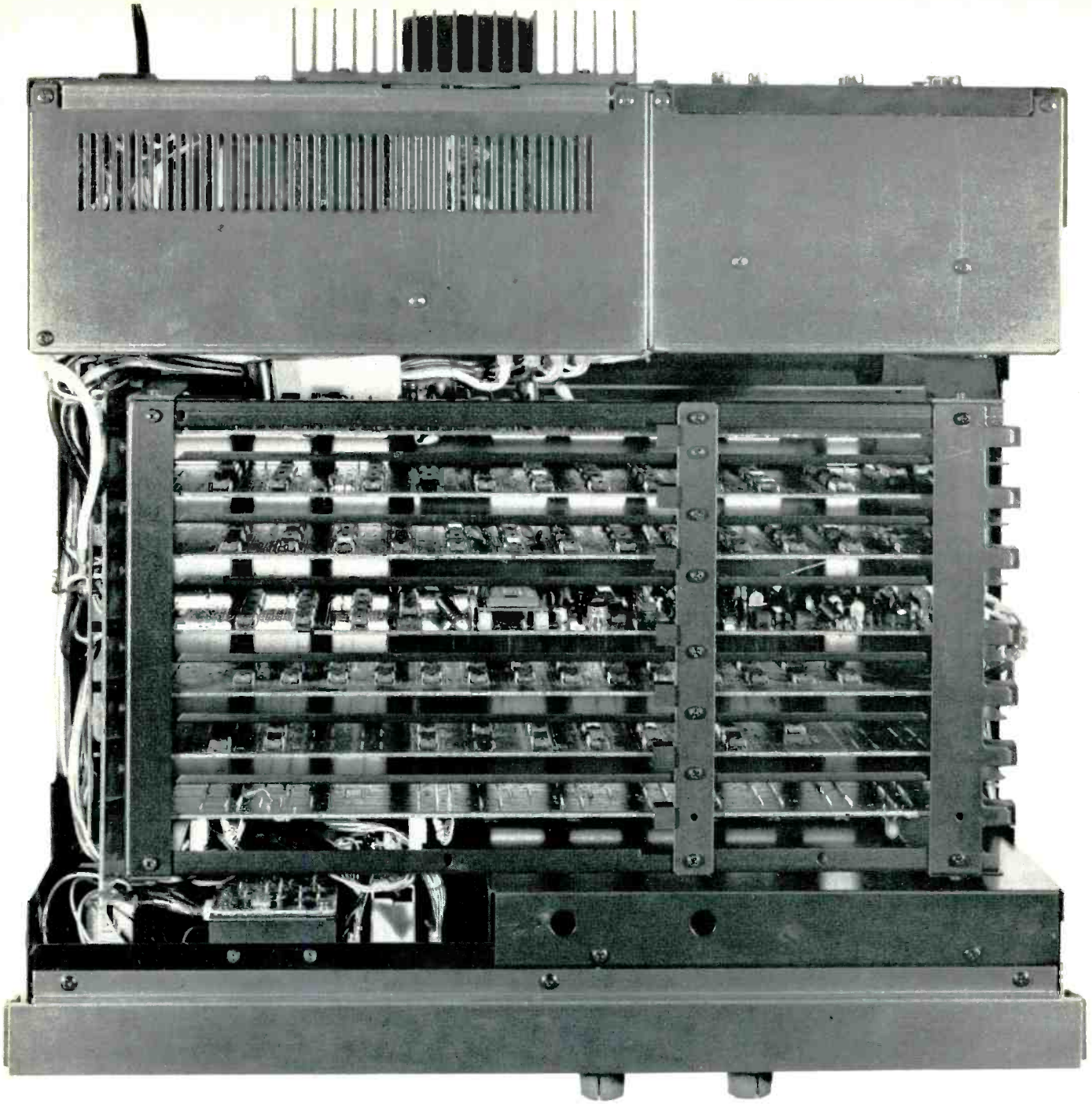
YAMAHA



separates the PCM data from the video sync pulses. The CRC circuit detects data errors caused by dropouts, as previously mentioned. The memory circuit absorbs any jitter in the playback signals that might be caused by tape transport wow and flutter. D/A conversion follows, and the recovered pulses are then expanded by 1:4, following which the interpolation circuit compensates for any dropout code errors. The analog switch function has already been described, and once the correct pulses have been routed to left- and right-channel signal paths, low-pass filters smooth out the pulses, recreating the continuous waveforms which constituted the original audio signals.

Laboratory Measurements

We treated the PCM-1/VCR recorder combination on the lab bench in much the same way as we would any audio tape recorder, making the same sorts of measurements which we would make for a fine audio cassette or open-reel tape deck. Of course, the nature of the combination is such that it is not possible to monitor resulting recordings as they are being made. So, to plot frequency response, we recorded spot frequencies in the range from 20 Hz to 20 kHz. Unlike the situation with conventional analog tape decks (especially cassette decks), we were no longer restricted by high-frequency tape saturation and were therefore able to plot record/play response at 0-dB record level (as indicated on the PCM-1's LED meters). Results are shown in Fig. 4, and you will simply have to take our word for it that they are in no way exaggerated. Response was down 2.0 dB at 20 kHz, as the action of the low-pass filter began to be felt.

We decided pretty early on in our bench tests that the only way to really show how magnificent this digital recording system is would be to compare results, graphically, with results obtained from our own half-track reel-to-reel tape deck operating at its top speed of 15 ips. The two 'scope photos of Fig. 5 tell the story most graphically. Fig. 5A shows noise and

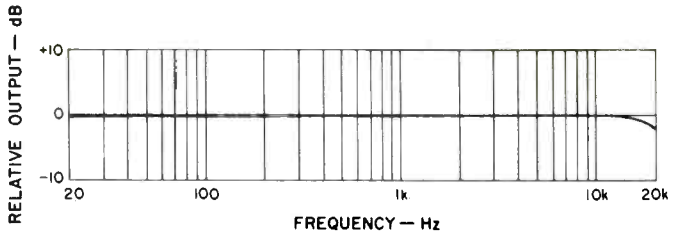
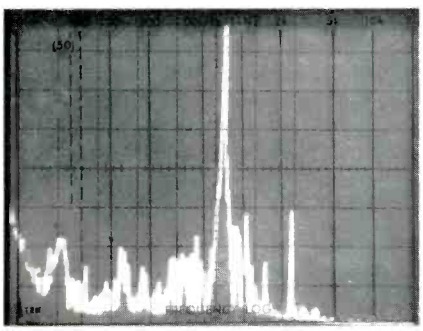


Fig. 4—Record/playback response at "0 dB" record level, using the PCM-1 with VCR recorder.

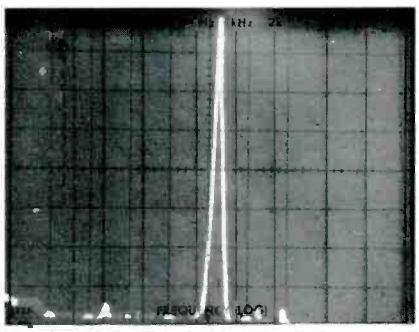
distortion associated with a 1-kHz signal recorded on the analog deck at 0-dB record level, while in Fig. 5B we see the results obtained using the PCM-1 (also at 0-dB record level). Actual THD at 1 kHz measured an incredibly low 0.03 percent using the PCM-1, exactly as claimed. Signal-to-noise ratio, referred to the same 0-dB record level, measured 82 dB.

Next we measured CCIR IM distortion, using a two-tone test signal of 9 kHz and 10 kHz. For the PCM-1, the CCIR IM measured a low residual 0.0017 percent (the limits of our test signal source), while in the case of the analog recorder used for comparison, we read 0.05 percent. Spectrum analysis of the results are shown in the two 'scope photos of Fig. 6. Note the modulation noise surrounding the two tone spikes in Fig. 6A and the complete absence of such noise in Fig. 6B. The sharp spikes that are present in Fig. 6B should not be confused with distortion components. They were, rather, small dropout spikes from the tape which look a good deal worse on the analyzer than they actually sounded. The tallest of these random "ticks" is a good 65 dB below reference signal level in any case and, audibly (while listening to a steady-state tone), they sound like very subdued little pops that my technician and I both describe as "pop corn" noise for want of a better term. Under actual music listening conditions, however, they were completely masked and totally inaudible.

Anyone who has ever taken the trouble to measure SMPTE IM distortion in a tape deck knows that the numbers are pretty horrendous. In the case of our open-reel deck we measured an IM of 2.8 percent at 0-dB record level. For the PCM-1 we measured a mere 0.07 percent, most of which appeared to be in our signal source and not a product of the taping and playback process! Analysis of the played-back 60 Hz and

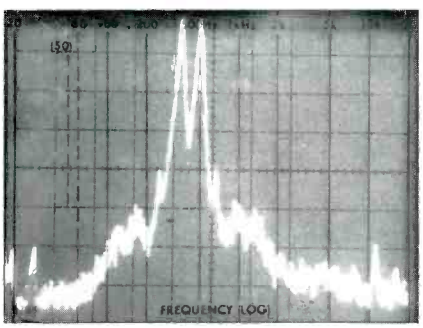


A

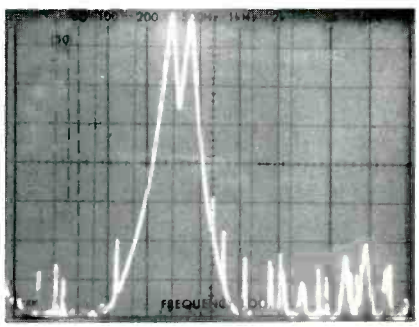


B

Fig. 5—Oscilloscope photo A shows noise and THD components associated with a 1-kHz signal (spike at center) recorded at 0 dB. Compare this with results obtained using the PCM-1 in photo B.

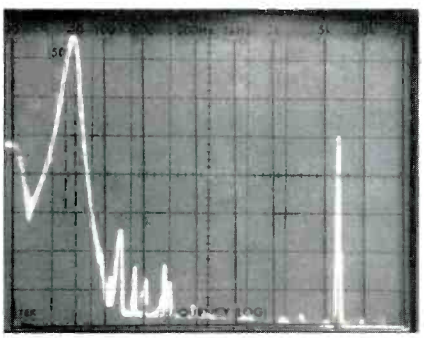


A

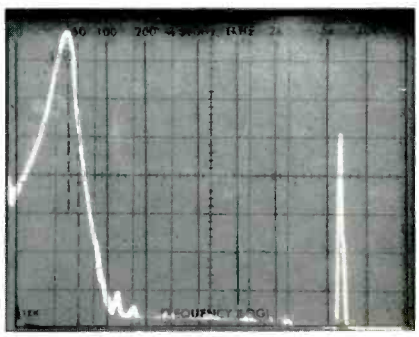


B

Fig. 6—Oscilloscope photo A shows two-tone (9 and 10 kHz) IM test results using high-quality analog deck. Photo B shows results obtained with PCM-1.

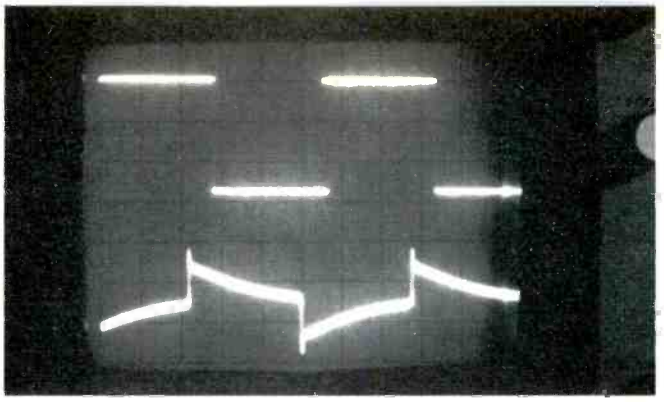


A

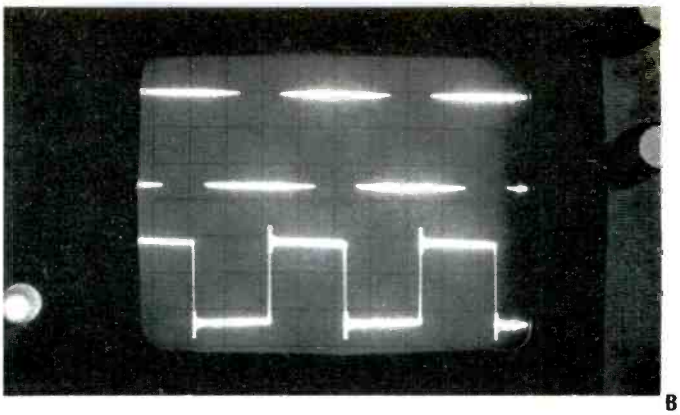


B

Fig. 7—Spectrum analyzer display of playback of recorded SMPTE IM test signal for open-reel analog deck at 15 ips in photo A and for PCM-1 system in photo B.



A



B

Fig. 8—Reproduction of 100-Hz recorded square wave signal on the analog O-R tape deck in photo A and on PCM-1 in photo B. Upper display is input in both cases.

7 kHz SMPTE IM signal was made using the spectrum analyzer, and results are displayed for the open-reel deck and for the PCM-1 in Figs. 7A and 7B.

Trying to record a square wave on any analog tape deck almost always results in a disappointment, as is clearly illustrated in Fig. 8A. Note, however, how close we were able to come to reproducing such a square wave from a tape recording in the case of the PCM-1, as shown in Fig. 8B.

Having convinced ourselves that the PCM-1 used with a VCR can do an incredible audio recording job using test signals in a laboratory environment, we were now faced with

Fig. 9—Stored spectrum analysis of dynamic range and frequency distribution of wide dynamic range music from a decoded dbx disc recorded using PCM-1 and VCR.

the problem of attempting to verify its recording and playback capabilities using musical program material. What in the world were we to use as a program source? Clearly, any transcription of existing tapes (even master tapes) or the very quietest records we own would prove nothing. Their dynamic range and signal-to-noise qualities would fall far short of indicating just how much dynamic range the PCM-1 could handle. Nor did we have access to any live symphony orchestra concerts during the weeks that we had the PCM-1 in our possession. What to do?

We finally came up with our own scheme which, while admittedly a bit unusual, served the purpose. Having recently acquired some of the new dbx-encoded "noiseless" discs and the necessary decoder with which to play them, we decided to record the decoded signals from such discs directly through the PCM-1 and the associated VCR recorder. Dbx discs offer the possibility of at least 80 dB of dynamic range and an almost complete absence of audible surface noise. Sure enough, the scheme worked — at least well enough to prove the point. During playback of the VCR tape we let our spectrum analyzer sweep continuously for about 20 minutes, storing the varying amplitudes on the storage 'scope facilities associated with the analyzer, and this "collection" is shown in Fig. 9. The total amplitude range on the 'scope face from bottom to top is 80 dB (10 dB per division), while frequencies extend from 20 Hz to 20 kHz from left to right. Note that in the vicinity from 100 Hz to 250 Hz amplitudes actually went "off-scale," indicating a dynamic range in excess of 80 dB (since "silence" was represented by the baseline at the bottom of the display). While reproducing this music, we continuously monitored a regular oscilloscope visually, to which the output of the recovered signals from the PCM-1 were applied, and at no time did we see any evidence of clipping or overload. While access to live music might have been more exciting, we feel that this roundabout method did confirm the PCM-1's dynamic range capability of 80 dB plus.

While an investigation of the nature of the "video" signal recorded on the tape will not serve to characterize the quality of sound reproduced from the PCM-1/VCR combination, we were nevertheless curious to see what this recorded signal (as "read" from the VCR tape itself) looks like. Figure 10 shows the actual video signal recorded on the tape for about two vertical frames, while in Fig. 11 we have expanded the display (increased sweep speed) to capture a bit more than one horizontal line of the standard video signal observed at the output of the VCR. If you look carefully at this "line" of video information, you can see the spaces separating individual 13-bit words. The downward-going pulse at the right of the display is, of course, the horizontal sync pulse that should be familiar to anyone who has done any TV servicing.

Fig. 10—Recovered signal from VCR, before connection to the PCM-1, is the familiar video signal that one would expect. Spaces are vertical sync pulses and blanking between frames.

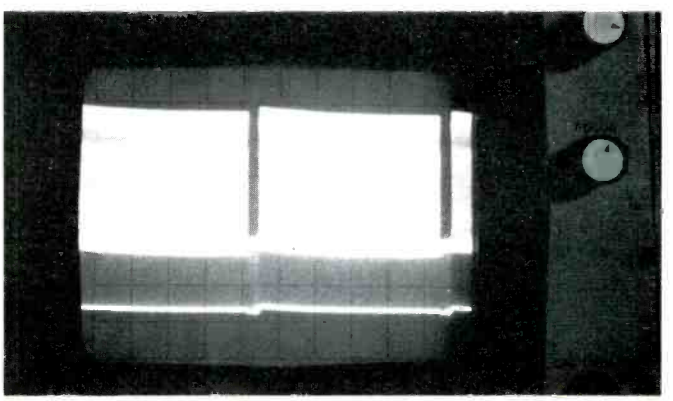
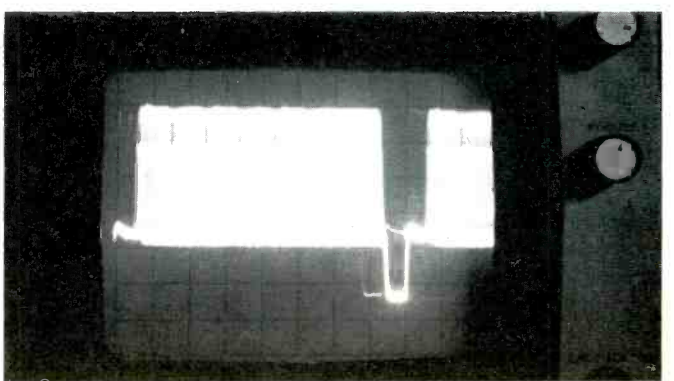


Fig. 11—One "horizontal line" of video signal at output of VCR contains several "words" of digitized audio information.



We couldn't resist the temptation to see what the digitally recorded signal might look like if displayed as a video picture on a TV screen. So, just for fun, we hooked up the VCR to our TV set and played the digitally recorded tape. Interpreting the published specifications, we believe that what you see in Fig. 12 are approximately 49,350 "bits" of digital information, arranged in discrete 13-bit "words" to describe the samples of the original audio signals which we recorded onto this tape. Again, the spaces between "words" are clearly discernible. To get this photo required a time exposure and, as you might guess, the pattern is constantly changing at an incredible rate. Fortunately, our VCR is equipped with stop-frame action, so by "locking onto" a single video "frame" we were able to photograph this striking display. When you think about it, the density of information in just this single frame is enormous!

It goes without saying that in terms of sound quality, absence of distortion, *total* lack of wow and flutter, signal-to-noise ratio and dynamic range, the PCM-1 unit used in combination with a VCR tape deck runs rings around any analog tape recorder I have ever had an opportunity to use or test. That's not to say that there are no disadvantages for the serious home recordist in using a system such as this. The most obvious of these, of course, is price. I do not know whether Sony intends to seriously promote this product to retail customers at its present $4,400.00 price level, but if they should do so, there are still the problems of lack of editing capability. You can't just rip into a video cassette package, and even if you could, you'd have a hard time editing this kind of recorded information in the usual "razor blade and splicer" manner.

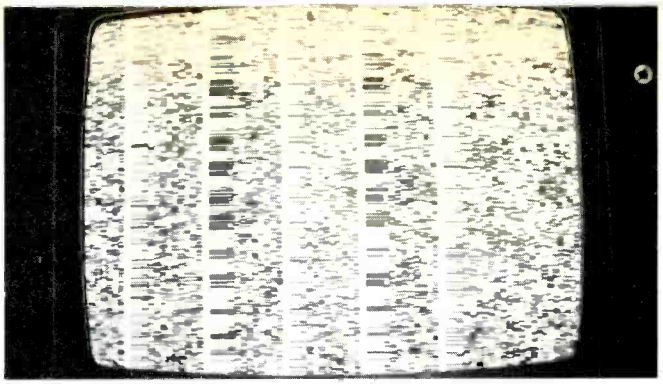


Fig. 12—This is what one frame of digitally recorded audio signal looks like when played back on a TV monitor screen.

Then, too, the PCM-1 circuitry is arranged in such a manner that no LED meter indications are perceived until you activate the associated VCR to which it is connected. That means that to "cue up" record levels, you have to place the VCR in the pause mode — a mode that is not recommended for more than a few minutes if you don't want to damage the tape or the tape head.

For all of these minor disadvantages, it is very clear to me that someday all of us will be recording audio signals in this completely digitalized form. I am grateful to the people at Sony for providing their PCM-1, whose development must have represented an enormous investment with little possibility of immediate return. I am particularly grateful to them too for providing my first practical lesson and experience in digital audio recording. Now that this ground has been broken, it won't be too long before we can purchase digital recording equipment at more down-to-earth prices.

Leonard Feldman

Sansui Model BA-F1 Stereo Power Amplifier

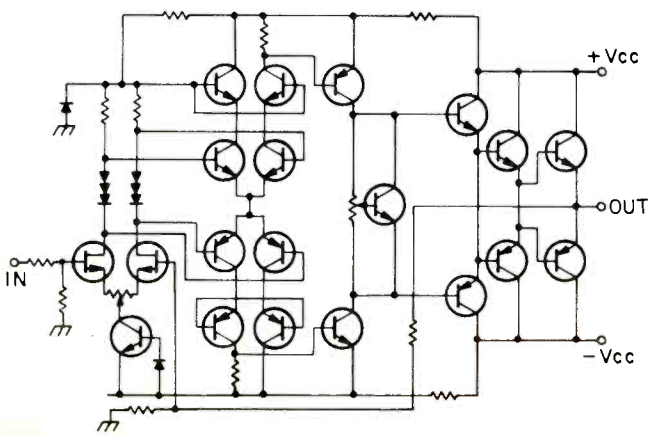
Manufacturer's Specifications

Power Output: 110 W per channel, 8-ohm loads, 5 Hz to 20 kHz.
Rated Harmonic Distortion: 0.008 percent.
Rated SMPTE IM Distortion: 0.008 percent.
Damping Factor: 100 into 8 ohms.
Frequency Response: D.c. to 600 kHz, +0, -3 dB.
Slew Rate: ±200 V/ μS.
Rise Time: 0.5 μS.
Input Sensitivity for Rated Output: 1.0 V.
Hum and Noise (Referred to Rated Output): 125 dB.
Power Requirements: 120 V, 50/60 Hz, 470 W.
Dimensions: With rack mount adaptors, 19 in. (482.6 mm) W x 7⅜ in. (187.3 mm) H x 17¾ in. (450.8 mm) D; less rack mount adaptors, 17 in. (431.8 mm) W x 7⅜ (187.3 mm) H x 17 in. (431.8 mm) D.
Weight: Less rack mount adaptors, 44.1 lbs. (20.05 kg).
Price: $665.00.

Sansui is a firm believer in the importance of fast rise time and high slew rate in audio amplifiers. Both terms describe the speed with which an amplifier can handle sharp transient signals such as occur in modern musical recordings and other music program sources. The company has also made a lengthy study of TIM and has, in fact, come up with their own distinctive method of measuring this audible form of distortion. Although their approach differs somewhat from the method proposed by Matti Otala, it seems nevertheless to offer a valid relative method of TIM measurement.

New circuitry and design techniques based upon these studies have been incorporated in Sansui's new BA-F1 power amplifier. A matching preamplifier/control unit, Model CA-F1, is available for use with this power amp and, according to the maker, embodies some of the same d.c. design philosophy as in the BA-F1 amp. While the rated power output of the BA-F1 is not monumentally high (110 watts per channel into 8-ohm loads with no more than 0.008 percent total harmonic or intermodulation distortion), the sound quality delivered by this not inexpensive amplifier is simply superb.

Fig. 1—Partial schematic of Sansui BA-F1 circuitry.



Physically, the amplifier is a fairly large and heavy unit, measuring 19 inches in width by 7⅜ inches high by 17¾ inches deep and weighing 45 pounds. Its front panel can be equipped with standard rack mounting adaptors and is finished entirely in black. Dominating the front panel are a pair of power output meters designed to read peak power over a very wide range from 0.01 watts to 220 watts per channel (well above clipping level of the amplifier). Calibrated in terms of both watts and dB, the 0 dB point corresponds to 110 watts output (the rated output of each channel); above that point, if the amplifier is driven to clipping or overload levels, a red bar of light integrated into the meter scales flashes almost instantly to denote clipping levels.

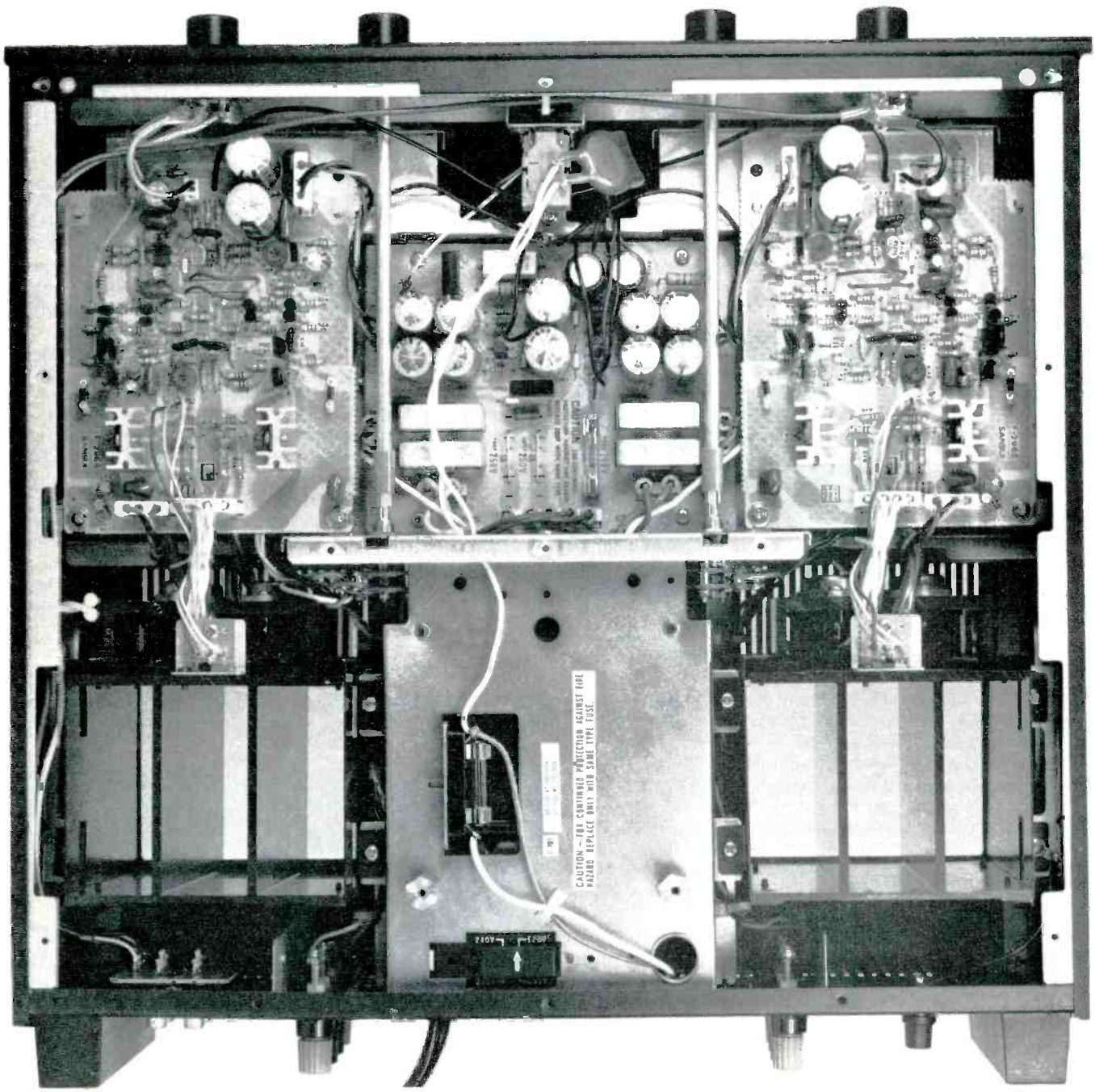
Below the meters, centered on the panel, is a rectangular power on/off switch which illuminates in a green color when power is applied. Above this switch is a "protector" indicator light which flashes on when power is applied (until power supplies are stabilized and the amplifier is operational) or if the built-in protection circuits are triggered for any reason. In addition to separate left- and right-channel level controls, each channel's output circuitry may be switched by means of separate front panel rotary switches to feed either of two connected speaker systems or both systems. This is one of the few basic power amplifiers we know of which offers this versatile speaker switching system.

The rear panel of the amplifier has the required color-coded speaker connection terminals to accommodate four speakers (two pairs) as well as two pairs of paralleled input jacks, a line fuse holder, and a switched and an unswitched convenience a.c. receptable.

Circuit Description

Sansui uses what they have dubbed a Diamond Differential DC Circuit in this power amplifier. Essentially, this circuit makes certain that there is always adequate driving current, no matter how demanding or pulsive the input signal. While a detailed schematic of the DD/DC Circuit is not disclosed (ostensibly because of patents pending worldwide), the company does offer the representational schematic diagram of Fig. 1. The circuit would appear to be basically a dual complementary differential circuit with push-pull output formed of two pairs of PNP-NPN transistors. As the partial schematic indicates, the input signal is voltage amplified by two separate pairs of transistors. These symmetrical differential pairs feature excellent common-mode rejection ratio. When an input signal demands a greater power output, the upper and lower pairs of transistors work as a current differential amplifier to achieve high drive current.

There are two protection circuits in the BA-F1, a d.c. detector and an overload current detector. These, together with a relay circuit, offer protection for the power transistors (which are configured as a three-stage Darlington-connected, parallel push-pull circuit) and connected speakers. Circuitry of the left stereo channel is completely independent of that of the right channel. Although there is only one massive power transformer in the unit, it has secondary windings which are separate for each power amplification channel, and completely separate capacitive filtering is used for each channel. Massive "chimney type" heat sinks are used for housing the output transistors of each channel.



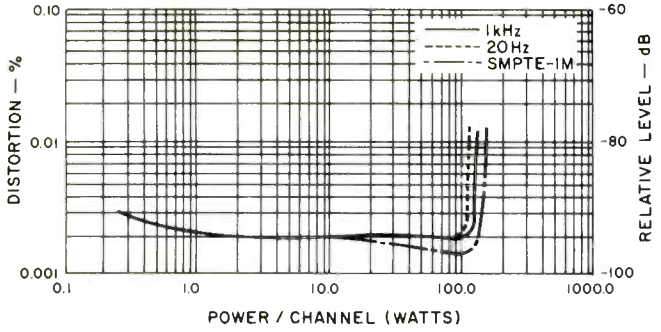


Fig. 2—Distortion vs. power output, 8-ohm load.

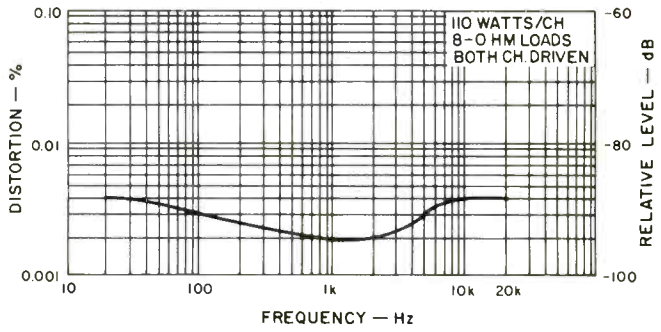


Fig. 3—Harmonic distortion vs. frequency.

Laboratory Measurements

The Sansui BA-F1 amplifier delivered 120 watts per channel with both channels driving 8-ohm loads for its very low rated distortion level of 0.008 percent, using a 1-kHz test tone. Power output versus harmonic distortion and SMPTE-IM distortion are plotted in Fig. 2. Even at the frequency extremes of 20 Hz and 20 kHz, output power available was well above the 110 watt rating assigned by Sansui, with a worst-case reading of 117 watts (at 20 Hz). For a constant 110 watts output, power bandwidth extended from 5 Hz to 30 kHz, as shown in Fig. 3, with rated THD (0.008 percent) reached only at those frequency extremes. Frequency response (for a -3 dB roll-off) extended from d.c. ("zero Hz") to an incredibly high 1.0 MHz! Dynamic headroom was 1.02 dB, while damping factor, measured at 50 Hz, was a high 100, as claimed.

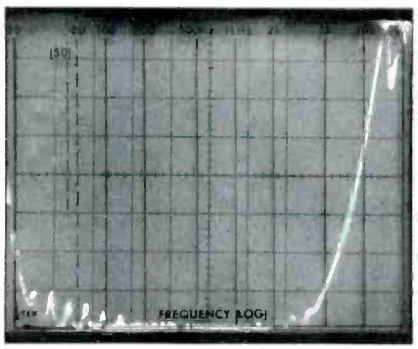


Fig. 4—Two-tone IM measurement of the Sansui BA-F1 amplifier using 19- and 20-kHz input signals.

In order to differentiate between the performance of an amplifier such as the Sansui BA-F1 and more conventional a.c.-configured amps, we applied some additional bench tests before subjecting the unit to musical listening tests. Using a two-tone IM measurement method (19 kHz and 20 kHz, at equal amplitudes), we examined the output signal by means of a spectrum analyzer for evidence of a 1-kHz beat (CCIR IM Distortion) as well as any other spurious products (IHF IM). The 1-kHz product observed measured a low 0.017 percent, while the total of all spurious beats produced added up to the equivalent of less than 0.03 percent, or 70 dB below rated output. A photo of the spectrum analyzer 'scope face displaying these results is shown in Fig. 4.

Slew rate, or the ability of the amplifier to handle rapidly changing voltage levels with great speed, was measured using a 10-kHz square wave adjusted for a peak-to-peak output of 50 volts.

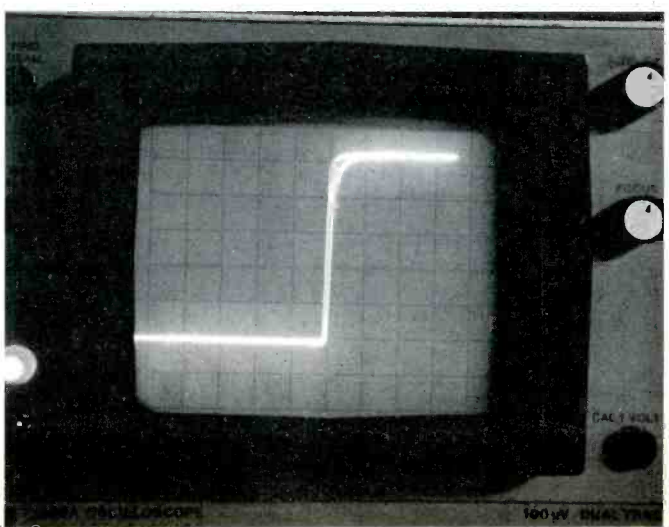
In the 'scope photo of Fig. 5, we have superimposed the input and output waveforms to show the minute slope of the rising wavefront of the output signal compared with the input signal. That slope measured 200 V/ μS, based upon the horizontal sweep rate we used, which was 2 μS per horizontal division. A slew-rate of 200 V/ μS is far greater than would be required from any known program source played through the amplifier.

Use and Listening Tests

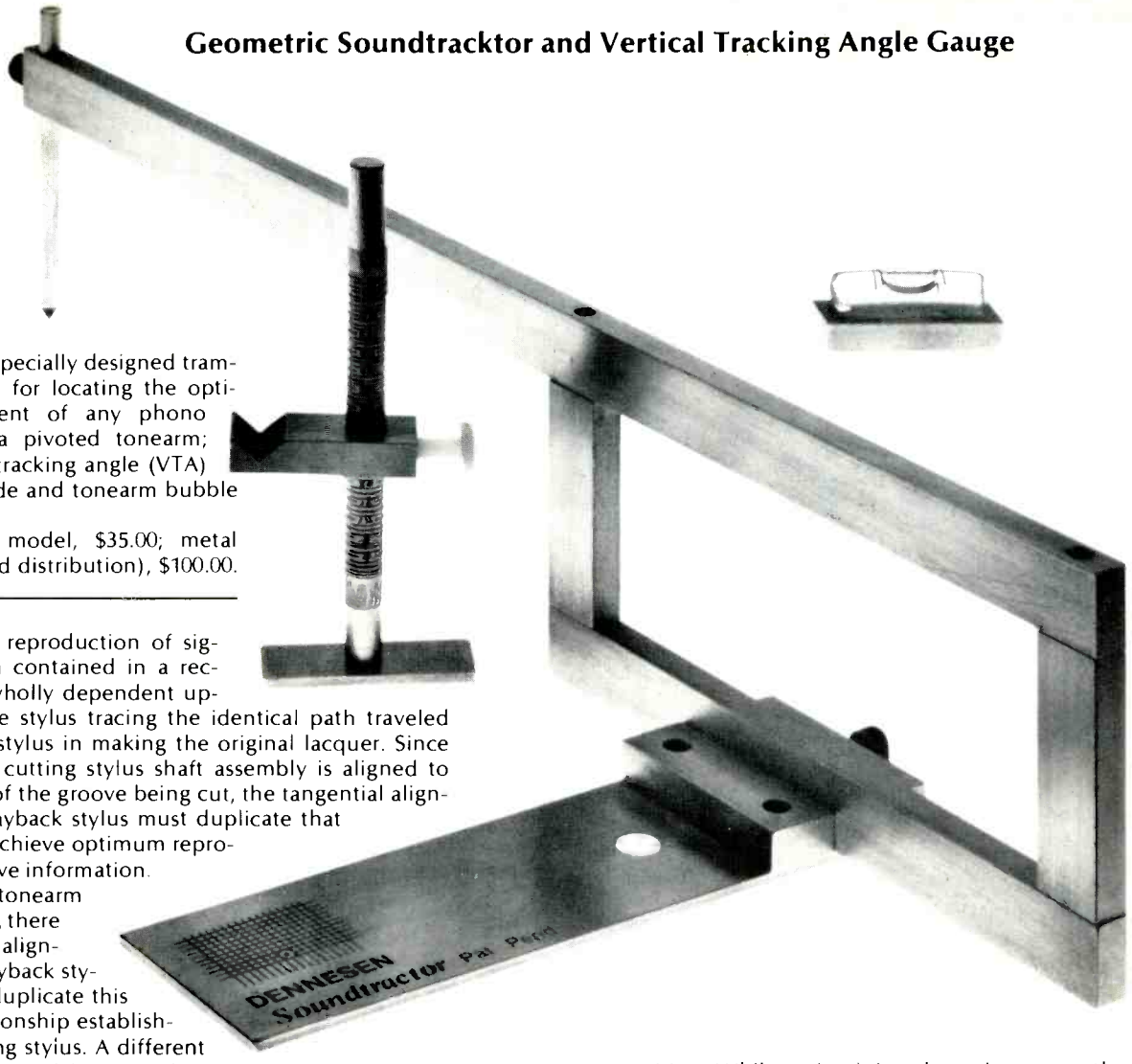
To our ears, the Sansui BA-F1 offered about as clean sound reproduction as it has ever been our pleasure to hear. Bass was extremely tight at all listening levels short of overload, and highs as well as midrange tones were clear and completely devoid of any audible IM distortion, notch distortion, or transient distortion. Those few diehards who maintain that a solid-state amplifier cannot produce sound that is as pure as that produced by vintage tube-amp designs might do well to compare the sound of an amplifier such as the Sansui BA-F1 with any of their favorite tube amps — as we in fact did. With certain types of program material such as some of the new direct-to-disc recordings, the solid-state BA-F1 in combination with the companion Sansui CA-F1 preamp actually provided tighter and more pleasurable sound, at least to our ears.

To the purist who seeks the proverbial "straight-wire-with-gain" power amplifier, the Sansui BA-F1 comes about as close to meeting that elusive goal as anything we have heard in recent months. Of course, it is not an inexpensive amplifier and you can purchase 110 watts of power for a lot less. But that never stopped a dedicated audiophile from seeking out the best — regardless of cost. *Leonard Feldman*

Fig. 5—Superimposed display of 10-kHz square wave input and output signals observed in measuring the slew rate of the BA-F1 amplifier.



Dennesen — Geometric Soundtracktor and Vertical Tracking Angle Gauge



Scheme: (1) A specially designed trammel and base for locating the optimum alignment of any phono cartridge in a pivoted tonearm; (2) a vertical tracking angle (VTA) reference guide and tonearm bubble level.
Prices: Plastic model, $35.00; metal model (limited distribution), $100.00.

The accurate reproduction of signal information contained in a record groove is wholly dependent upon the cartridge stylus tracing the identical path traveled by the cutting stylus in making the original lacquer. Since the axis of the cutting stylus shaft assembly is aligned to an arc tangent of the groove being cut, the tangential alignment of the playback stylus must duplicate that arc tangent to achieve optimum reproduction of groove information. For any pivoted tonearm effective length, there exists but one alignment of the playback stylus which will duplicate this tangential relationship established by the cutting stylus. A different alignment is required for each change in effective tonearm length.

From the time that the monumental mathematical treatise on pivoted tonearm geometry was published by H.G. Baerwald in 1941, there appears to have been only two other major papers published on the subject — B.B. Bauer's in 1945 and J.D. Seagrave's in 1956/57, each confirming the work of Baerwald. Baerwald conclusively established mathematical proofs for the required tangential relationship and commented on the readily audible effects of tangential misalignment of the playback stylus.

Use Test

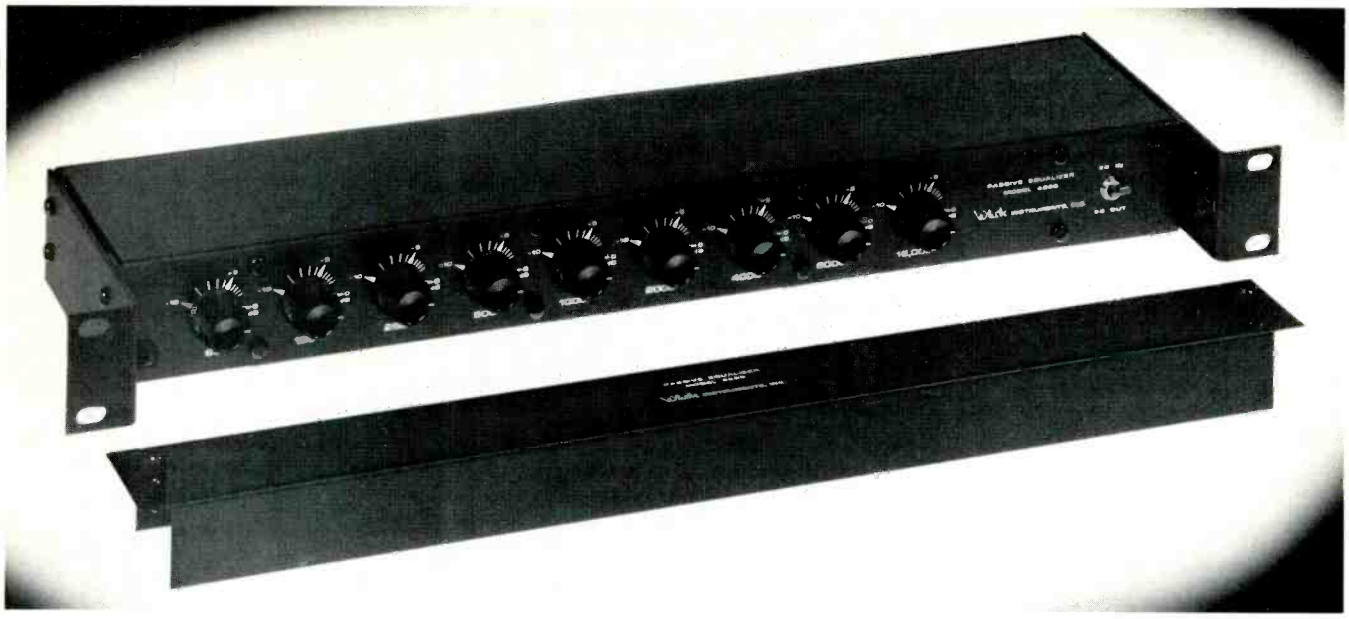
Although the work of Baerwald, as well as Bauer and Seagrave, has been more or less ignored over the years, the development of modern phonno playback systems demanded the re-examination of the phono cartridge alignment problem in pivoted tonearms. Dennesen Electrostatics tackled the problem and developed the Geometric Soundtracktor, which has been designed to translate the rather complex lateral tonearm geometry of proper alignment into a simple, easy-to-use tool, provided the tonearm has an obviously marked pivot center. The Geometric Soundtracktor is made up of a base plus a trammel and pointer. The base is placed over the turntable spindle, and the trammel is set into the base track and positioned so that the trammel pointer is set directly over the pivot point of the tonearm. When this is accomplished, the trammel is locked to the base plate with a thumb screw, placing the Geopoint in the optimum position. While maintaining the pointer over the pivot point of the tonearm, the cartridge is adjusted in the headshell so that the stylus tip is directly on the Geopoint and the sides of the cartridge are aligned parallel to the grid lines surrounding the Geopoint, at which time the cartridge screws are tightened. The cartridge is now aligned for the proper offset angle and overhang, as well as the two optimum null points. The time spent in performing an accurate lateral alignment is usually less than five minutes, as compared with over an hour with most previously available tools.

Accompanying the Geometric Soundtracktor is a vertical tracking angle (VTA) reference gauge, which looks like a tonearm rest post, plus a bubble level. Although the unit does not determine the actual vertical tracking angle of the stylus, it does establish the reference number for each record in your collection where the sound is most balanced and focused. We found this aspect of the total effort to be rather tedious, but once the VTA is established and marked on the record sleeve, it is a relatively simple matter to set the tonearm to the established VTA number.

We have used the Dennesen Geometric Soundtracktor for several months and highly recommend it to tonearm and cartridge designers and manufacturers as well as anyone involved in setting up a phono cartridge for playback. Using the Geometric Soundtracktor eliminates the tediousness of the job and delivers a resultant accuracy to better than 0.003 inches. *B. V. Pisha*

Enter No. 92 on Reader Service Card

White Model 4220 Passive Equalizer



Manufacturer's Specifications
Filter Frequencies: 63, 125, 250, 500, 1k, 2k, 4k, 8k and 16k Hz.
Maximum Attenuation: 10 dB.
Distortion: Less than 0.05 percent up to 7.8 V
Operating Level: Up to 25 V.
Required Load: 10 kilohms.
Dimensions: 19 in. (480 mm) W x 1¾ in. (45 mm) H x 5½ in. (140 mm) D.
Weight: 3 lbs. (1.4 kg).
Price: $220.00.

For those readers who didn't notice from the heading, let attention be called to the fact that this octave-band equalizer is a passive unit, with no power requirements and no active devices. The Model 4220 is a single-channel (or monaural) unit, although two were supplied for test, held together with wooden end pieces. The end pieces are grooved to take a slide-in Lexan front cover which allows visual checking, while keeping off dust and slowing the wandering diddler. A front-mounting security cover is also available, more appropriate for commercial sound installations. The nine filters are on standard ISO frequencies, from 63 Hz to 16 kHz. A filter at 31.5 Hz would probably not be missed in most installations. Adjustments are made with rotary controls with tapered, fluted knobs. The panel markings in white on the black background are easily read. A toggle switch selects EQ *In* or *Out*.

On the back panel are input and output phone jacks, with all connections also appearing on a screw-terminal barrier strip. There is also an octal socket for an optional crossover plug-in. This is a nice feature for the manufacturer to include, permitting a change to bi-amplification with minimum equipment additions. As supplied, the White units had jumpers in the sockets for normal operation. Because of its passive design and lack of isolation of the filters, the 4220 is sensitive to source and terminating impedances. The source impedance should be 1000 ohms or less, and most mixers and preamps meet that requirement easily. The output load is of a more critical nature, and it should be within 10 percent of 10 kilohms. White gives instructions on the calculation of the correct shunt resistor to be added to the terminal strip for amplifier input Zs of 10 kilohms or more. The 4220 is *not* designed to work into 600-ohm or other low-impedance circuits.

Top and bottom covers were held firmly in place with ten screws each into threaded inserts, quite a contrast to the usual few self-tapping screws. The components were mounted on a high-quality p.c.b. with excellent soldering. Precision capacitors and 1 percent resistors were there, but the Allen-Bradley sealed Mil-spec controls were the most impressive.

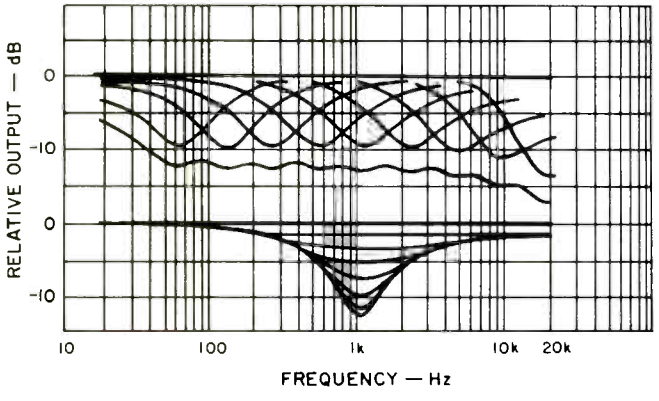


Fig. 1 — Top, response of each filter with 10-dB cut and with all filters at -10 dB; bottom, responses with 1-kHz filter at 0, -2, -4, -6, -8, -10, and -12 dB and maximum cut.

Performance

With all of the filters set for zero attenuation, the frequency response was perfectly flat from 20 Hz to 20 kHz. This result is shown in Fig. 1, which also has the plots of each filter set individually to -10 dB, and then with all sections set to -10 dB. The measured 3-dB down points were at 2 Hz and 536 kHz. In general, the filter shapes were symmetrical and consistent, but there were deviations at the highest frequencies. This was at least partly due to the fact that the terminating impedance was a bit below 10 kilohms at 10 kHz and above. Best results with the equalizer, therefore, are obtained with a constant 10-kilohm load, across the entire band.

The response of the combined filter outputs had relatively little ripple, indicative of minimum phase discrepancies. The center frequencies of the filter sections were very close to ISO standards, usually within 1 percent and far better than most octave-band units. Figure 1 also shows the response of the 1-kHz filter with steps of 2 dB in attenuation until the maximum cut was reached. All scale calibrations were within 0.5 dB, a refreshing change from the results with other units.

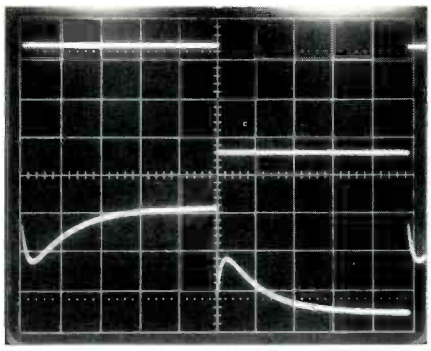


Fig. 2 — Equalizer response to 200-Hz square wave with 1-kHz filter at -8 dB.

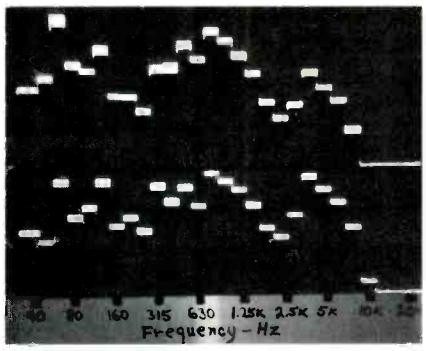


Fig. 3 — Loudspeaker output before (top) and after (bottom) equalization.

If there is no attenuation set in, the driving source actually is terminated in the 10-kilohm output load. With cuts, the impedance seen rises, particularly at the frequencies with attenuation. Similarly, with no attenuation, the measured impedance looking back into the output is the source impedance at the input. The rise in output impedance (including the shunt resistor) would not be a problem for units in close proximity, but should be kept in mind if the terminating unit is some distance away.

Without attenuation on any of the filters, there was no change in output with EQ switched in or out. There was no form of gain matching scheme, so caution would be needed for such a switch if there was much attenuation. Running input levels up to 30 V did not cause any noticeable distortion in the waveform. With its passive configuration, the output was always close in phase with the input. Adjustment of lower-frequency filters caused the 1-kHz reference frequency to shift more positive, about 30 degrees at most. Adjustment of higher-frequency filters caused the reference to lag about 40 degrees at most.

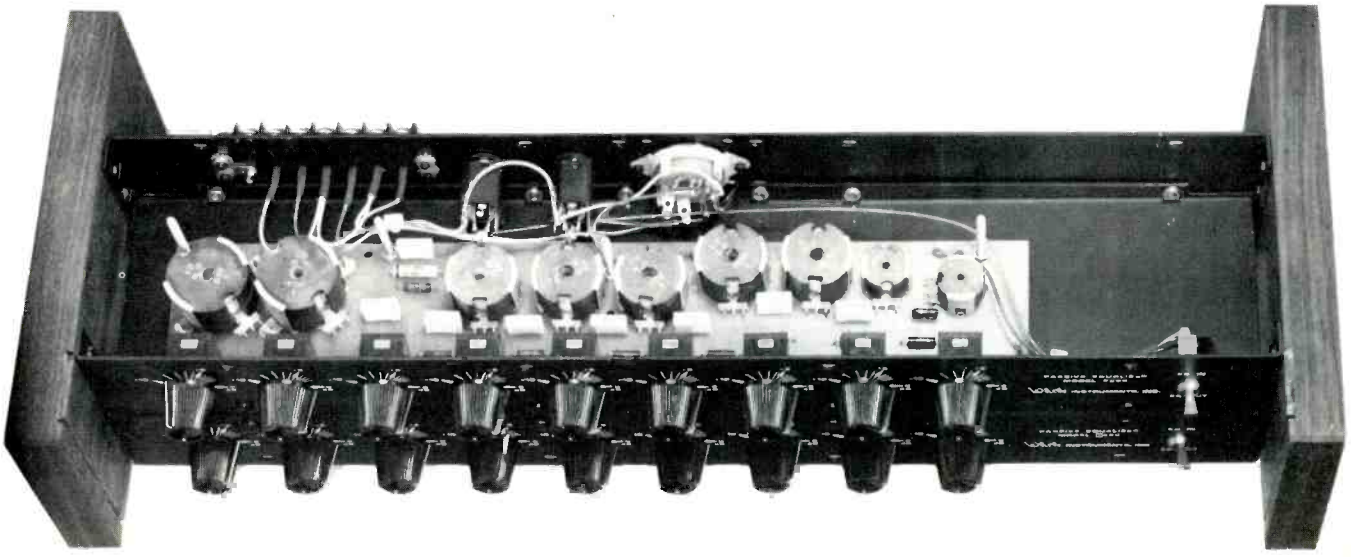
With drive levels of 2 V or less and attenuations of 5 dB or less, all measured distortion figures were the same as the Sound Technology 1701A source. When the unit was driven with a 100-kHz square wave, the output looked very much the same, including all rise times. No slew limiting was observed, but there were some expected effects from adjusting the filters. Figure 2 shows the input and output of the White unit with a 200-Hz square wave and the 1-kHz filter set at -8 dB. A check was made of the output signal-to-noise ratio with a 1 V reference; the result: -98.5 dBA, which was probably determined by the test equipment. The manufacturer gives the worthwhile caution that the equalizer should not be placed where it might pick up hum. A purposeful "dirty trick" attempt was made to find a position for the 4220 that would pick up hum from an operating cassette deck. No matter what was tried, 60-Hz hum and all its harmonics were down more than -95 dBV on a spectrum analyzer. Obviously, the unit should do quite well in this regard in most locations.

In-Use Tests

The two 4220s were put to work to improve the sound from a couple of so-so loudspeakers. The top portion of Fig. 3 shows the response of one of the speakers on axis while being driven with pink noise. There's a lot there that's pretty poor, including a peak at 63 Hz and an elevated region around 1 kHz. Because the 4220 has cut only, all adjustments were made to bring down peaks. After use of the 63, 125, 500, 1k and 4k Hz filters, the response was as in the bottom of Fig. 3. It's no silk purse, but at least we moved to a better part of the sow. The bass had become more even, and the highs were more in balance with the rest of the spectrum. It was not possible to do anything about the holes in the response, since even equalizers with boost capability cannot compensate for areas of low output, except in a minor way.

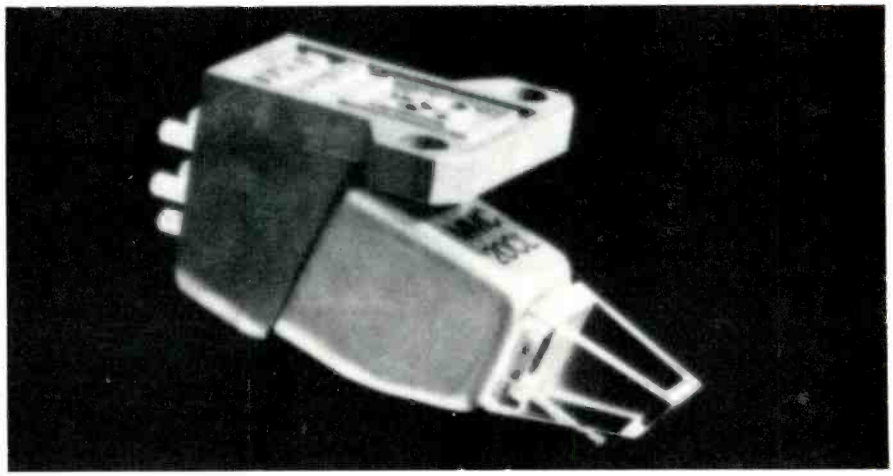
Within its constraints of impedance requirements, attenuation only and lack of gain matching, the White equalizer offers excellent performance. With some minor attention to placement, there should be no hum pickup. It will handle very high levels, the distortion is very low, and it is easy to bi-amp the unit. For those who are interested in octave-band units, the White 4220 offers the above, in addition to high-reliability design.

Howard A. Roberson



B & O MMC 20CL Phono Cartridge

Manufacturer's Specifications
Type: Moving iron.
Stylus: Contact line nude diamond.
Tracking Force: 1 gram.
Effective Tip Mass: 0.3 mg.
Cantilever: Single crystal sapphire.
Static Compliance: 30 x 10^{-6} cm/dyne.
Frequency Response: 20 to 20,000 Hz, ± 1 dB.
Channel Separation: 30 dB at 1 kHz, 20 dB from 500 Hz to 10 kHz.
Channel Difference: Less than 1 dB.
Voltage Output: More than 0.6 mV/cm/S, rms.
Load Impedance per Channel: 47 kilohm.
Load Capacitance per Channel: 220 pF.
Price: $200.00.



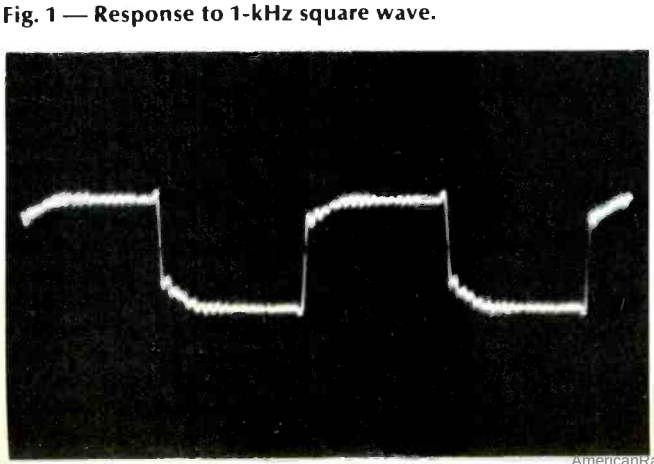
Bang & Olufsen (B & O) has introduced a new series, MMC 20, of their moving-iron generating principle phono cartridges in a particular geometry called the moving micro cross (MMC), which transforms mechanical energy to electrical energy. In this series, unlike the previous models, the most important innovation is in the cantilever design. To increase the stiffness of the cantilever, B & O has departed from the usual aluminum or beryllium metals and introduced a cantilever formed from a single sapphire crystal. B & O claims that the single-crystal sapphire is 21 percent stiffer than beryllium and more than five times as stiff as aluminum. The single-crystal sapphire, according to B & O, has a resonance beyond 20 kHz. Further, the velocity of sound in the single-crystal sapphire is twice that in aluminum, reducing any phase distortions at high frequencies.

The contact-line (CL) nude diamond stylus of the MMC 20CL phono cartridge is bonded to the tip of the single-crystal sapphire cantilever and is not replaceable by the user. The particular shape of the stylus gives a long contact in the vertical direction and a narrow line contact horizontally along the groove, thus providing a large overall contact area.

Although the MMC 20CL is designed for direct mounting (plug-in) into the B & O turntable tonearm, it comes with an adapter that permits it to be installed in any modern tonearm that uses half-inch spaced mounting centers.

A transparent plastic guard on the front of the cartridge is used to protect the stylus and at the same time permit the stylus to be seen for easy cueing. The MMC 20CL cartridge comes with a screwdriver, stylus balance, stylus brush, and the usual mounting hardware. Also included is a frequency-response curve plotted for the individual cartridge as well as a computer-generated test printout for each individual cartridge showing its output, balance, separation, velocity, and 16-kHz level in comparison to the level at 1 kHz.

Fig. 1 — Response to 1-kHz square wave.



Measurements

The MMC 20CL cartridge was mounted with its adapter in a Technics headshell and used with the Technics EPA-100 tonearm mounted on a Technics SP-10 Mk II turntable. We oriented the MMC 20CL in the headshell and tonearm with the Dennesen Geometric Soundtracktor. Although the cartridge is designed to track at one gram, it appears to be a little temperature sensitive so that at higher than normal room temperatures, the tracking force had to be increased by 200 mg. Our laboratory tests were conducted at an ambient temperature of 70° F, ± 1° (21.11° C) and the relative humidity was 73 percent, ± 3 percent. The tracking for all reported tests was at one gram, as recommended by B & O, and with an anti-skating force of 1.8 grams. The normal cartridge load of 47 kilohms in parallel with 250 pF capacitance was used for all the tests. As is our practice, measurements are made on both channels, but only the left channel is reported unless there is a problem in the right channel, when both channels will be reported for a given measurement.

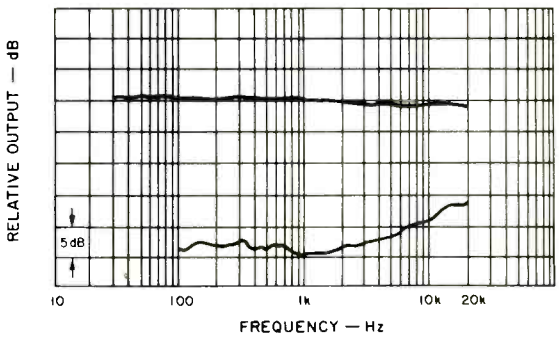
Frequency response, using the Columbia STR-170 test record, is flat within +1.0, -1.7 dB from 40 Hz to 20 kHz, specifically +1 dB from 60 to 70 Hz, +0.5 dB from 100 to 1000 Hz, then dropping to -1.7 dB at 6 to 7 kHz, -1.25 dB at 10 kHz, -1 dB at 15 kHz, and -1.5 dB at 20 kHz. Separation is 24.75 dB at 1 kHz, 18 dB at 10 kHz, 16.5 dB at 15 kHz, and 16 dB at 20 kHz. From these data, one can conclude that the MMC 20CL has an excellent frequency response and a more than adequate high-frequency separation.

The response to a 1-kHz square wave shows a critically damped square wave with a very rapid rise time, no overshoot, and minimal ringing, with a stylus resonance of about 34 kHz. The cartridge-arm low-frequency resonance was at 14 Hz and of 1-dB amplitude with the Technics EPA-100 tonearm. The vertical resonance was about 12 Hz in the same arm.

The following test records were used in making the reported measurements: Micro-Acoustics TT-2002; Shure TTR-103, TTR-109, TTR-110, and TTR-115; Columbia STR-170, STR-100, STR-112, and SQT-1100; Deutsches Hi-Fi No. 2; Nippon Columbia Audio Technical Record (PCM) XL-7004, and Ortofon Direct-Cut Pickup Test Record 0001.

Wt., 4.1 g, 5.65 g with adapter; d.c. res., 678 ohms; ind., 228.5 mH; tracking force, 1.0 g; anti-skating force, 1.8 g; output, 0.82 mV/cm/S; IM distortion: (4:1) +9 dB lateral, 200/4000 Hz, 18 percent; +6 dB vertical, 200/4000 Hz, 16 percent; crosstalk (using Shure TTR-109), >30 dB; channel balance, within 0.1 dB; trackability: high freq. (10.8 kHz pulsed), 24 cm/S, mid-freq. (1000 + 1500 Hz, lat. cut), 25 cm/S, low freq.

Fig. 2 — Response of left channel and separation.



(400 + 4000 Hz, lat. cut), 19 cm/S; Deutsches Hi-Fi No. 2 300-Hz test band was tracked cleanly to 67 microns (0.0067 cm), lateral at 12.62 cm/S at +7.5 dB and 55.4 microns (0.00554 cm), vertical at 10.32 cm/S at +5.86 dB. Surprisingly, slight mistracking was noticeable at 70 microns, but was not harsh in nature.

The MMC 20CL was able to play all the tracking and transient ability bands on the Micro-Acoustics TT-2002 musical test record. The Shure Obstacle Course — Era III test record caused the cartridge no difficulty until level 5 of the solo violin where the beginning of distortion was just evident. Unfortunately, the MMC 20CL was unable to track beyond level 4 of any band of the Shure Obstacle Course — Era IV. This is not uncommon inasmuch as very few cartridges can track this musical test record beyond level 4 of any band.

Use and Listening Tests

As usual, we performed our listening tests both before and after measurement. We found the cartridge to be neutral in performance, adding no coloration to the music being played. We were unable to hear any distortion in the records we played, with their varying recorded velocities. The MMC 20CL appears to favor the human voice, in particular the soprano. We were especially impressed with the cartridge's ability to cleanly reproduce the cannon fire on the Telarc 10041 Tchaikovsky: *"1812" Overture, op. 49* recording and the 19.2-Hz organ pedal (held for 55 seconds) in the Franck: *Pastorale in E Major* as recorded on the Hammond Castle Pipe Organ by Decibel Records DB 1000 (Box 631, Lexington, MA 02173). If you cannot hear the 19.2-Hz pedal, remove the grill cloth on your speakers and watch the cone vibrate at this low frequency.

After an extended period of listening to the B & O MMC 20CL phono cartridge, it becomes obvious that its reproduction of music is excellent despite what some laboratory findings might indicate. Not infrequently, we wonder if laboratory measurements really tell us anything about how a phono cartridge will sound.

B.V. Pisha

Evaluation Equipment and Records

The following equipment and specific records listed below, as well as many discs listed in past reports, were utilized in the listening evaluation of the MMC 20CL phono cartridge: Technics SP-10 Mk II turntable, Technics EPA-100 tonearm, Nikko Beta 1 preamplifier, Crown IC-150A preamplifier, Audire DM-700 power amplifier, Audio Innovations LED 2C Dynamic Power Display, Columbia SQL-400A SQ decoder, and a pair of stacked Duntech DL-15B speakers in each channel. Each pair of speakers was connected to the Audire DM-700 power amplifier with Monster Cable. The turntable was equipped with the Hiraoka Disk-SE22 turntable mat.

The following records were among those used to aurally assess the performance of the B & O MMC 20CL phono cartridge:

Stereo

Hammond Castle Pipe Organ (Vol. 1), D. Marshall (organist) — Decibel Records (Box 631, Lexington, MA 02173) DB 1000.

Offenbach: *La Perichole* (Crespin, Vanzo, Bastin), Lombard, Strasbourg Philharmonic Orchestra — RCA (Erato) FRL 2-5994.

Lehar: *The Merry Widow* (Sutherland), Bonynge, National Philharmonic Orchestra — London OSA 1172.

La Stupenda! (Sutherland) — London OS 26603.

Concert, Welch (organist) — Wilson Audio Specialities (147 San Felipe Way, Novato, CA 94947) H-I-77.

Berg: *Lulu* (Silja), Dohnányi, Vienna Philharmonic — London OSA 13120.

Strauss, R.: *Ein Heldenleben*, Solti, Vienna Philharmonic — London CS 7083.

Brahms: *A German Requiem* (Kanawa, Weikl), Solti, Chicago Symphony Orchestra and Chorus — London OSA 12114.

Direct to Disc

Sonic Fireworks (Vol. 1), Morris, Atlanta Brass Ensemble — Crystal Clear Records CCS-7010.

Sonic Fireworks (Vol. 2), Morris, Atlanta Brass Ensemble — Crystal Clear Records CCS-7011.

Taj Mahal, Live and Direct — Crystal Clear Records CCX-5011.

The Dillards: *Mountain Rock* — Crystal Clear Records CCS-5007.

The Power and the Glory (Vol. 2), Holzgraf (organist) — M & K RealTime Records RT-113.

The Magnificent Basso (Li-Paz) — M & K RealTime Records RT-102.

Pulse Code Modulation (PCM) Digital to Analog

Tchaikovsky: *1812; Capriccio Italien*; "Cossack Dance" from Mazeppa, Kuzel, Cincinnati Symphony Orchestra — Telarc Digital DG-10041.

Moussorgsky: *Pictures at an Exhibition/Night on Bald Mountain*, Maazel, Cleveland Orchestra — Telarc Digital 10042.

Naturally, Mel Lewis, The Jazz Orchestra — Telarc Digital DG-10044.

Mehta Conducts Mahler: *Symphony No. 4 in G Major*, Israel Philharmonic Orchestra — London Digital Recording LDR10004.

Mendelssohn: *Symphony No. 4, "Italian,"* Dohnányi, Vienna Philharmonic — London Digital Recording LDR10003.

Tchaikovsky: *Symphony No. 4*, Maazel, Cleveland Orchestra — Telarc Digital 10047.

Bartók: *Concerto for Orchestra*, Ormandy, Philadelphia Orchestra — RCA Digital ARC1-3421.

Beethoven: *String Quartets Nos. 3 and 6*, Smetana Quartet — Denon OX-7138-ND.

Tchaikovsky: *Symphony No. 4 in F Minor, op. 36*, Sanderling, Berlin Symphony Orchestra — Denon OX-7137-ND.

The Works of Workman, Reggie Workman — Denon YX-7539-ND.

Live in Tokyo, Archie Shepp Quartet — Denon YX-7538-ND.

Anthem for the New Nations, Dollar Brand — Denon YX-7537-ND.

Round Midnight, Dave Burrell — Denon YX-7541-ND.

Gon's Delight, Takashi Mizuhashi and His Friends — Denon YX-7540-ND.

Denon records are distributed by American Audioport, Inc., Columbia, Mo. 65201.

European letter

Donald Aldous

The audio scene in the United Kingdom can be described as active, if not buoyant, although the key words in hi fi at the moment here are "digital," "micro," and "metal tapes," at least among the so-called hi-fi buffs who are studying the hi-fi magazines. Probably too many are being published in England, which may be confusing the novitiate hi-fi enthusiast, although I must declare my interest in one of the leading papers, *Hi-Fi News & Record Review*. Hi-fi is addictive, and the desire to upgrade one's system is played upon by the advertisers and store sales departments.

One area of growth, almost worthy of being called a trend, is the increasing numbers of music-centers (one-package audio systems, requiring just that a couple of loudspeakers be attached) coming onto the British market. The audio purist may sniff at such combinations, but they are liked by the ladies of the household and by those in homes with small living rooms.

The technical standard of these systems is improving all the time, provided the customer is prepared to pay for the performance. One advanced composite unit recently released is the Bang & Olufsen Beocenter 7000, made in Denmark. This model contains disc record, tape, and radio sources combined with a 2 x 40 watts rms amplifier, all operable by infrared remote control accompanied by an electronic preprogramming facility.

The basic play of any sound source is by a single touch of one button, either on the main panel or on the remote control module. Five FM/VHF and one AM station can be selected in this way, or the turntable or tape deck can be operated. The disc unit employs B & O's disc sensor—already a successful method—to register the presence, size, and speed of a disc before the arm is automatically activated. The tape deck has automatic recognition and bias setting for CrO_2 or Fe_2O_3 tapes.

Every instruction received through the main or remote controls is processed by the Beocenter's microcomputer, which rejects a nonsensical request with a reject signal flashed on the unit's digital readout display. A logical instruction will be answered by a display indicating acceptance and showing the function selected.

Facilities include all the usual secondary output functions (tone, balance, speaker switches, and buttons for operating the built-in timer which can be programmed to play any sound source at any time within a 24-hour period). It is also possible to record radio programs onto cassettes while one is away from home. Additional connections are provided for headphones, a microphone, and an external tape unit. Dimensions are width 28¾ inches (72 cm), height 3¾ inches (9.5 cm), and depth of 15¼ inches (38 cm). This is not a cheap design and is listed at 725 pounds sterling, including the value added tax, or approximately $1,667.50, with loudspeakers added as desired.

Arms Across the Sea

The failure of quadraphony to find a "standard" system has left its mark on the industry and the buying public,

who are very cautiously investigating the new technologies as they don't want their existing or newly purchased equipment to be outmoded in the immediate future. One instance is that in a bid to standardize on video disc systems, Sony and Philips have recently entered into an agreement allowing each to make free use of the other's patents. Furthermore, these two companies have pledged to develop optical video products that are interchangeable. This arrangement comprehensively includes optical, audio and video disc systems using lasers to read signals encoded on a disc.

The significance of this undertaking is that the Sony-Philips tie-up includes the American Philips company and the subsidiary Magnavox. This in turn means that prospects for American/European/Far Eastern compatibility are now closer to reality.

Most readers of *Audio* will surely have seen Roland Gelatt's admirable book, *The Fabulous Phonograph*, first published in 1954. In those pages you will have read the account of Decca's Chief Engineer, in the Second World War years, and Arthur Haddy's work on improved sound recording techniques, leading to the development of *ffrr*—full frequency range reproduction—by this company whose records were released quietly on the British market at the end of 1944. Stravinsky's *Petrouchka*, under Ansermet, was issued on Decca's *ffrr* in 1946, and quantities of these discs reached the USA late in that year. This technical advance is now part of phonograph history, and in late news Decca has announced it will sell the major part of its losing music business to Polygram, jointly owned by Philips of Holland and Siemens of West Germany. Polygram's record interests include the Philips, Polydor, and DG labels.

Honoring Excellence

The British magazine *Hi-Fi News & Record Review* established an Audio Award scheme in 1967, with the aim of recognizing achievements in the recording world by British musicians and technicians. Recipients of this award—an attractive intertwined treble clef in bronze metal—have included Sir Adrian Boult, Neville Marriner, Sir Peter Pears, Colin Davis, Dame Janet Baker, John Williams, Julian Bream, and Andre Previn. Yes, you'll have guessed by now that the 1979 awards went to Arthur Haddy (Decca) and Tony Griffith (EMI) who has worked with most of the major record companies, other than Decca, and in recent years has specialized in transferring 78s to LPs, as well as being responsible for many reissues of post-war recordings. Recent work included preparing a boxed eight-record musical biography of the recordings of Sir Thomas Beecham, covering all aspects of the maestro's activities from the original 1910 sessions to the final recordings. The set is dedicated to Mr. Griffith.

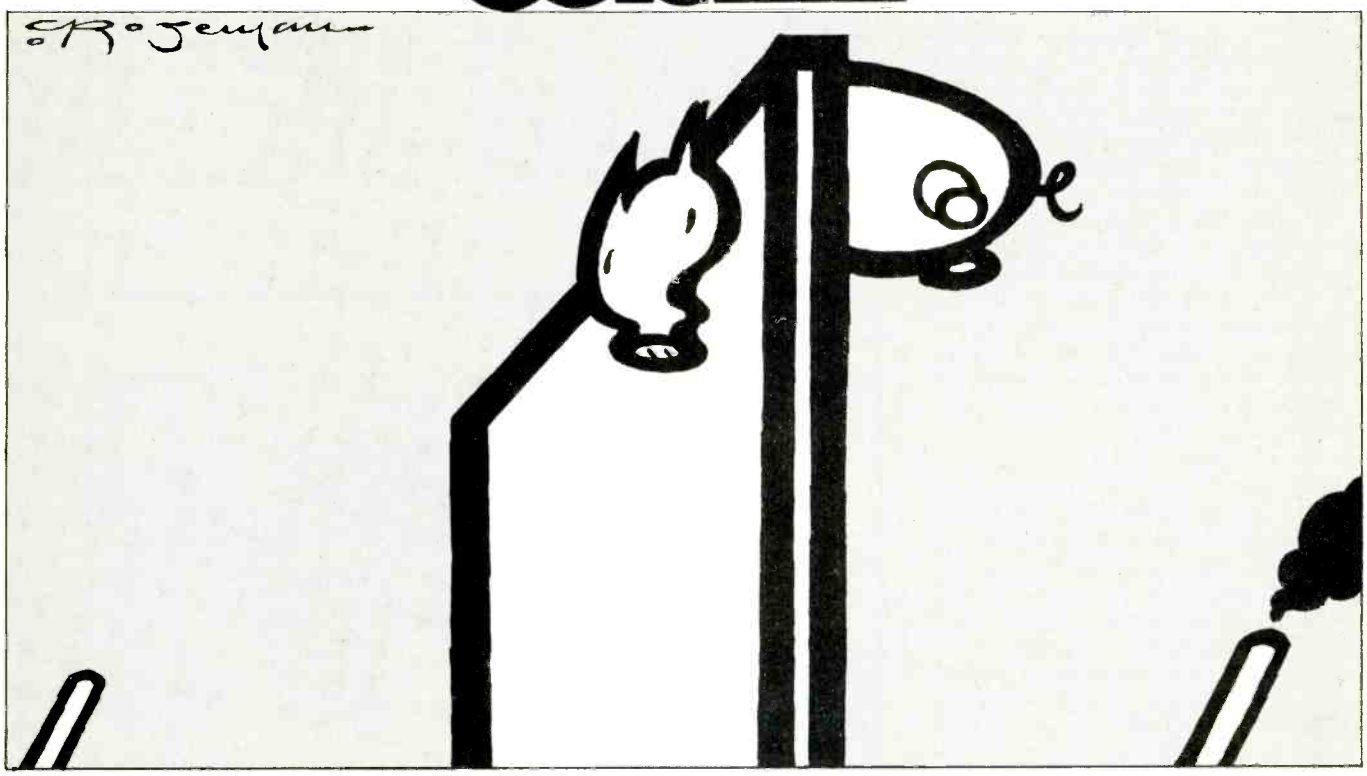
My friendship over the years with these two fine engineers allowed me to introduce their work at the Royal Festival Hall in London when the presentations were made by Malcolm Williamson, Master of the Queen's Music.

In closing this letter, any *Audio* readers concerned with bird song recording, or any form of wildlife recording, will wish to know about the 1979 April-July issue of *The Journal of the British Institute of Recorded Sound*. It contains the most comprehensive survey of this subject I have yet seen, with plenty of references and bibliographies on a worldwide basis. Contact the Director, B.I.R.S., 29 Exhibition Road, London, S.W.7 England for information on acquiring a copy.

Jon Tiven

Michael Tearson

The column



The Wall: Pink Floyd
Columbia PC2 36183, 2 discs, stereo, $13.98.

Nobody can touch Pink Floyd for sheer majesty and grandeur. Few even try anymore. **The Wall,** their first album since **Animals** came out nearly three years ago, will do nothing to hurt their premier status. Like all of their later work, the album is a conceptual whole, the story of an entertainer from childhood through maturity to the ultimate collapse. The entertainer is called Pink Floyd, or so it is made to appear, and the wall is what he builds around himself with the willing assistance and aid of those near and dear—his mother, his wife, teachers, audience. . . .

Most of the album is Roger Waters' composition, and much of it is deceptively simple musically. The wedding of words to melody has rarely been more complete, as the melodies underscore the rise and advance (and eventual defeat) of the spirit, so that the continuity is clear even without following the words. Arrangements are effective and, however dense they get with various effects (more on these later), they remain uncluttered, never gratuitously cluttered. A lot of credit for the clarity both of sound and intent must go to producer Bob Ezrin, longterm rock wars veteran who is most known for his extravaganza production jobs for Alice Cooper's best work.

The album could have turned out uncompromisingly dour, with a theme as joyless as **The Wall** has, but the magic of Pink Floyd is that they always manage somehow to transcend their consistently depressing subject matter. It may be hard to get next to **The Wall,** but that is due almost entirely to the sheer amount of material, not to anything sub-par about it. Again Pink Floyd has delivered the goods, an album of unquestionable quality, both technically and creatively, one which reaches for and grasps a lot.

As the album advances from childhood through maturity, certain themes from the outside world's music tantalizingly appear as melodic hints. The title line of *Goodbye Blue Sky* sings amazingly like *Ruby Tuesday*. The opening section of *One of My Turns* is a virtual lift from Leonard Cohen while the prominent bass part of part 1 of *Another Brick in the Wall* is right out of Mike Oldfield's **Tubular Bells.** The album's climactic scene in which the wall is ultimately torn down, *The Trial*, sounds very much like the demented music hall music from the play "Marat Sade."

To bridge the songs, Floyd and Ezrin have devised a dazzling series of special sound effects which act as the glue of the album. Sounds include crowds cheering madly for Pink Floyd, helicopters in motion, telephone operators placing intercontinental calls and, most impressively, excerpts from television program soundtracks. Two I've identified are a piece from the soap opera (most appropriately named) "Another World" (the "Mrs. Bancroft" sequence on side 2), and "Gomer Pyle."

The Wall is masterfully recorded, as we have come to demand from Pink Floyd, certainly one of the most technologically aware of bands. It has the biggest sound they have ever achieved with the largest dynamic range they have ever attempted, from the quietest of musings to the most hammer-driven rock beat. As I've stated, it is an album that takes a lot of effort to fully absorb, but Floyd with Ezrin have made it easily worth the effort.

Once again Pink Floyd has returned to push the limits of your sonic imagination. **The Wall** is a magnificent audio experience.

M.T.

Sound: A Performance: A+

Reggatta de Blanc: The Police
A & M SP-4792, stereo, $8.98.

The Police's first album showed an exciting rock band with reggae inclinations that could kill with two songs but barely get off the ground with the remainder. On their second album they've forsaken most of their rock base and turned strictly into a reggae band with white faces, and unfortunately the move doesn't work to their advantage. The lack of consistency becomes even more apparent, and while Sting's vocal comparisons to Bob Marley made for entertainment when he sang a tune like *Can't Stand Losing You,* an entire LP of a white Marley singing reggae isn't nearly as exciting. The single, *Message in a Bottle,* is truly exceptional — I recommend you buy it — but the rest of the album just doesn't hold water, if you pardon the pun. *J.T.*

Sound: B+ Performance: C+

Jackrabbit Slim: Steve Forbert
Nemperor JZ 36191, stereo, $7.98.

His timing is fascinating. At a point when rock and roll is reasserting itself in the marketplace, out from Mississippi comes young Steve Forbert, a minstrel right out of an open casting call for a Dylan/Prine type. His first album of a year ago was a sleeper hit, and a very fine, very personal and personable album.

He has approached his second album with more assurance and a new producer. **Jackrabbit Slim** was made in Nashville, where Dylan cut both **Blonde on Blonde** and **Nashville Skyline.** Sadly, Forbert's album is closer in weight to the latter, later Dylan album. **Slim** rocks more than **Alive on Arrival** did and has more spirit perhaps, but the songs on the second album are no match for those of the first. There are some standouts, *Make It All So Real, Say Goodbye to Little Joe,* and *The Oil Song* — included as a seven-inch extra disc in the first 100,000 copies, the album's only pointed and topical moment.

Steve Forbert is an artist still growing into his destiny, and I don't think that this lesser album will throw him too far off track. But I've a nagging feeling that he is enough out of joint with the fashion of the times, like Prine or Steve Goodman, that he will never make that big, satisfying splash however good his records will be, although he will always have his fans. Of course, he could get lucky. He has been this far. *M.T.*

Sound: B– Performance: C

How Cruel? Joan Armatrading
A & M SP-3302, stereo, $4.98.

How Cruel? contains four new Joan Armatrading songs on one side of a 12-inch disc on which the other side is blank. It is half an album. It is also terrific, the best stuff Joan has released since her self-titled album of a couple seasons back. Each song is a polished gem that reflects the unique musical personality that is Joan. It makes a superb introduction to the artist if you have not met her music before.

Which is exactly why A & M decided to issue it. This label has been trying aggressively to evolve alternative formats to the album for its upcoming artists, attempting to break the perpetual price spiral that keeps album costs skyrocketing. In the case of Joan Armatrading, whose talent is huge, whatever it takes to make her better known is definitely worth it. *M.T.*

Sound: B+ Performance: A

Six Squeeze Songs Crammed into One Ten-Inch Record: Squeeze
A & M SP-3413, stereo, $5.98.

Another of A & M's format experiments finds the best of Squeeze's first two albums on a low-priced deluxe package. The band has already become a constant chart-topper in England and Australia, so the company is trying out a new approach for them in the good old U.S. of A.

The collection is as good as it could be for so young a band. *Cool for Cats* and *Up the Junction,* in remixed-for-single versions, and *Slap and Tickle* are all from the **Cool for Cats** album, while *Goodbye Girl* is a new version of something they had recorded previously. The two from the first album, *Bang Bang* and *Take Me, I'm Yours,* show how far the group has come in a big hurry.

Squeeze is surely a band to watch in the early '80s. They have drive, freshness and nerve, a heady combination. This is the perfect introduction. *M.T.*

Sound: B Performance: A-

Damn the Torpedoes: Tom Petty & The Heartbreakers
MCA/Backstreet-5105, stereo, $8.98.

Tom Petty's third album is clearly his best yet, but it is still not the amazing album he has in him. It has snappy rock and roll tunes played with flair and class and spirit. The production (Petty with the excellent Jimmy Iovine) is to the point, wasting nothing on frills, just like the songs.

The Petty sound is the closest thing today to the classic airflow sound of The Byrds. Matched with Petty's songs it makes for real fun music if ultimately lightweight. It just doesn't stick to the ribs, and after a whole album you're still hungry for more. Liken it to the Burger King of rock. It might not be the most nutritionally balanced meal, but there are times when a Whopper hits the moment's bullseye. That's what Petty does, especially with his rockers. But please note that he is definitely no Double Whopper. *M.T.*

Sound: B+ Performance: B

Phoenix: Dan Fogelberg
Full Moon/Epic FE 35634, stereo, $8.98.

Phoenix is quintessential Fogelberg, at least as fine an album as any he has done before even if it doesn't really cover any new ground. The production is excellent, as always for Dan. Even if he is not the incisive writer that Jackson Browne is, to cite an example, he is clearly somewhere not far down the line.

Joe Walsh, an old friend, makes a cameo appearance on guitar on *Face the Fire,* one of the album's only truly fiery moments. Still the control that Fogelberg maintains at all times is clearly in evidence. *M.T.*

Sound: A- Performance: B+

John Diliberto

John Lissner

jazz & blues

Duke Ellington—1938
Smithsonian R-003, mono, two discs, $9.99.
Duke Ellington—1939
Smithsonian R-010, mono, $9.99.
The Duke, 1940, Live from the Crystal Ballroom in Fargo, N.D.
Jazz Society AA520/1, mono, two discs, $15.98.
Duke Ellington and His Orchestra, 1940, Fargo Encores
Jazz Guild 1006, mono, $6.98.

Only the most dedicated and affluent Ellington lover could possibly keep up with the stream of posthumous Ellingtonia on disc, but these four issues are a must for any jazz collector. The music contained in them attests to the fact that during the late '30s and on into the early '40s, Duke Ellington lived in an almost perpetual state of creativity.

Most of the recordings assembled for the two Smithsonian double-sets, and remastered by Columbia Special Products from Brunswick and Columbia 78 rpms, duplicate material already issued some years ago in two Columbia boxed sets titled **The Ellington Era,** but the Columbias, though still listed in the Schwann, are almost impossible to find. The period covered by the Smithsonians is from January of 1938 through February of 1940, a vital phase in the Ellington orchestra's development, culminating in the magnificent 1940-42 ensemble. By January of 1938, the swing craze was making headlines everywhere, and Ellington responded with such pieces as *Steppin' Out in Swing Society, The Gal from Joe's, Battle of Swing,* and *I'm Checkin' Out Goodbye.*

In responding to the fact that jazz was turning into swing, the Ellington orchestra began to achieve an impressive rhythmic integration, swinging as a whole band rather than as brass and reeds above a rhythm section, as had the Ellington "Jungle" band (and, indeed, most jazz bands) of the late '20s and early '30s. One of the most uninhibited Ellington swing records of this period, *Dinah's in a Jam,* recorded for Brunswick in April of 1938, is a splendid swing-riff piece with a small-band flavor. The selection, offered in the 1938 Smithsonian collection, contains a superb chase chorus between Johnny Hodges and Cootie Williams. Other Ellington swing era classics, such as *The Gal from Joe's, Braggin' in Brass* and *The Sergeant Was Shy,* reveal that Ellington was moving away from the heavy, often static big-band scoring of the early '30s toward the more dynamic swinging patterns of his 1940 band. The 1938-40 period, represented by the new Smithsonian issues, is undoubtedly an impressive period of Ellington growth both as a composer and orchestrator. In the early '30s, the brass section dominated Ellington's composition and orchestration, but as we move into the swing period, Ellington appears to achieve a smoother, more asymmetrical instrumental balance.

While entering the intensely competitive swing sweepstakes with such exultantly rocking records as *Battle of Swing,* Ellington deployed his ensemble as no other swing band. Such pieces as *Steppin' Out in Swing Society,*

Jazz Potpourri, Braggin' in Brass, and *I'm Slappin' Seventh Ave.* show him achieving brilliant, unorthodox modulations. His swing compositions, compared to those of the Goodman-Henderson school, tend to be structurally unconventional. Indeed, the Ellington recordings in the two Smithsonian collections offer a kaleidoscope of swing-era sound that is utterly distinctive in its tonal, rhythmic, and melodic qualities. From the harmonic standpoint, Ellington remained far ahead of his swing-era contemporaries. His use of ninths, sometimes moving chromatically, and his resourceful voicing of chords made every other swing-band arranger seem harmonically stunted. Even in this stage of Ellington's evolution, these swing-era classics show he was far ahead of everyone in shaping the sound of precision big-band jazz.

The Smithsonian collections are also nostalgic journeys that shed light on the Ellington relationship with his sidemen. Among the soloists here are the great brassmen Rex Stewart, Cootie Williams, Lawrence Brown, and Juan Tizol. (I shall not dwell on all the individual pieces, but I must single out Brown's gorgeous lead trombone and Cootie's muted elegance on the sensuous ballad, *Gypsy Without a Song.*)

Clarinetist Barney Bigard emerges as a jazz soloist of the highest order. His pithy solo statements on selections like *Lonely Coed, Pussy Willow, Mighty Like the Blues,* and *Battle of Swing* are models of creativity and conciseness. The three-minute confines of most 78 rpm recordings certainly bred admirable qualities of brevity and restraint among the swing-era big-band soloists. Unlike many of the players we hear today, they avoid excess of emotion and technique. They focus on the arrangements, working themselves into the composition, subordinating themselves to the material at hand. Unlike many modern-jazz players, the great Ellington soloists seemed to have viewed themselves as a part of the total musical flow rather than a self-contained, egocentric luminosity. Ironically, it is because of these characteristics that they achieve so much orginality and individuality. Aside from a few noisy tracks, the overall sound transfer job is quite satisfactory on the Smithsonians, in keeping with the high sonic standards of this series.

The splendid Jazz Society and Jazz Guild collections capture live from the Crystal Ballroom in Fargo, a dance date with Ellington's greatest orchestra, his 1940-42 band. Two dedicated jazz buffs, Jack Towers and Dick Burris, obtained Ellington's permission and recorded virtually the whole evening of this Nov. 7, 1940 one-nighter. As fine as the Ellingtonians sounded in the RCA studios at that time, the band was never as exuberant and volatile as when playing at a dance, and these relaxed, on-the-spot, private recordings capture it at its zenith.

The Fargo dance lasted from eight in the evening until after one o'clock the following morning. The Crystal Ballroom was about one-hundred-and-twenty by eighty feet and had excellent acoustics. Towers and Burris set up two microphones in the ballroom and fed the music to a battery-operated disc cutter. Considering the primitive recording equipment, the sound, particularly on the Swedish Jazz Society double-set (taped from the original acetates), is extraordinary. The most unsatisfactory balance occurs during the announcements and the vocals when Ellington singer Herb Jeffries and the announcer appear to be talking or singing into the house mike.

The Jazz Society set highlights extended versions of such Ellington memorabilia as *The Mooche, Ko Ko, Mood Indigo, Harlem Airshaft, Stompy Jones, Bojangles, Never No Lament,* and *Sophisticated Lady,* and offers a dazzling Ben Webster solo on *Stardust.* The Canadian Jazz Guild disc contains the remainder of the selections recorded that evening including definitive versions of *Across the Track Blues, Cottontail, In a Mellotone,* and a driving *Caravan.* The Fargo collections are indispensable to the Ellington lover; listening to them one can gain a vivid impression of what it was like to attend a dance at the peak of the swing years in which the music was supplied by the greatest orchestra in jazz. Hustle out and track down these albums; the music is as fresh and robust today as when it was recorded two generations ago. The Jazz Guild and Jazz Society releases can be found in jazz collectors shops in larger urban centers (Rose's Discount Records in Chicago; King Karol in NYC), while the Smithsonians may be obtained by writing Smithsonian Customer Service, P.O. Box 10230, Des Moines, Iowa 50336.

John Lissner

Smithsonians (both)

Sound: A- Performance: A+

Jazz Society

Sound: A- Performance: A+

Jazz Guild

Sound: B+ Performance: A+

Passion Dance: McCoy Tyner
Milestone M-9091, stereo, $7.98.

After all the albums with strings, horns, voices and all-star sidepeople, McCoy Tyner has put out an album of his unadulturated self. Recorded live in Tokyo, Tyner is free to run unaccompanied through half an album. On the other half he is joined by the challenging rhythm team of Ron Carter and Tony Williams, who propel Tyner in a thunderous *Moment's Notice* and *Song for the New World.*

Tyner has always opted for powerful drummers who often burdened him with redundant rhythms and overbearing volume. Williams' drumming is full of polyrhythmic bursts, crisp punctuation, and a rolling momentum that locks in with Tyner's piano. Ron Carter leaves his cliches behind again as he provides the throbbing pulse that wends its way between Tyner and Williams.

Tyner once more breaks no new ground. Yet his sweeping piano orchestrations, two-handed explorations, and pounding chords provide fresh vistas every time. There's a feeling of triumph and exultation in his *Song for the New World.* His power and drive are not diminished in the solo *Passion Dance,* even after the stormy trio version of *Moment's Notice.* On *Search for Peace* he maintains his full-bodied sound in a rhapsodic ballad setting.

This live recording fully captures the sheer physical strength and depth of Tyner's playing. He makes ample use

of the overtones and reverberations of the piano to create his sound, and none of it seems to be lost in the transfer to vinyl. *Passion Dance* aptly fits the unity of body, spirit, and sound that McCoy Tyner creates.

John Diliberto

Sound: B+ Performance: A

Don't Ask: Sonny Rollins
Milestone M-9090, stereo, $7.98.

You can go on talking about Sonny Rollins' immaculate tone and melodic inventiveness forever, but it won't disguise the fact that he has been making some very thin music lately. Why? Don't ask. Rollins has been trying to hew a course into the popular mainstream for a few years now with a limited degree of success. The music isn't thin simply because he uses electric instruments and contemporary R&B rhythms. It's thin because he doesn't do anything with them that you can't hear on a million faceless disco albums. *Harlem Boys,* the opening track, sets the tone with an insistent rhythm that quickly becomes leaden. Rollins simply restates the theme in his solos until the percussion break when he takes a burning run that leaves the song in the dust. This proves to be just an interlude. The song returns to its funky rhythm and before it ends, you know it's going to fade. It has nowhere else to go.

In an attempt to fuse R&B with mainstream jazz, Rollins has come up with *Disco Monk,* an unlikely juxtaposition that has some beautifully reflective solos by Rollins sandwiched between an overbearing disco groove.

Where the disco beat doesn't prevail, the disco mix does. *And Then My Love I Found You* and the title track feature straight-ahead, swinging grooves, but the bass and drums are mixed up front so they dominate rather than support. Rollins takes his finest solos of the album on these cuts. His lines are full of twists and lyricism that are probing, but assured. This contrasts with guest Larry Coryell, whose guitar solos seem out of place in several instances. Strings of ideas and flash follow one another in search of a context, which becomes less evident in the two unaccompanied duets between Coryell and Rollins. On *The File,* Coryell provides a busy backdrop for Rollins' roving improvisation with flamenco chording that occasionally drops quotes from Hendrix's *Foxy Lady. My Ideal* doesn't fair as well. Rollins sets a slow, balladic groove, then Coryell destroys it with a jagged, disconnected run.

Rollins hits a lot of grooves on one album, including the Asiatic *Tai-chi* on which he plays lyricon in a pentatonic improvisation. But there's nothing here that makes one snap in amazement, wonder, or feeling. His rhythm section of Mark Soskin (piano), Jerome Harris (electric bass), Al Foster (drums), and Bill Summers (percussion) is adept at running with Rollins but doesn't have enough to make him fly. This leaves Rollins in a holding pattern until he breaks away from these concepts and finds another new way, as he has in the past.

John Diliberto

Sound: B- Performance: C

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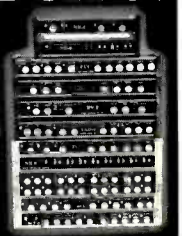

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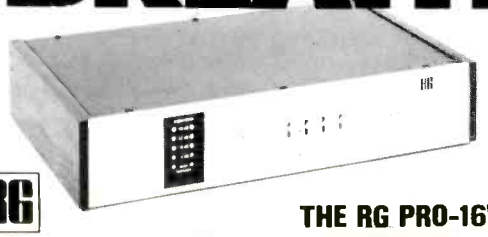

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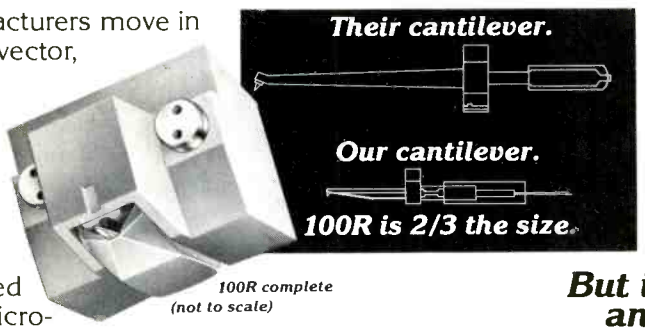

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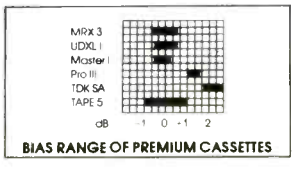

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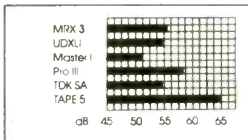

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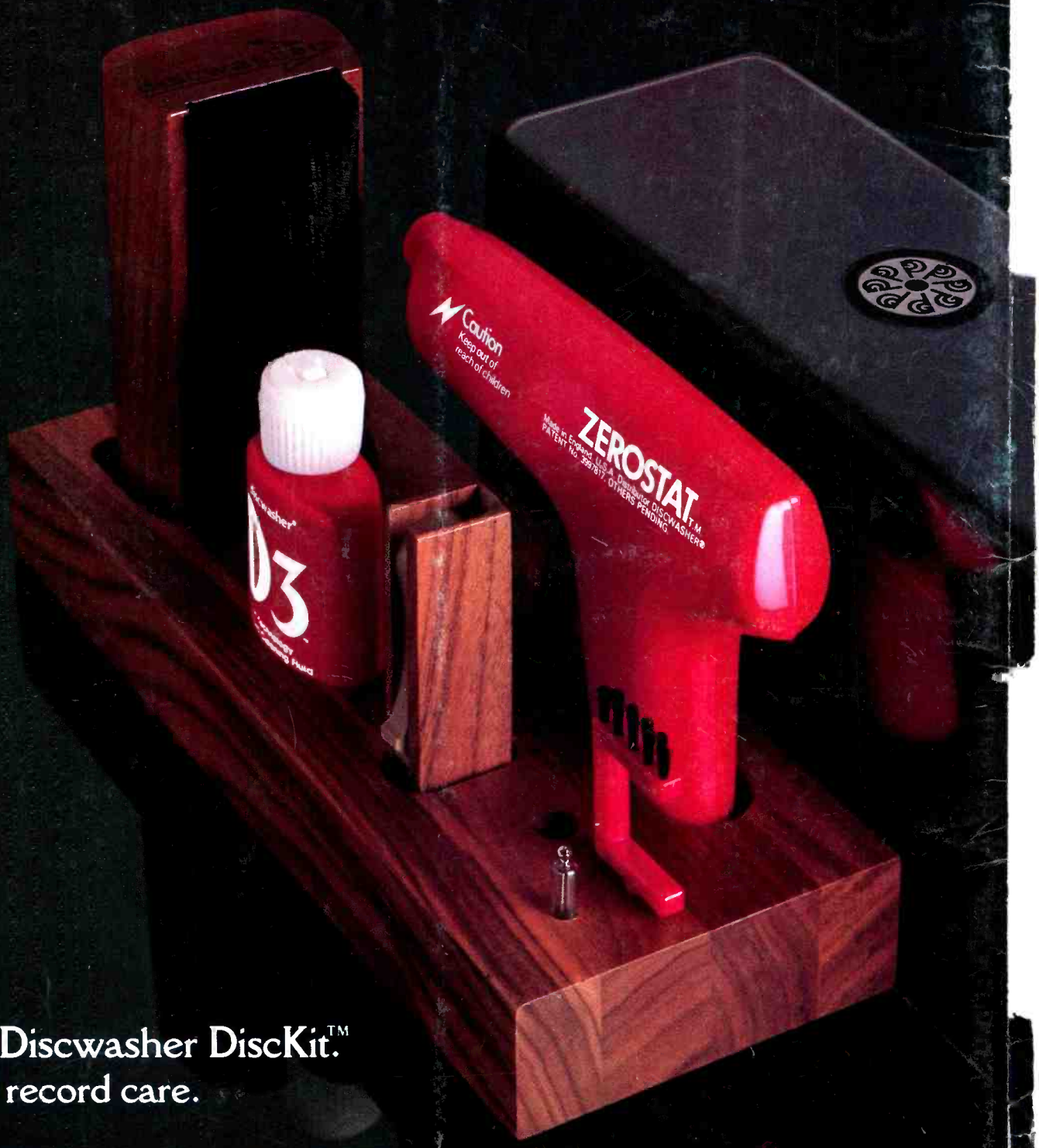

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