THE B.A.S. SPEAKER

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In This Issue

With winter approaching at more than a snail's pace (at least here in Boston), we enter once again the listening season—time to be anxious about the "harsh," "glassy," "grainy" sound of our phono preamplifiers. In this issue is part one of what may be a definitive analysis to reveal those mysterious distortions that mar the sound of almost all transistorized preamplifiers.

The first portion of this discussion is contained in the October meeting summary, where we report on a lecture-demonstration given by Tom Holman of Advent Corporation. His proposed preamplifier testing method seems straightforward, the correlation between the test and the sound is claimed to be good, and the live demonstration was startling. Our meeting summary also contains excerpts from a related paper given at the November meeting of the AES, published with the kind permission of Holman and Advent.

In addition to reporting Holman's work, our feature publication this month describes the results of a BAS test-and-listening clinic that was held the week following Holman's talk. The results verify Holman's model, although a few major discrepancies will bear further thought. In general, however, it would seem that there now exists a definitive test which, if passed by a preamplifier, will guarantee good sound. More than a few manufacturers will be sent back to the lab by these revelations.

This article is in three parts. First, Mark Davis and Al Foster describe the experiments in which 24 different preamplifiers were tested using the Holman interaction and square-wave tests; second, Al Foster puts the situation into perspective, giving his own experiences with two highly touted preamplifiers, the Marantz 7C and the Phase Linear 4000; and finally, Jim Brinton engages in a bit of question-and-answer for those who either are still curious or those who are not technically oriented and need a bit more direct information than otherwise provided.

Legal Advice Sought

The BAS last year (1974-75) closed out its membership at about 350 persons. A few more late memberships are expected during this year (1975-76). As of this writing (October) we have 320 (1975-76) members, which is about double the number at this time last year. Renewal rates are again extraordinarily high, much higher than for any commercial publication.

There is, however, an attendant problem with this burst of growth: the IRS. In past years we were told that as long as our membership dues totalled less than about $4000, the IRS did not want to be bothered with an application for `tax exemption on the basis of non-profit status. This year it appears we will grow beyond this nominal figure, and therefore some official applications are in the offing—to the IRS and to apply for non-profit status. The BAS is therefore in need of a small amount of good legal advice. If any members, preferably local, could give us some (free) legal advice, would they please contact the BAS through P.O. Box 7? Thanks.

— The Treasurer (HZ)

For Sale

Note: Unless the contrary is clear from the body of your want ad, your address will not be printed here, but only your name and phone number, to protect you from theft. If you want to have your address included, be sure to make this obvious in your letter.

- Pioneer SE-700 electret headphones, new, with warranty card. Revox F36, 4-track, 3 ¾ and 7½ ips, only 20 hours of use (last electric eye unit, a classic!). Dayton-Wright XG8 Mk. I electrostatic speakers with ST-300 (custom-framed XG8/2 cabinets, gold grille). Revox A77 Mk. 4 HS 2-track, never used, bought Sept. '75. Ross Robinson, Windsor, Ontario, Canada; (1-519)945-8486.
- AR receiver and turntable, mint. Victor Anderson, Box 139, Cambridge, Mass. 02138; (617)492-7049 evenings and weekends.
- SWTPC multiband equalizer, $75. Sony 6055 receiver with lovely home-created walnut cabinet, 30 watts/channel, AM/FM, $175. Bell and Howell/Heath oscilloscope, triggered sweep, 5-inch, all solid-state, $100. Gary Rancourt, (617)899-8090 days or (617)369-1949 evenings.

Wanted

- Quad 22 preamplifier, Quad U amps, Quad AM2 tuner (or AM3 tuner). Ross Robinson, Windsor, Ontario, Canada; (1-519)945-8486.
- Rabco SL-8 or SL-8E. David Shreeve, 3402 N. Oakland Avenue, #106, Milwaukee, Wisc. 53211; (414)96273362.

BAS Buyers' Guide

The following comments on bargains and good treatment from dealers have been submitted by various members.

• Top Discount Audio, at 333 North Michigan Ave., Suite 2025, Chicago, Illinois , 60601, sells Maxell UD cassettes at attractively low prices. The C-46 is $1.80, C-60 and C-90 are $2.00, and the C-120 is $4.00. I ordered 15 cassettes and received the shipment within a month.

David Sherwood

• When in the UK: First buy a copy of Exchange and Mart, a weekly classified newspaper of about 100 pages which has a hi-fi section. The several UK retailers that I've found best informed include Hi Fi Pro, Buckingham Palace Rd.; Audio T, 190 West End Lane; R. E. W. Centrepoint (they have the best equipment display but only so-so salespersons); K. J. Leisure-sound, Wigmore St.; and Studio 99, Fairfax Rd., all of these in London. Finally, Maildisc & Co.

welcomed me after a full year's absence by using both my first and last names. They're unfailingly courteous and absolutely reliable and honest. They've never made a mistake in my account, and performed many services "above and beyond the call..." — Ross Robinson

• A friendly place to purchase records is Crotchet & Co., Church Stretton, Shropshire SY66DR, London, UK. Standard policy is 20% off list price of any LP, and you pay the postage. This is less expensive than Henry Stave's pricing. The managers are Bob Smart and his family, who work out of their bungalow in Shropshire Hills. There is no stock on hand, but this is an advantage because British law forbids tax-free exporting of goods from stock. Thus the discount becomes 26% off list price.

With confusion ascendant in the British record industry, EMI six months behind, and Decca raising prices every Friday, it is best to order from people such as the Smarts, who let you know what is happening to your order. Here are a few good quotes from Smart's letters: "It's an odd thing about your local records—the U.S. can send a man to the moon and back, which must involve equipment of the highest standards, yet you cannot produce an everyday item like a grammophone record without faults. If there were as many faults in a Jupiter, it wouldn't get off the ground." And, "Thanks for the new order. Fancy doing a darn fool thing like sending the Haydn quartets instead of Mozart's Haydn Quartets. Well, you must admit Mozart made life confusing by that title of his ! " And finally, "Incidentally, is Angel put out by RCA in America? Of the RCA products here I have a very poor opinion and would not, myself, buy them at any price. They seem to go in for lumps and dips which thump like mad. Is that your trouble with local discs, too ?" Well, now that you've asked. . . — Clark Johnson

• I have mail-ordered discs from Ron's Music Shop (advertised in HFN&RR) and have been well satisfied. — Donald Konicoff

Letters

There are two areas which I feel hi-fi publications have treated poorly or ignored altogether. The first is component reliability. Unlike some audiophiles, I would willingly trade a bit of sonic quality for a component that is not always in the shop for repairs. I would also willingly trade some initially outstanding sound for sound that holds up for a year or so, e.g., I have no need for a super-stylus that stiffens after a month. Perhaps members of the BAS would publish their comments about brands to watch out for. [See one answer below.—Ed.)

Secondly, I think most publications underplay the selection of cartridges. Like loudspeakers, cartridges differ greatly from one design to another, and even from unit to unit within a model number. Unlike loudspeakers, however, the "best" cartridge available—if only such a cartridge could be identified—is often affordable. Hopefully, some of the time and energy spent A-B-ing loudspeakers could be turned to comparing cartridges—making suitable allowance for adjusting levels, of course. [Again, see below.—Ed.] R. Bradford Malt

Treated Right by Mac

I've been having my McIntosh amplifiers checked at McIntosh clinics for years. On several occasions they haven't come up to spec until tubes were changed or other components were replaced. So it would seem the conclusion, made for example in the October 1972 Speaker ("McIntosh and Marantz Test Clinics"), that you have 100% chance of meeting specs when you buy Mac or Marantz, is a bit wide of the mark. The engineer will, however, ensure that the unit does meet specs if you do bring the amplifier in, and the same presumably holds true for Marantz.

— Tom Shedd

More on Good Service

At one time or another, I'm sure we all have had problems with our audio equipment. In getting repairs made I've met some people in various companies who really had my interests at heart. So that other members could profit from my good encounters, I felt I would make these people known to the Society. Knowing someone on the inside with a sympathetic ear can make all the difference in the world.

Listed below are a few people in whom I have a great deal of confidence. They have always treated me well and have gone out of their way to give me satisfaction. [Do other members have similar lists ?—Ed.]

At Infinity Systems, Customer Service Manager, Doug Wright cheerfully, and personally, replaced a tweeter in a Monitor I while I waited and even watched. He has also been extremely helpful with advice.

At SAE, Bob Hunt, in the Customer Service Department, is that rare breed of person who knows that it is not sufficient that a device work; rather, it must really work well. He has helped me many times with both service and good advice—he is determined to give satisfaction.

At Sequerra, Tom Cadawas, Engineer, is determined to satisfy. He removed some front end drift in my tuner and freighted it back to me in two weeks. He even offered to go out on the production line and hand pick a hotter front end.

At Shure/SME, J. Wennerstrom, in the Customer Service Department, quickly and courteously, send me spare parts for an SME arm.

A couple more good guys include Tony Heller of Pacific Stereo (Glendale, California) and the whole Jonas Miller Sound crew in L.A.

-- The above passed on by a member who prefers not to have his name published.

A-B'ing Cartridges

I have been using an Ortofon M15 Super (conical) phonograph cartridge for 2 years, and it is superb. It has been A-B'd with the Decca, Denon 103S, Supex, and several others. While it is not a perfect reproducer, it is musical, non-fatiguing, not fussy about setup, and quite sturdy. I have it mounted in an SME arm (non-detachable head). -- Donald Konicoff

After using the Empire 2000E/III, about which I have previously written, I tried a Stanton 681EEE. It produced sweeter highs and has performed well for some time, but I have recently replaced it with an Ortofon VMS20E. The Ortofon brings out more detail than the 681EEE, particularly in the bass but also in the high end. Its transient response is also better, and the frequency response is superior to the 15SE. At the moment I am enjoying the sound more than ever before, but with the number of new cartridges appearing on the market, future prospects remain exciting. — Nate Garfinkle

Speakers from the UK

I have become convinced, through listening and through reading all the English hi-fi magazines, that the British really know how to put speakers in a box. I wonder if members have any impressions of the KEF 104, the Gale, the Spendor, or others of similar apparent quality. I have heard the Spendor BC II's: the sound is accurate and well imaged and the old-world cabinetry and craftsmanship are superb. -- Donald Konicoff

"Stacking" the Quad Amplifier

I have received a reprint from Quad on a method of "stacking" a pair of Quad amplifiers in each stereo channel, and also a copy of a paper presented at the 50th AES convention describing a new output circuit that involves "current dumping." This design features class A operation at low levels and push-pull for power. A 100-watt/channel version should be in production in a year. Advantages claimed include no need to match the robust npn output transistors, no adjustments for bias or to minimize crossover distortion (because there is none), and no audible changes with transistor junction temperature. Interested Quad fans should write for more details.

— Nate Garfinkle

Turntables Tested

This is in part a follow-on to my comments about the Rabco ST-4 in the April 1975 Speaker. I have since then built the rumble attenuator filter described by Edgar Villchur in the March 1965 issue of Radio-Electronics and have used it with a test record to obtain some crude but interesting rumble comparisons among two different ST-4's, a Dual 1019, and an AR turntable.

My tests indicate that the AR (with a Shure M91) had the lowest rumble. The 1019 (with a Shure V15-III) was 1 to 2 dB higher. The ST-4's (with an Empire 888E) tested another 5 dB higher than the 1019. However, when I disconnected the arm tracking mechanism on one of the ST-4's, it's rumble became comparable to that of the AR; thus the tracking mechanism clearly contributes to rumble, as I had suspected. This difference is clearly audible with my IMF's, at least with the volume turned up.

Also, I've taken a look at the new ST-7. Obviously the design work is not yet finished, as the unit's acoustic isolation is virtually nil. Hopefully HK will soon do better than this.— Tom Shedd

Quick-Change Advice for Open Reel Tape

There are many methods for attaching the leader of an open reel tape to the hub. Here is mine. Just fold the first quarter-inch in two and crease it firmly. Insert this into the slot in the hub, and you will find that the hold is firm enough to wind smoothly but not so tight that the tape is abruptly yanked out when the reel is rewound.

— Dan Shanefield

Four-Channel Still Lives

For anyone encouraged by the appearance of the CD-4 decoder noted in the September Speaker (p. 15), you might be interested in some source material from a company other than U.S. RCA. I have received a list of some sixteen ERATO CD-4 discs pressed in Japan through JVC; two of these were used at the Copenhagen AES convention. In SQ, EMI are starting to export some ERATO material (on the Electrola label and pressed in Germany). Philips and DGG are also testing some SQ-encoded discs in the Japanese market and are planning to bring some Q8 cartridges into the U.S. Any member who is interested can write to me (through the BAS at P.O. Box 7) for a list of either the ERATO CD-4 or SQ numbers and titles.

— Nate Garfinkle

Input from the Rock Scene

Something that hasn't turned up in any of the recent issues of the Speaker is any mention of rock records that are excellent technically. In addition to some of those mentioned in The Absolute Sound, discs that I have found good are:

- Taj Mahal, "No Roots," Columbia KC33051
- Linda Rondstadt, "Heart Like a Wheel," Capitol ST11358; and "Prisoner in Disguise," Asylum 7E1045
- Jesse Winchester, "Learn to Love It," Warner BR6953
- Eagles, "Desperado," Asylum SD5068; and "One of These Nights," Asylum 7E1039.

All of these are of exceptional quality, with good dynamic range, little surface noise, and excellent mixdown technique.

— Robert Hiatt

Record Recommendations for Your Woofer

As noted by Bert Whyte in Audio, July 1975 (p. 4), three records with unusually deep bass are Michael Murray on the organ of Grace Cathedral on Advent (records) 5009, Peter and the Wolf on Vanguard VSQ30033, and Also Sprach Zarathustra on Vox/Turnabout QTV-S34584. I was able to A-B the master with the disc of one of these, and after this traumatic experience, I didn't want to listen to a disc for several days. Perhaps some day we'll have discs to match the master tapes,

— Nate Garfinkle

dbx Licenses Teac

Those of us fortunate enough to have heard dbx noise-reduced master tapes will cheer at word that that company has licensed Teac to use its compander noise-reduction system. Teac is presently the largest seller of tape-recording gear in the United States, providing about one of every four units sold, and although dbx circuitry will be a short while appearing in the Japanese company's products, the wait should be worth it.

The effect of this deal should be great and multifaceted. Not only will dbx noise reduction put really professional quality recording within reach of the average consumer, it will also make it possible for companies with dbx masters in their vaults to sell "pre-recorded" tapes with performance beyond anything now available.

Since there is a domino effect in business, there is the chance that other recorder makers will follow Teac's lead and ally themselves with dbx. If this comes to pass, it will solve dbx's chicken-and-egg problem by putting many dbx decoders in the field. This in turn might make it attractive for disc makers to release (more) encoded records. And heaven knows, audio could use a little help on the record front.

For now, it seems that dbx circuitry will be offered on all Tascam machines automatically and on Teac models as an extra-cost option. There is no data yet on just when Teac will make its announcement on this, or on the models to be equipped with dbx. But if you are planning a major tape-machine purchase, you might wait on events for a few months.

— Jim Brinton

Addendum to Tonearm Damping

My note on damping in the October Speaker applied only to vertical damping, since I find that most of my need for damping is in the vertical direction, where warps in the outer edge of a disc cause the arm to oscillate up and down. The most troublesome frequency is roughly 4 Hz, just as reported by Kogen et al, in the August 1973 Audio (p. 18). I therefore don't bother with horizontal damping in my system.

If you do wish to apply damping in the horizontal plane, however, just do the following. First put your preamplifier into the mono mode. This cancels purely vertical signals and delivers only the horizontal portion of the cartridge output to the preamplifier output jacks. (Don't use the tape out jacks—these may be prior to the stereo-mono switch.) (For an explanation of vertical cancellation, see Audio, March 1973, p. 44.) Now set the stylus on the record groove and very gently push the tonearm shell sideways with a pencil. As you let go suddenly, watch the oscilloscope trace. Adjust the horizontal damping paddle according to Figs. 1 and 2 of the October Speaker to minimize overshoot or undershoot.

To see whether horizontal resonances actually do build up in your phono system, play several different kinds of discs with the above oscilloscope setup to monitor the horizontal response, and look at the characteristic low-frequency signal superimposed on the music (you could also use a quiet groove). Even though the preamplifier should be rolling off these infrasonic frequencies, a really significant signal would show up readily, just as it does in the case of vertical response to a warped record.

— Dan Shanefield

Another Record Cleaning Device

BAS member Christopher Gupta (Toronto) enthusiastically recommends the "Pixall," an adhesive roller used for cleaning records. To quote the Pixall's advertising literature: "The apparatus is simplicity itself, comprising a 3-inch-wide by 2 ¼-inch-diameter roller with supporting bracket and handle. The salient feature and key to the whole operation is a specially coated adhesive tape, five feet in length, wound round the roller and protected, when not in use, by an acetate wrapper. To clean a record the disc should be placed on a flat surface [not the turntable] and the roller applied to the disc at a tangent to its center label (taking care to avoid any contact with the label) and then rolled across the grooves towards the outer rim with the application of slight pressure. This operation should be repeated until the entire grooved surface area of the record has been treated—and it all takes less than a minute.

"Once the surface of the adhesive tape becomes choked with foreign matter, thereby losing its effectiveness, this outer surface is then simply peeled off and cut away, . . . leaving a smooth, fresh surface ready for future use. When the five feet of tape has been fully utilized, replacement is by means of roller refills."

The caution against contacting the label with the roller results from the fact that the adhesive is so strong that the label may be torn off. The manufacturer claims that this strong adhesive is necessary to "overpower" the static attraction of the record for dust.

Gupta indicates that he cannot objectively verify that the Pixall cleans "those delicate serrations inside the microgroove" as the manufacturer claims, but he does say that records cleaned with the Pixall sound better than when cleaned either with the Discwasher or the Parastat.

The manufacturer also claims that the Pixall leaves no residue. Gupta tested this claim by putting fingerprints on a clean mirror. After two passes with the Pixall the fingerprints were completely gone and there was no trace of residue.

The Pixall is available from Milty Products Ltd., New Mansion House, 173/191 Wellington Road South, Stockport, Cheshire, England, SKI 3UA. The cost is about $7, with roller refills available for about $1.25.

— Bob Borden

A Wire-Wound Delay Line

In spite of rumblings about futuristic IC delay lines being investigated within the BAS, I must confess that I couldn't wait, so I besmirched my system with the next best thing, a Lafayette spring reverb unit. I feed my rear channels through this "Echo-Verb II" machine (catalog number 99F92116W at $34.95 for a stereo unit), which is designed primarily for live rock music groups, and use a cheapie rear-channel power amplifier. Believe it or not, it really adds to a big-hall feeling and sounds just great! At low volume and with the bass control highly accentuated, the sound is not audibly distorted.

For organ music, to produce the effect of an ancient stone-walled cathedral, I also run the signal for the front (bi-amped) woofers through the spring system. The sharp, twangy harshness it adds to the signal actually enhances the realism of the music.

With the spring feedback control turned to zero, the basic amplifier in the Lafayette unit passes 20 Hz to 20 kHz within 2 dB. At my usual feedback setting of 60% of full scale, the response begins to become pretty bumpy. The slowly decaying (damped) reverberation signal adds a great deal of spaciousness, more than that obtained with a simple one-time delayed signal (for example, that obtained with the Madsen tube, which I've also tried). Bucket-brigaders take note, and be sure to recycle the delayed signal.

As a side experiment, I've set the control to 20% of full scale; this has a great deal less effect than the 60% setting, and spoils the transient response of a tone burst by about the same amount as does a good cone-in-a-box loudspeaker. Then, running this signal through a good electrostatic speaker or a Magneplanar system, I was amazed at how little effect it had. Perhaps it's the large size and/or the bipolar nature of these types of speakers, rather than their transient response, that makes them sound so good.

Spring reverberation is, of course, a standard processing method used in the production of even the better classical records (including those from Europe). It helps to overcome the dry sound obtained with close-miking during recording. In the present application, the difference is that the rear channels alone obtain this time delay, which is delayed longer and is less mixed with the undelayed signal than when a master tape is prepared.

For a black-vinyl-pigskin box intended for high school bands, the Lafayette delay box does a pretty nice job—at least until something better comes along at ten times the price.

— Dan Shanefield

There are several versions of spring delays available on the market, most of which are also intended for rock band use; Lafayette even offers a second model at about twice the price. They should be available at a discount through stores that handle band equipment. (See also a review of the Pioneer reverb unit in the March 1975 Speaker.) Consider that when delay-line units actually do become available, your spring unit won't be obsolete—just sell it to a needy band.—Ed.

Calibrating Your BAS Oscillator

When I attempted to calibrate my BAS oscillator I immediately discovered that the range switch did not multiply exactly by ten. Rather than spending money trying to trim the capacitors and resistors for exact decade multiplication, I instead made an independently calibrated scale for each range, as shown in Fig. 1.

Taking a round knob, I epoxied a thin plexiglass "arrow" to the bottom, scribed a centerline, and drilled three 3/32-inch holes spaced 3/16 inch apart to obtain the cursor shown in Fig. 2. With the knob mounted on the "frequency" potentiometer shaft, I inserted a ball point pen through each hole in turn and swung arcs on a piece of paper taped to the oscillator panel. As you calibrate your oscillator, mark the desired calibration frequencies using a needle, and add tick marks later with a fine pen. I used dry transfer lettering to finish off the panel artwork (see Fig. 1), and from this made a "Scotch-Cal" escutcheon, which gives the appearance of silk-screening onto brushed aluminum. (Unfortunately this process requires access to a precision copy camera and a diazo machine.) Of course, an adequate panel can be made from heavy paper or thin plastic, or you can scribe and mark directly into the aluminum panel.)

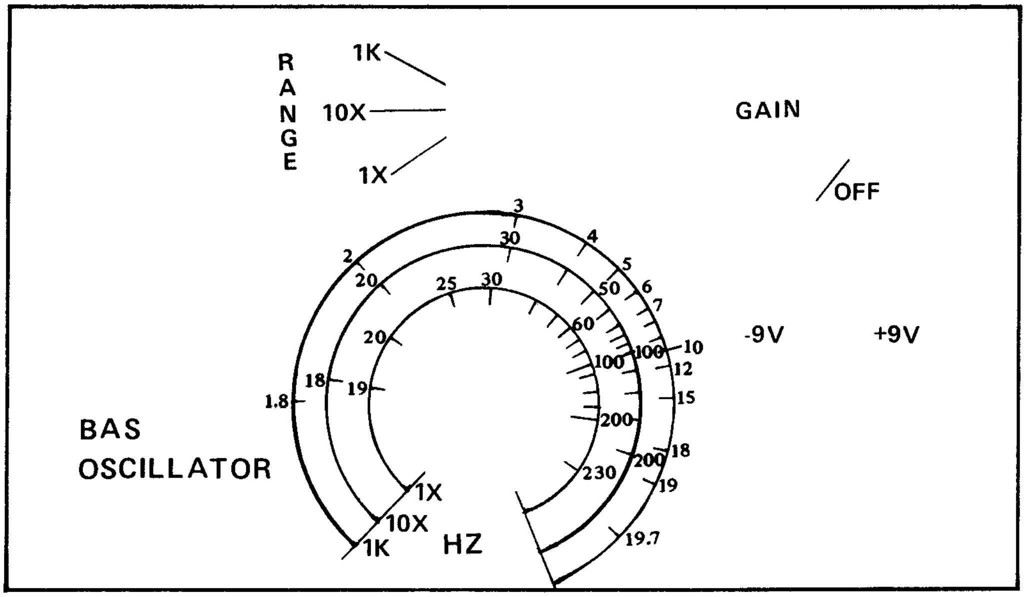


Figure 1

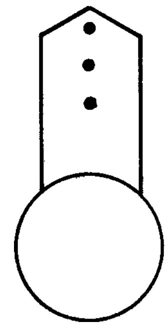


Figure 2

There is a small parallax error in reading through the holes in the plexiglass, but this is negligible compared with the inherent lack of resolution on the high end of the scale. Using a Fluke 1900A frequency counter I could not set the oscillator knob closer than 10 Hz at 10 kHz, but this 0.1% error is certainly adequate for audio work.

Better resolution could be obtained if the range switch were relocated to the upper left-hand corner of the panel and the battery-test jacks were placed on the side along with the output jacks (adjusting lead lengths and the placement of the PC board accordingly). This would allow the use of a longer cursor and longer scales, A vernier dial could also help, but they tend to become expensive. (Steer clear of the Lafayette $2 dial, which gives only 180° of rotation as required for tuning capacitors but not enough for potentiometers.) Accurate calibration is more important than any of these possible frills, and I've found the above method ideal for the $19 BAS oscillator.

— Bob Borden

A Review of the Newest Sheffield: "Lab II"

The newest release from Sheffield, "LAB II," represents a departure from some of their previously held traditions in recording technique. In the October 1974 issue of High Fidelity it is stated that no limiting, compressors, or tape recorders are used in the Sheffield "direct-to-discs" recording chain: "The absence of compression and limiting, virtually universal in commercial practice, is credited with lending the instruments remarkable impact."

The first three releases from Sheffield are excellent examples of what happens when the usual limiting links within the recording chain are eliminated or properly used. The latest recording, however, is an excellent example of how not to use limiting.

A limiter is used to restrict the dynamic range of an instrument whenever it may exceed the maximum excursion capability of the disc-cutting stylus. When the limiter has been used either excessively or improperly, the audible effects are harshness and a loss of clarity.

An excellent example of "harshness" is the sound of the female vocalist, Thelma Houston, in the LAB II recording. In her five cuts on the album, whenever she starts to sing loudly, an irritation occurs which forces the listener to reduce the playback level.

An example of the "loss of clarity" is in her accompanying chorus. Their words are barely distinguishable, and the sound is as if more "crackling" were occurring than singing.

LAB II is also ideal for visually observing these effects of improper limiting. Plug the outputs of your preamplifier/amplifier into the horizontal inputs of an oscilloscope. As Thelma Houston starts to sing loudly, square waves will appear on the scope. The louder she sings, the more dominant the square waves become. You will also observe that limiting was used even more often with the chorus, but only occasionally with the drums. (If limiting were not being used, the distortion would instead represent microphone, microphone-preamplifier, or disc-cutter overload; the audible and visual results on a scope would be identical. In any case, this should not occur to this degree on any quality recording.)

LAB II also departs from another of Sheffield's previous traditions, that of outstanding peak-to-rms ratios. This ratio, expressed in dB, refers to the ratio of the maximum transient (or peak) level encountered in a short musical segment compared to the corresponding rms (or roughly the average) value. LAB U's highest ratio is 2 dB below values measured in the previous Volume III recording. The peak levels of LAB II never exceed +14 dB above the standard "0" VU recording level, which puts it only on a par with the best of the commercially available recordings. For my taste, the female vocalist on LAB U was also recorded too close; the accompanying distortion makes that painfully clear.

In spite of its faults, however, LAB II sounds excellent on the purely instrumental selections, and I wouldn't be without a copy of this Sheffield effort. The reggae and rock format represents a delightful combination of current tunes. And, if you can dig it, delightful listening.— Alvin Foster

The Exodus of Advent Averted

This summer, flags at Advent were flying at half mast. Rumors abounded that the company was in for Chapter XI, and the comment "some of my best friends worked at Advent" was on more than one set of lips. VideoBeam TV's, once as rare as unicorns, were stockpiled in the Advent warehouse. Advent's annual report is now out, and the real financial story can be cleared up.

The bottom line of Advent's 1974-1975 problems are summed up in the statement: "A net loss for the year of $2,972,798 was incurred on total sales of $16,724,049." Blame was placed on "significant production problems and significantly higher than anticipated startup costs of manufacturing labor and related overhead expenses attendant to the introduction of VideoBeam." Part of the problem was also a change to "pay-as-you-go" especially for R&D, rather than a previous "deferred" system. Sales out-the-door were stifled and far below those possible or anticipated, particularly in light of the intense recognition of the TV in the print media. In the tight money economy, Advent attempted to increase its borrowings. With "a slowdown in payments to trade creditors, . . . certain of the Company's suppliers were unwilling to ship goods except on a C. O.D. basis. In June 1975, the Company's institutional lenders declared the Company's term loans to be in default and demanded immediate payment."

With the rug pulled out, Advent took decisive action. In addition to measures that reassured and stalled off the banks, Advent essentially became controlled by one Peter J. Sprague, who became Chairman of the Board and one of two major stockholders (Henry Kloss is the other). Sprague came to Advent with superb corporate credentials—his previous position was Chairman of National Semiconductor, a company that has often put the more established semiconductor companies (TI, Motorola, and Fairchild) to shame with innovation.

For all practical purposes, Sprague bought Advent out of bankrupcy, although an additional stock offering nationwide is planned to put Advent's capital position on still more stable ground. (Sprague wasn't overly generous, however; he paid $1.50 for his shares, while they are selling at $8 to $10 Over-the-Counter.) Peter B. Seamans, a co-founder of the company, also helped Advent with additional investment. A final figure in these actions is Philip Doub, who is a second National man and is president of Design Research, a firm familiar to Boston residents.

This short review is not intended as a hype for Advent, nor is it intended to reproduce Advent's Annual Report. We should simply be assured that our good feelings about Advent can continue into the future. The $1000-per-set price increase for the VideoBeam should help erase the $ 3M loss within the first few thousand sets (far less than a year's production if in full swing).

It is worth noting, however, that the sales and profit in the company's audio arm were excellent, contrasted with many other companies' performance in this slack year. Loudspeaker sales increased about 18% in 1975, with the Large Advent still at or near the top for all branded loudspeakers sold in the U.S. Advent chrome cassettes are once again with us, as are a new deluge of superb CR/70 recorded music cassettes. Expanding sales abroad will allow others to share our own content with a product recognized as having a fine price-versus-performance ratio. Now if I could just get my hands on that Advent phono preamp. . .

— Harry Zwicker

The Idea File

In last month's Speaker I offered a few ideas for comment and possible experimentation. In this new tradition of ideas and questions, we offer this month several ideas that may be somewhat farther out. Again, we emphasize the need for feedback and for other ideas and suggestions from you.

1) Driving Loudspeakers. All modern loudspeakers are designed to be driven from a constant voltage (zero impedance) source. Is this the only way to go? What about a speaker driven from a current source? Could someone provide a theoretical analysis of this concept? What's wrong with it? What's right with it? Could it work if the speaker itself were designed differently?

2) Servo Woofers. National Semiconductor Corporation makes a solid-state pressure transducer. Does it have sufficient frequency response and accuracy to be used as the feedback element for a feedback-controlled woofer? It could be installed in the enclosure rather than on the woofer cone itself. It is relatively inexpensive and looks to be easy to work with. It would be nice if someone came up with a compact and clean infra-woofer.

3) Power Meters. No power meter that I am aware of on any power amp actually reads power. All read output voltage, and the scale on the meter tells you watts, if you assume an 8-ohm (usually) resistive load. There are very few loudspeakers that ever look like 8-ohm resistive loads. There is a way around this, however. There are now available IC devices that can multiply two input signals. If you multiply volts and amps, you have instantaneous watts to the loudspeaker. Also, by using such a device with a constant-voltage amplifier output, you could see the variation of current with frequency, which is inversely proportional to impedance. Presto—a quick impedance curve. Who will be the first to build one and write it up?

4) Spectrum Analyzers. Tom Holman's talk on phono preamps (see the meeting summary) gave an excellent approach for testing phono circuitry. Needed for the testing are a square-wave generator, an inverse RIAA equalizer (to contour the square wave), and a spectrum analyzer. Square-wave generators are cheap and easy. RIAA inverse equalizers are straightforward. But the hardest to come by will invariably be the spectrum analyzer. Is there any way to build a bare-bones spectrum analyzer that will provide the data needed, if not the display? How about looking at the output of a very narrow bandpass filter that is swept across the frequency spectrum? This would give you the information, I think, but not the pretty display.

— Mark Saklad

5) Comparison of Record Cleaning Devices . How well do the various record cleaning devices work? Which just skim the surface and which clean down into the grooves ? Which leave damaging residues and which don't? A survey should include the Discwasher, Watts' Preener and Parastat, the Pixall (see note elsewhere in this issue), the Vac-O-Rec, my vacuum system, aid any other devices members might be using. What we need to make this practicable is access to a high power stereo microscope. Can anybody out there supply this ? — Bob Borden

In the Literature

Contributions this month were received from D. Williams, D. Craig, and D. Shanefield.

Acoustical Society of America, Journal of the, Sept. 1975

- Sabine's Reverberation Time and Ergodic Auditoriums: Skip to page 649 for a brief review of early acoustical theory (Sabine, c. 1900).
- . . . Interaural Delay . . . Caused by the Human Head: From CBS Labs (Ben Bauer et al.); data on the phase-shift or time delay of signals in a sound field in the vicinity of our two ears. (p. 693)
- Note: If any of our members attended the November 3-7 Meeting of the ASA, would they consider summarizing the more useful papers for the Speaker ?

Audio, Nov. 1975

- Four-Channel Sound: What Do You Really Hear: A discussion of phase in mono, stereo, and quad sound fields. The author of this piece, Dan Shanefield, is rather familiar to BAS members. (p. 44)
- Equipment reviewed this month should be of great interest to members: Phase Linear 4000 preamplifier, Nakamichi 500 cassette deck, Epicure Model One power amplifier, and the Pioneer CT-F7171 cassette deck. (p. 58)

Audio Engineering Society, Journal of the, May-Sept. 1975

- May: Some Considerations Regarding Four Channel/Stereo Broadcasting Systems: How to transmit discrete four channel in the present stereo-bandwidth frequency allocation.
- July/August: Overcoming Record Warps and Low-Frequency Turntable Rumble in Phonographs: "Certain classes of warped records cannot be tracked by ordinary tonearms, and even those with elaborate vibration dampers or viscous damping often result in stylus displacements which seriously affect the sound quality. By detecting and controlling the absolute stylus force, many of the bothersome low frequency turntable problems can be solved. A stylus regulator system employing feedback control is described." By 3M Company engineers. (p. 450)
- September: A . . . Condenser Microphone Preamplifier. (p. 530)
- On the Noise Performance of a Magnetic Phonograph Pickup: Study of thermal noise generated by the pickup, which shows that a simple four-element model for cartridges (used by Zwicker in earlier issues) is inadequate. (p. 546)
- Simple Equations for Multichannel Stereophonic Sound Localization. (p. 553)
- Some Useful Graphical Relationships: Applies to loudspeakers and is by R. Heyser. (p. 562)

Buying Guide to Speakers (High Fidelity)

Text is for beginners, but the comprehensive listings include warranty information and mention of those models that include fuse holders. Photographs, both with and without grill cloths, are used liberally. An informative advertisement by B&O (pp. 30-31) explains how low-to-mid-frequency phase coherence is achieved in one of their loudspeakers by adding an extra driver that straddles the crossover frequency and by using an extra modification within the crossover itself. [This ad appears also in Nov. 1975 Stereo Review.—Ed.)

Consumer Reports, Oct. 1975

Worth mention is the evaluation of hearing protectors, mostly intended for the total elimination of damaging sound levels caused by mechanical equipment. Still, if you are serious about your music, you should consider the use of these products while cutting the grass, for example. (Clarke, while not mentioned in the CR survey, makes an excellent and complete line of headphone-like padded gear and has a good sales brochure.) In addition, use one of the less drastically noise-reducing earplugs while commuting in any busy city. (p. 618)

db, Sept. 1975

- Being Practical About Feedback: Part one of a three-parter by Norman Crowhurst. (p. 22)
- A Simple and Superior Microphone Preamplifier: Uses a National Semiconductor LM381AN op-amp, noted for its high fidelity and low noise. (p. 28)
- Test Records—A Valuable Measurement Tool: Reprint of an earlier article discussing standard test records. (p. 41)

Electronic Design, Sept. 27, 1975

- Keep Your Op-amp Circuits Quiet: Noise analysis of modern devices, complete with a handy chart of sources of noise as a function of frequency. (p. 88)
- Circuit Turns on Tape Recorder Only When Sound Is Detected: A $10 build-it for sound-activating your cassette, more applicable to telephone answering than audio use. (p. 100)

Electronic Design, Oct. 11, 1975

- Focus on FET's: Reviews general product lines of major companies, possibly of use to preamp designers.
- MOSFET Power Soars to 60 Watts With Currents of 2 Amps: N-channel vertical MOS-FET by Siliconix is the first in a coming line of power V-FET's from a domestic manufacturer. Sold for $5.50 (in 100's), these outperform the Sony devices in terms of speed but not in power. (Is this the mysterious source of Sequerra's V-FET's alluded to by Barrett?) Nice to see the USA in this business, and at a nice price. (p. 103)

Electronic Engineering Times, Oct. 20, 1975

- Accent on Audio (John Fink): Yamaha is discussed. An interesting comment is the mention of their logo—three crossed tuning forks even when used on their motorcycles! Most of the article is devoted to reviews of the B-1 amplifier, the CT-7000 tuner, and the NS-1000M speaker. (p. 41)

Electronic Servicing, Oct. 1975

- Eight-Track Workshop: Discussion of cleaning and servicing eight-track players. Also applies to keeping cassette units and open-reel decks mechanically up to par. (p. 23)
- Servicing Stereo Audio Systems: Noise and Curing It: Unfortunately, this installment is of little practical use, although it does give a review of the electrical and mechanical sources of noise in phono systems and electronic devices in general. (p. 30)

Electronics, Oct. 2, 1975

- Active Filter Has Stable Notch, Response Can be Regulated: A better notch filter that uses three IC's and has variable Q. (p. 115)
- Noted from the Sept. 4, 1975 issue is a 2 x 130-bit CCD (analog) delay line from Fairchild, which hopefully will be the predecessor of a unit suited to audio use (e.g., more like 2 x 1024-bit).

EDN, Oct. 5, 1975

- Grounding in Sensitive Circuits: For the circuit designer, elaborate description of how to (and how not to) lay out signal grounds. (p. 44)

High Fidelity, Nov. 1975

- Not ordinarily mentioned in this column, but especially of note is the article "How to Improve Your Speakers" by Jim Brinton, President of the BAS and Editor of the Speaker. (p. 63)
- While we're in this issue, note also the review of the Royal Sound loudspeaker, which received note from Peter Mitchell long ago, and the comments on Carlos Kleiber's Beethoven Symphony No. 5.

IEEE Proceedings, Sept. 1975

- Models of Hearing (M. R. Schroeder): The BAS hereby promises to compile a readable article on the modern models for human hearing. This will be based not only on the information of this paper, but also on the several additional papers that have been brought to our attention in the past month. Much of the present IEEE paper is, however, easily readable and well worth the effort. (p. 1332)

IMF Newsletter, Number 11

IMF loudspeaker company publishes this occasional newsletter both to present the design views of Irving M. Fried and to promote the IMF product line. Fried is after the mold of outspoken Paul Klipsch, and is a believer in impulse testing (re Heyser). The report for September 15, 1975, contains a discussion of viscous damping for tonearms. Members can get on the mailing list for this freebie by writing to IMF Products, 7616 City Line Ave., Philadelphia, Penn. 19151.

Popular Electronics, Nov. 1975

- Stereo Scene: Bits and pieces about omnidirectional loudspeakers, transient dispersion, a box for correcting phase-errors uniformly across the audio spectrum (for use in phase-matching stereo channels to make phase-sensitive quad decoders more accurate), and more on demonstration records. (p. 22)
- A New Industry Standard for FM Tuner Measurement (Len Feldman): Discussion of the new IEEE-IHF-EIA FM tuner specification standards. (p. 50)
- Test report on the IAD B3A dynamic range expander, including some interesting data on the "unique" transient response of this device. (p. 68)
- A frequency counter kit selling for $69.95 is advertised (p. 110). Although this comment is not to be taken as a recommendation for this instrument, it is worth noting that this price is even lower than the SWTPC counter in its battery-powered form ($84.90), and that this counter boasts 6-digit (rather than 4-digit) readout. The lower frequency limit is, however, very unclear, and may be as high as 100-Hz resolution (versus 0.1 Hz for the SWTPC). If this product proves worthwhile, further attention should be drawn to it.

Radio-Electronics, Nov. 1975

- Square Waves and Audio Performance: Not to be confused with the square-wave tests of the phono stage described in this month's meeting summary (performed with an RIAA recording network), this article describes the more usual use of square waves as a convenient method of checking frequency-bandwidth and frequency-response aberrations in equipment, and also testing for TIM. (p. 52)
- Bookshelf Speakers: Continuation of this strange attempt to compile manufacturers' loudspeaker specifications into coherent tables. This time frequency response, distortion, and power handling are described. A quick look through the tables shows that the number of exceptions to a common basis for comparison of, for example, distortion versus frequency, is so large as to make comparisons among manufacturers impossible. (p. 63)

- Tested this month are the Radio Shack QTA-770 receiver and the more interesting Shure M95-ED cartridge. (p. 54)
- Also of possible interest is the construction article on a small electronic synthesizer, the GNOME by PIAA Electronics. This interesting company has a line of very inexpensive basic synthesizers and electronic generators (e.g., surf-synthesis and wind-chimes at $13 and $20, respectively). The BAS can obtain a 10% discount on orders for 10 or more identical kits; if you are interested, send a card to the BAS and we will organize a buy if the total number exceeds 10. (p. 37)

Saturday Review, Oct. 4, 1975

Several articles of interest include pieces on Japan's Electronic Hifinatics (by Irving Kolodin), and on Caruso, Verdi, and Heifetz.

Scientific American, Oct. 1975

- Musical Illusions: Not necessarily musical illusions, but tests with sine waves that demonstrate the right-handed versus left-handed mental processing of our two ears. For comparison, see the nearly unreadable article in the ASA Journal (June 1975), written by the same author but without the Scientific American audience in mind. (Note also, if you are a fanatic, the article on right-versus-left hearing in Science, October 17, 1975, p. 286.)

Stereo Directory and Buying Guide, 1976

In case you missed it at its pre-publication price, this annual compendium of products and specifications is now out. Articles this year include a repeat of the Hi-Fi Troubleshooting piece, including foldout. In the interior, note the Audio-Research line (CA-1 preamplifier and three power amplifiers), DCE's expanded line (Ron Dunlap and Co.), the absence of any EPI preamplifier, many new European entries, and far too many pages of speakers for any audiophile to peruse at one sitting.

Stereo Review, Nov. 1975

- We're sure that you've already noticed this, but just to pat ourselves on the back, read J. Hirsch's column on A-B testing, with it's reference to BAS results on the stringent requirements for channel matching.

Wireless World, Sept. 1975

Not much this month; note the discussion of speech compression to shorten tape playing time and increase data rate (p. 433) and the discussion of Doppler distortion (again) in the letters section, this time including the effect of the listening room.

October BAS Meeting

BUSINESS MEETING

With over 100 in attendance at GTE Labs, the quorum requirement was easily met and the election of officers was completed. Elected by unanimous vote: Treasurer, Harry Zwicker; Corresponding Secretary, Joyce Brinton; Recording Secretary, Alvin Foster; President, James Brinton. Proposed amendments to the BAS Constitution and By-laws, discussed in the October Speaker, will be voted upon at the November meeting.

BAS oscillator kits were again available from Peter Mitchell at $17, or $19 with prepunched board and chassis. (Mail orders should include an additional $2 for postage and handling.) Peter also described and demonstrated a quick and easy modification for the AR tonearm that made it capable of tracking very high-compliance cartridges such as the Ortofon VMS20. The original arm damping was removed and silicone fluid was added to the vertical pivots (Peter has an ample supply if you need some). About 75% of the plastic cartridge shell was shaved away to lower the arm mass. With light cartridges such as the Ortofon, it may be necessary to remove (a hacksaw will do) some of the counterweight for proper adjustment of tracking force. The foam platter cover was replaced with a ring of individual rubber chassis feet (from Olson Radio) to cut down dust collection. Kitchen sponges under the base are used for acoustic isolation. About 15 people expressed interest in pursuing this type of modification.

Additional measurements on the Thermo Electron microphone capsule by Peter show the 814C to have lower distortion than the 814, even well below overload. The distortion levels were: 95 dB SPL, 0.1% versus 0.6%; 105 dB SPL, 0.3% versus 1.0%. A final purchase of these capsules is planned and the last group of orders was taken at the meeting.

Very few of the questionnaires included with the September Speaker have been returned. Jim Brinton urged members to fill in the blanks and drop it in the mail, as it is one of the few ways in which the BAS obtains feedback on its programs and publications. This is an easy way to tell us what things we are doing that you like so more of the same will be forthcoming.

MEETING FEATURE: NEW FACTORS IN PREAMPLIFIER DESIGN

BAS member Tom Holman, an engineer at Advent Corporation, presented a preview of his investigations into why various phonograph preamplifiers sound different and how to relate "sound" to measured differences in distortion. He also described a preamplifier that was designed to perform well on these as well as conventional measurements, and demonstrated that it did sound superb.

This meeting summary has been adapted from his presentation and from a paper on the subject to be given at the October-November meeting of the Audio Engineering Society in New York City.

Toward More Meaningful Measurements

The normally quoted specifications of current high-quality phonograph preamplifiers, such as frequency response, noise, distortion, and overload, offer only limited guidance in determining how a preamplifier will ultimately sound. The conditions under which test measurements are made represent a gross simplification of the real-world environment in which the preamplifier is used. For instance, (1) none of the conventional tests measures performance under transient conditions; (2) test results, with the exception of some noise measurements, are not ordinarily weighted for the psychoacoustic response of the ear (e.g., some distortion products or frequency bands may be more annoying or important than others); and (3) frequency response of the preamplifier to signals out of the audio passband, below 20 Hz and above 20 kHz, may affect the in-band performance through intermodulation in the preamplifier, or, more likely, later in the system. It is not surprising, therefore, that these standard specifications have a low correlation with the listening experience. Although conventional measurements may be useful in giving the circuit designer information about how a circuit behaves, they cannot be said to be at a state where preamplifiers, sorted by specifications, will be ranked subjectively in the same order. New, more sophisticated measurement procedures are needed in order to establish test conditions that more closely simulate actual operating conditions, and that will point out the subtle but annoying forms of distortion.

Preamplifier listening test comparisons can also be misleading unless handled with great care. Cartridge loading must be proper, both resistively and capacitively, and must remain constant for all test tones. A-versus-B gain must be very accurately watched (to within a small fraction of a dB). Grounding and shielding must be carefully checked, since the output of the preamplifier is asked to come physically close to the input (for switching purposes), and some units are prone to oscillation under these conditions. Only after these things have been done can preamplifier listening tests be said to be definitive. What is typically found, after these items have been looked after, is that differences are still heard that are subjectively termed frequency response errors; most often one observes the quality of "brighter" versus "duller" sound.

The following is a re-examination of some preamplifier design criteria and a description of a new set of measurements that correlate very closely with the listening experience. A preamplifier design based on these criteria is also discussed, along with its measured and audible performance specifications.

Cartridge-Preamplifier Interactions. Among the various factors that influence the high-frequency response of a phono system, the preamplifier-cartridge interaction is one that is seldom fully appreciated. While cartridge designers usually state the proper loading to ensure specified response, few turntable, arm, or preamplifier manufacturers specify the minimal capacitive load presented to the cartridge by their products. Even less well understood is the adverse effect that the cartridge's frequency-dependent complex impedance load can have on the response of the preamplifier input stage.

To determine the general effects of the cartridge-preamplifier interaction, a typical cartridge was connected to a preamplifier and driven electrically through a 10-ohm series resistance using a sine-wave source with RIAA pre-emphasis equalization. A nominal cartridge loading of 200 pF was used (see Fig. 1). Measurements made with this equivalent circuit show the expected high-frequency rolloff associated with the inductance and capacitance. In practice, this rolloff helps flatten the mechanical resonance "rollup" of a real cartridge if operated into a pure resistor. In addition, however, many tested preamplifiers showed that their high-frequency response was being influenced by the frequency-varying cartridge load impedance. A good way to measure this inverse interaction is to compare the frequency response of the cartridge-preamplifier system both with and without the addition of a high (constant) impedance, wide-bandwidth, buffer (isolation) amplifier with low input capacitance (Fig. 2). Of course, a 47K cartridge system resistive termination is required at the buffer input. Use of this technique reveals differences that are both measurable and audible.

In one example, a preamplifier in a $500 price class receiver, when driven by a voltage source, showed an RIAA equalization error of only ±0.5 dB from 20 to 20,000 Hz. But when driven by the cartridge-equivalent system, the interaction was rather large. The difference between the un-buffered and the buffered measurements was +1½ dB at 7 kHz, crossing through zero reference at 10 kHz, and -6 ½ dB at 20 kHz. This high-frequency falloff may be partially explained by an observed 4-dB drop in preamplifier input impedance at 20 kHz from its value at 1 kHz. In another preamplifier, in which the interaction was less severe, the system capacitance was varied to try to match the buffered and unbuffered response. Although an improvement was noted, a perfect match was not possible, indicating that the falling high-frequency response was not due entirely to incorrect preamplifier input capacitance, but was probably due also to a dropping input impedance at high frequencies due to lack of loop gain[1],

During this experimentation an attempt was made to synthesize a model of the cartridge-cable-preamplifier system that would allow theoretical prediction of the phono system frequency response using known element values. But this was not achieved in spite of the use of sophisticated equivalent circuits for the cartridge. Recent work on cartridge modeling[3] has shown that the introduction of a nonlinear resistive element may be necessary if a workable overall system model is to be obtained.

Infrasonic Response. A second overlooked and important area of preamplifier design is the amplifier's infrasonic response, where the cartridge appears nearly resistive and the above interaction is negligible. In listening tests in which two amplifiers, otherwise identical, were

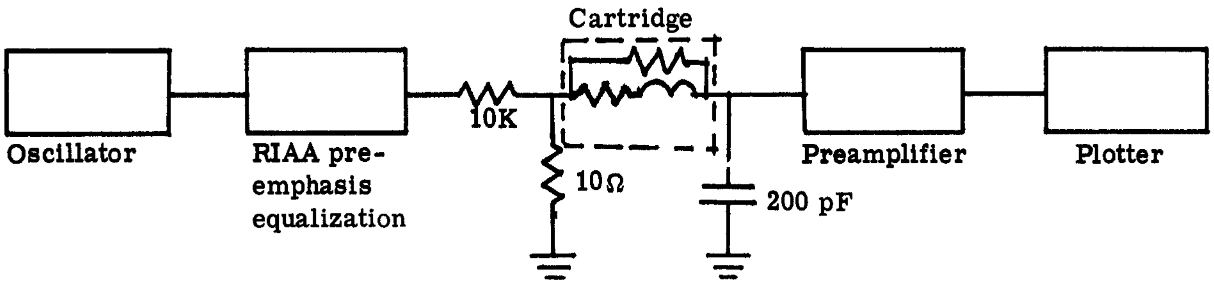


Figure 1

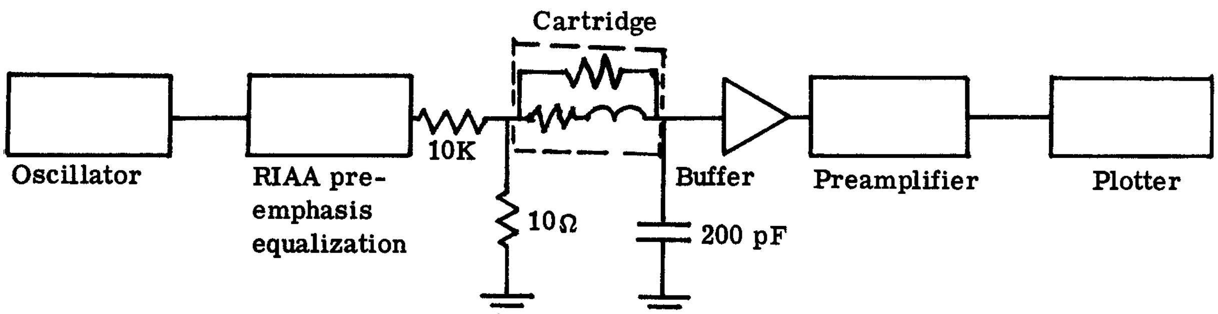


Figure 2

compared, the preamplifier with steeper infrasonic rolloff produced less audible intermodulation distortion and a more solid stereo image. Infrasonic cutoff also produces much less visible woofer motion on record warps and, consequently, less electrical and acoustical intermodulation, less amplifier overload, and fewer blown fuses.

(Various observers have also reported on the usefulness of damping in the tonearm/cartridge resonant system. The Boston Audio Society has reported that tonearm pivot damping reduces audible amplitude modulation effects, improves stereo imaging, etc. Arm damping operates in the smaller sense of making ever more highly compliant cartridges track record warps better, or in the larger sense of restricting low-frequency disturbances around the whole system. Whether this improvement results largely from a similar restricting of low-frequency disturbances has not yet been entirely sorted out.)

Noise Considerations. Noise performance of preamplifiers is influenced by the source impedance of the cartridge, and preamplifiers should be designed with a cartridge input in mind. Also, design (as well as measurement) should be made on a weighted basis so that performance is optimized for both the real source impedance and for the low-level characteristics of human hearing. Combining these notions with some well-known techniques for making low-noise amplifiers ensures a design within a few dB of the theoretical noise minimum. Among the design considerations are: (1) for an optimum noise figure within the range of expected source impedances, a bipolar transistor has the best matching characteristics; and (2) a series feedback configuration is superior to a shunt feedback form.[4] However, with noise performance already very close to the minimum, further breakthroughs should not be expected.[5]

Transient Response. While attempting to measure transient response of preamplifiers it was noted that many high-quality units did poorly on a test that was not considered particularly severe, namely, the reproduction of a 1-kHz square wave. In the measurement setup (Fig. 3), a

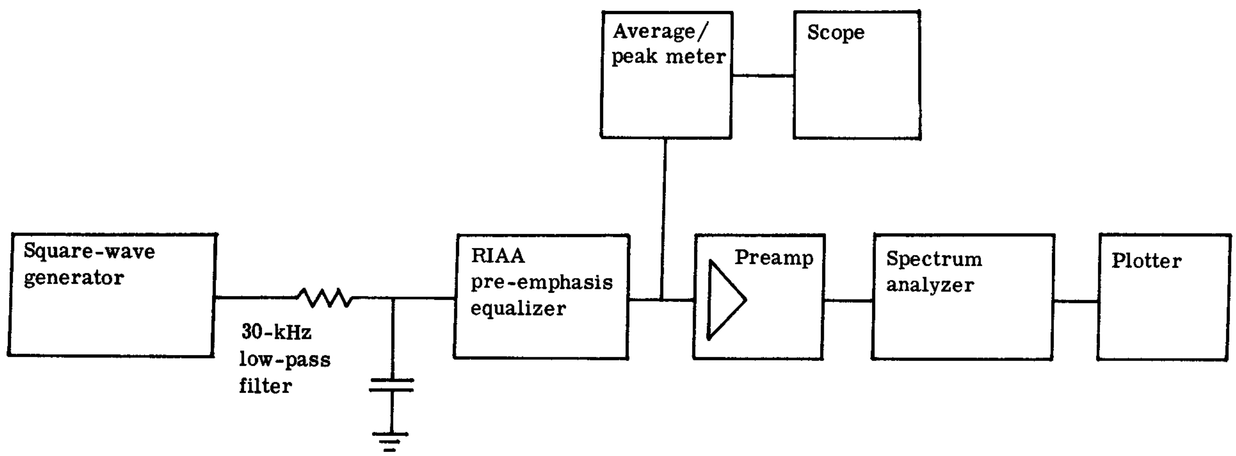


Figure 3

fast risetime square-wave generator with good symmetry was used. This square-wave signal was passed through a single-pole 30-kHz RC low-pass filter representing the practical frequency response limit that could reasonably be expected from a record made with the latest generation of cutterheads recording at half-play speed. This band-limited signal was then applied to an accurate RIAA pre-emphasis circuit that was carefully checked for nonlinear behavior. The signal, set at an average level equivalent to a 3.54-cm/sec "0" VU sine-wave test signal, was applied to the input of the preamplifier under test. The preamp's output should have been a square wave with a frequency spectrum containing only odd-order harmonics. (In practice, it is not possible to completely eliminate even-order harmonics from the square-wave generator but, with careful adjustment of the symmetry control, these residuals were reduced to -67 dB below the fundamental.

Transient distortion in the preamplifier, however, appeared in this test as an increase in even-order harmonic content. In the time domain, the distortion could be seen as an asymmetric reproduction of the positive and negative half-cycles of the square wave (Fig. 4). Square-wave test performance on a number of preamplifiers ranged from perfect square-wave reproduction to one unit in which the second harmonic was down only 13 dB, representing a 22% second harmonic frequency component where, at these levels, there should have been none. The results of these tests are given in Table 1.

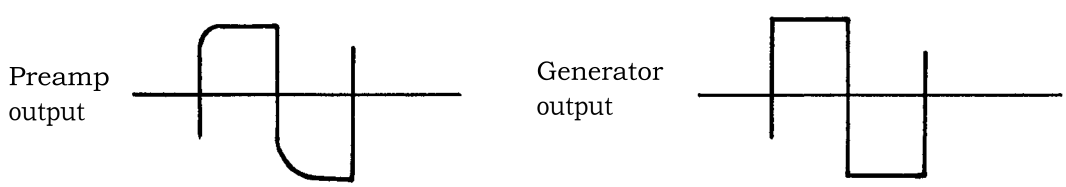


Figure 4

Table 1. Even-Order Harmonic Distortion of 1-kHz Square Wave
(dB Below Fundamental)

Phono Preamplifier	Frequency, kHz 2	4	6	8	10	12	14	16	18
None (source spectrum)	-67	-67	-67	-67	-67	-67	-67	-67	-67
Marantz 2230 receiver	-13	-18	-20	-23	-25	-26	-27	-28	-29
McIntosh C-26	-16	-20	-23	-25	-27	-29	-30	-31	-32
Crown IC-150	-30	-'33	-35	-37	-39	-40	-41	-42	-43
Integrated Circuit μA 749	-47	-51	-54	-56	-58	-59	-61	-62	-63
Dynaco PAS-3X (tube)	-50	-54	-57	-59	--61	-62	-63	-64	-65
Marantz 7C (tube)	-54	-58	-61	-63	-64	-65	-66	-67	-67
Advent design	-67	-67	-67	-67	-67	-67	-67	-67	-67

Several sources for this form of distortion are possible. The most familiar is slew-rate limiting, during which the amplifier operates extremely nonlinearly. However, this does not seem to be the only source. Preamplifiers that use large bypass capacitors to obtain ac gain, based on the assumption that the charge stays constant over a cycle, also seem to be prone to this form of distortion; small-signal assumptions may therefore not be valid for the levels present in phono preamplifiers.

From this knowledge it might be expected that asymmetrical waveforms would also yield results different from the ordinary sine-wave tests, and this was indeed the case. However, it was felt that no separate set of asymmetrical waveform tests were necessary, since units that exhibited clean square-wave spectrums also performed well on asymmetrical waveforms. The results of these square-wave tests separate and rank the performance of the various preamplifiers and correlate well with the listening experience as described below. Differences in real listening situations, however, may be much less dramatic than indicated by the figures, as recorded material will offer less severe a test due to cutterhead limitations.

Overload Specifications. The often quoted sine-wave input overload figure has little to do with the observed impression of overload distortion. One reason for this may be seen in the square-wave spectrum testing; these measurements were made at a relatively low level (0 VU) and show nonlinear behavior in many of the tested preamplifiers. In order to find what the peak levels on records actually are, a test was performed with one of the best tracking cartridges and highest overload preamplifiers. The output from the preamplifier was fed to a level-calibrated storage oscilloscope, and records known for their playing difficulties due to tracking and overload problems were played (about three hours worth were tried). The highest peak level found in that time was about 14 dB above 3.54 cm/sec. "Average" peaks were about 10 dB above 0 VU. Although this test may not be definitive, it strongly suggests that sine-wave overload numbers above, say, 60 mV rms are never exceeded by records. The specifications for a current generation cutterhead for peak level are 40 cm/sec peak velocity at 10 kHz in 10-msec tone bursts. This would translate roughly to an equivalent 40 mV at 1 kHz. If high sine-wave overload figures have any correlation with low perceived distortion, it may be only because, along with the achievement of this high figure, other areas of performance have also received careful attention.

Defining a Preamplifier Design

A new preamplifier design has evolved along with the refinement of these measurement techniques and the criteria described above. The most basic decision is the choice of design configuration or topology. The topology is strongly influenced by the active devices employed, and the devices are heavily influenced by the required noise performance. Designing for low noise is done with a knowledge of the resistive part of the source impedance, the modification of the frequency response by the requirements of the RIAA equalization, and the appropriate weighting function accounting for the ears' sensitivity to noise. The most important technique under the control of the designer is the configuration and operating point of the first stage. Here low-noise design is accomplished by dealing with a few precepts. The first stage must have gain in order to negate the contribution of noise in later stages. In the range of source impedances presented by cartridges, the bipolar transistor is the optimum device, as opposed to FET's or tubes. [There is argument on this.—Ed.] Feedback weights the results, but does not change the noise figure. Series feedback in cartridge-preamplifier systems is superior to shunt feedback (virtual ground) schemes. When these precepts are followed to arrive at an optimum topology, a system results that is within a very few dB of the theoretical minimum noise.

In the design presented here (Fig. 5) the differential input configuration is chosen to keep the RIAA network values at fairly high impedance levels (i.e., small capacitors) so that the output stage can supply enough current to be able to charge and discharge the capacitors quickly and therefore maintain a very fast slew rate. In fact, the impedance level used is reminiscent of tube designs, many of which have a noted ability for good performance on slewing.

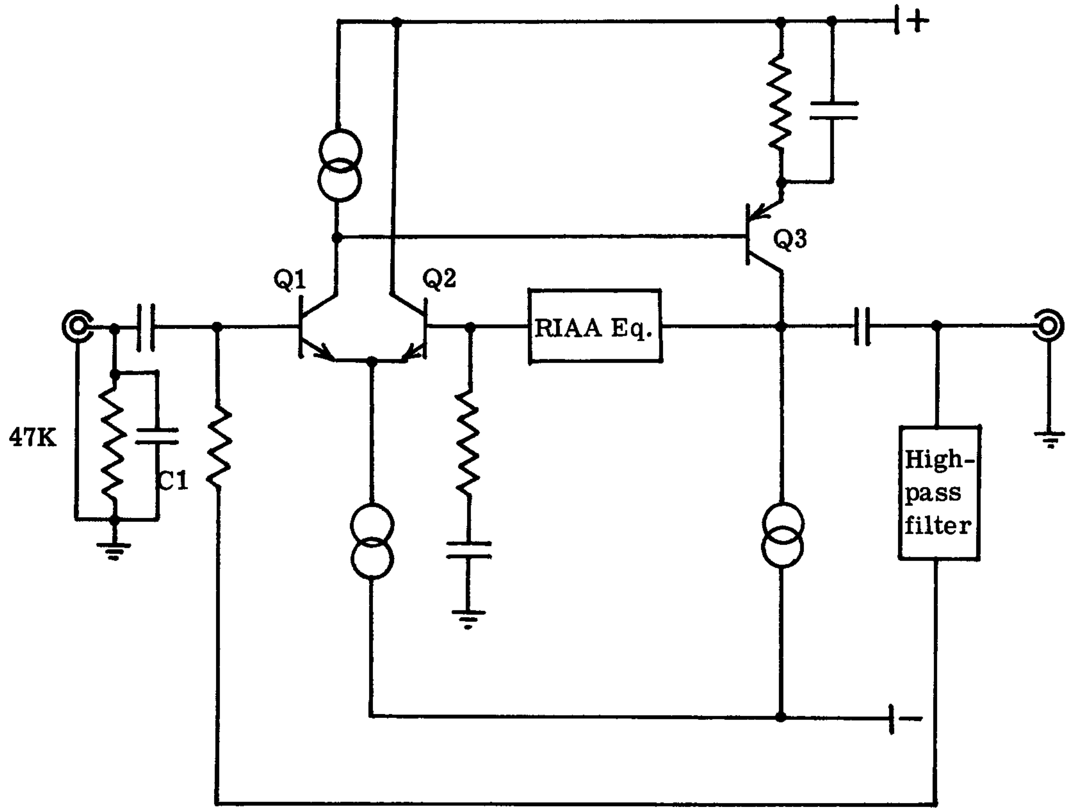


Figure 5

[The following three paragraphs are quite technical and could be skipped by the non-circuit-designers. Important conclusions are underscored—Ed.]

Open loop compensation of phonograph preamplifiers is fairly tricky due to the extensive feedback in the RIAA compensation loop around the amplifier. Many designers choose fairly low dominant pole compensation, which generally is safe in the steady state, but which does not allow the amplifier to slew well. In this preamplifier design, the second stage Miller-effect pole has been canceled by a zero formed by the RC component in the second stage emitter circuit. This <u>extends the second stage bandwidth</u> so that the dominant open-loop pole is formed by the first stage current source load. Since this is a very small capacitance with a fair amount of current available to charge it, the amplifier's <u>slew rate performance is extremely good (BW > 10 MHz)</u>. No capacitors in this topology are in places where their net charge must be quickly changed by large amounts.

The use of current source loading on the first stage produces <u>very high stage gain</u>, which yields large open-loop gain.[6] Large open-loop gain leads to large (closed-loop, RIAA-feedback) loop gain, which keeps the <u>input impedance high and the distortion low</u>. In fact, the preamplifier has <u>no measurable cartridge impedance interaction</u>, and distortion at 3 volts output at 1 kHz is less than 0.1%, most of which is second harmonic and therefore completely Inaudible.

The usual high-fidelity design practice of <u>low-frequency filtering</u> by use of synchronously tuned RC stages (those with a number of simultaneous poles on the negative real axis of the s-plane) yields a "soft" response corner. A better solution is to equispace pole pairs on a semi-circle in the left-hand half-plane, which gives a Butterworth (maximally flat passband) response. If we rule out inductors, this implies that feedback must be used to generate the appropriate response function. In this preamplifier, the low end of the first stage biasing resistor is boot-strapped to the output, which causes a <u>fairly sharp 18-dB/octave cutoff below</u> 20 Hz for a three-pole Butterworth design.

The performance specifications of the preamplifier are given in Table 2. Results of the cartridge complex impedance interaction (unmeasurable) and square-wave even-order distortion components (also unmeasurable) are particularly attractive. No conventional specification has been sacrificed to obtain high performance on these new tests.

Table 2. Preamp Performance Specifications

Frequency response from a voltage source: ±0.5 dB, 30 Hz to 20 kHz; -1 dB, 20 Hz; -6 dB, 10 Hz; -14 dB, 5 Hz

Cartridge complex impedance interaction with frequency response: Unmeasurable

Noise (Ref: 10 mV rms input, USASI "A" weighted, dummy cartridge source): -82 dB (with a shorted input, this improves by 4 dB to -86 dB)

Total harmonic distortion:	0.5 volt out at 1 kHz, 0.04%, mostly 2nd harmonic
	3.0 volts out at 1 kHz, 0.095%, mostly 2nd harmonic
	7.5 volts out at 1 kHz, 0.3%, mostly 2nd harmonic
	3.0 volts out at 10 kHz, 0.025%, 2nd harmonic

Intermodulation distortion:	0.5 volt out, less than measurement residual of 0.012%
(4:1 SMPTE with active	1.0 volt out, 0.022%
pre-emphasis booster in)	3.0 volts out, 0.085%
	6.0 volts out, 0.18%

Input sine-wave overload at 1 kHz: 100 mV rms

Square wave input even-order distortion components with 3.5 mV rms composite input: Unmeasurable, less than -67 dB for all harmonics

It is hoped that these new measurement techniques for phonograph preamplifiers lead to better <u>sounding</u> designs. The most important notion of this work is that new designs should evolve interactively with measurement technique and the listening experience, and should not be based solely on producing better measurements on conventional tests.

Listening Comparison

As a demonstration of the sound quality that can be expected from preamplifiers designed to these criteria, the prototype Advent unit was A-B compared with a McIntosh C-26 Preamplifier at the October meeting. Both were operated sequentially in a system consisting of a Shure V15 Type III cartridge, a Phase Linear 700 amplifier, and Advent speakers. Sheffield disks provided most of the source material.

As with past demonstrations, the acoustics of the auditorium seemed to interfere with the comparison process. The strong high-frequency absorption tended to obscure differences for those not close to a speaker. Several persons felt that the individual preamplifier characteristics had been much more obvious in prior home environment listening. There was general agreement that transients, particularly on drums and cymbals, were better reproduced by the Advent prototype, the C-26 sounding as if high-frequency overload, similar to tape saturation, were present. The noise level from the Advent seemed higher, although both measured the same. One explanation, offered by Peter Mitchell, was that the noise on the disc was reproduced clearly by the Advent but was masked by distortion in the C-26. It is similar to the impression obtained at a recording session when listening to the live performance first through the microphone-amplifier and then off the tape.

Advent has no present plans for marketing a preamplifier featuring this circuit; however, the design may appear, unheralded, in future products. — John Schlafer

Additional Comments. Although listeners' remarks after the demonstration were anything but unanimous, several of those present, myself included, were astounded by the audible difference between the Advent and the C-26 (which was chosen specifically as a less "good" sounding preamplifier). To my ears, it seemed that the Advent exhibited a substantial treble boost, but Holman claimed that there were neither level differences nor frequency-response aberrations between the two A-B'd units. The differences were far from subtle, and even after Holman explained that the difference in distortion should indeed manifest itself largely as an apparent level difference, it was just too dramatic to be believed. I await further in-home listening opportunities, and discussion with other members. But, see this month's publication for further comment. —Ed.)

References

1. King, George J., "Magnetic Pickup Loading," Wireless World, Dec. 1973, p. 592. Presents observations on interaction between cartridge impedance, cartridge loading, and preamplifier input impedance anomalies.
2. Williamson, Reginald, "Magnetic Pickup Loading," Wireless World, June 1973. Presents an equivalent circuit for a cartridge.
3. Halgren, B. I., "On the Noise Performance of a Magnetic Cartridge," J. Audio Eng. Society, Vol. 23, No. 7, Sept. 1975.
4. Walker, H. P., "Low Noise Audio Amplifiers," Wireless World, May 1972, pp. 233-237. Discusses series versus shunt feedback in equalized preamplifiers and optimization of noise figure.
5. Motchenbacher, C. D., and Fitchen, F. C., Low Noise Electronic Design, John Wiley & Sons, New York, 1973.

Validation of the Holman Preamp Tests

PART I: HOW PREAMPS COMPARE USING THE HOLMAN TESTS

Alvin Foster and Mark Davis

Introduction

BAS members James Brinton, Mark Davis, Alvin Foster, and Ira Leonard checked 24 preamplifiers using Tom Holman's cartridge interaction and square-wave tests. Most of the preamps had been auditioned and ranked by Foster prior to the tests, and his subjective rankings tended to confirm the validity of Holman's tests, although some anomalies were noted.

Cartridge/Preamp Impedance Interaction

Most stereo phono cartridges are designed to feed an impedance of 47 kohms in parallel with a small capacitance, typically 100 to 400 picofarads. Not all preamplifiers present such a load. To test for cartridge/preamp interaction, the setup shown in Fig 1 was used.

A sine wave swept from dc to 20 kHz from a General Radio model 1900A wave analyzer was fed to an attenuator, an RIAA pre-emphasis network, and a Pickering 750E cartridge in series with the input of the preamp under test (PUT). The preamp tape output was then fed back to the wave analyzer to be plotted (see Fig. la).

After a frequency run had been made, an FET buffer amplifier with a 47-kohm input load was interposed between the cartridge and the PUT, and another frequency run was made (see Fig. 1b). Because of the inherent high impedance of the FET, the buffer had no interaction with the cartridge. Thus if the PUT exhibited no cartridge interaction, the curves for the two frequency runs would be identical. The bulk of the capacitive load seen by the cartridge was contributed by the cable connecting the cartridge to either the PUT or the buffer, and was measured as 168 pF.

This setup is similar to the one used by Tom Holman, although he used an Ortofon cartridge. It is unlikely that this difference is significant, since most cartridges are electrically similar.

The results of this experiment are presented in Table 1. (Time considerations prevented all 24 preamps from being tested.) The preamps have been divided into two groups: those exhibiting measurable interaction and those that did not. Rather than illustrating all the curves, the frequency area and degree of deviation of each preamp are listed. The results do not reflect the accuracy of the RIAA curve of the PUT but describe only how the unit interfaces with the cartridge.

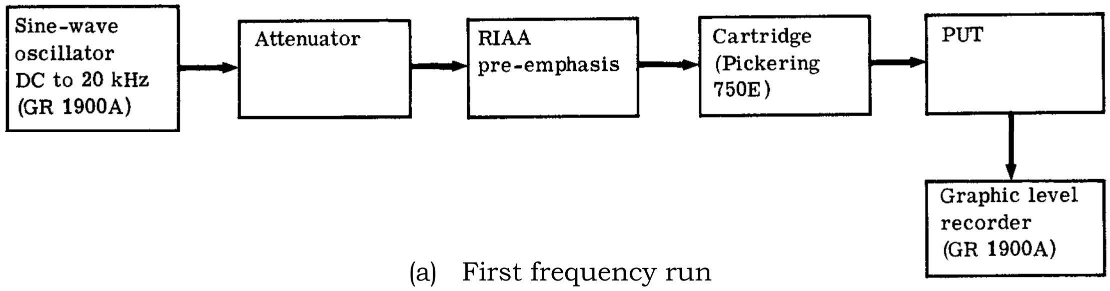
Table 1. Cartridge/Preamp Impedance Interaction

Preamp	Frequency Area Affected by Interaction	Deviation	Zero-Crossing Frequency
Acoustic Research Advent (not in production) Mark Davis FET design Private FET design SAE 1B	No measurable interaction		
ATD	15 kHz 20 kHz	-1 dB -2 dB	
Citation 11a	9 kHz 16 kHz 20 kHz	+2 dB -2 dB -3 dB	13 kHz
Lux	10 kHz 20 kHz	+1 dB -1 dB	16 kHz
Marantz 7C	17 kHz 20 kHz	-1 dB -1.1 dB	
Phase Linear 4000 (serial no. 4075)	10 kHz 20 kHz	+4 dB -4 dB	Interacts irrespective of input pot setting
Pickering	10 kHz 20 kHz	+1 dB +1.5 dB	
Quad	10 kHz 18 kHz 20 kHz	+2 dB +1 dB +1 dB	
Quintessence	10 kHz 20 kHz	+1 dB -1 dB	14 kHz
Radford	10 kHz 20 kHz	+1 dB -0.5 dB	16 kHz
Sansui 8	10 kHz 20 kHz	-1 dB +1 dB	16 kHz

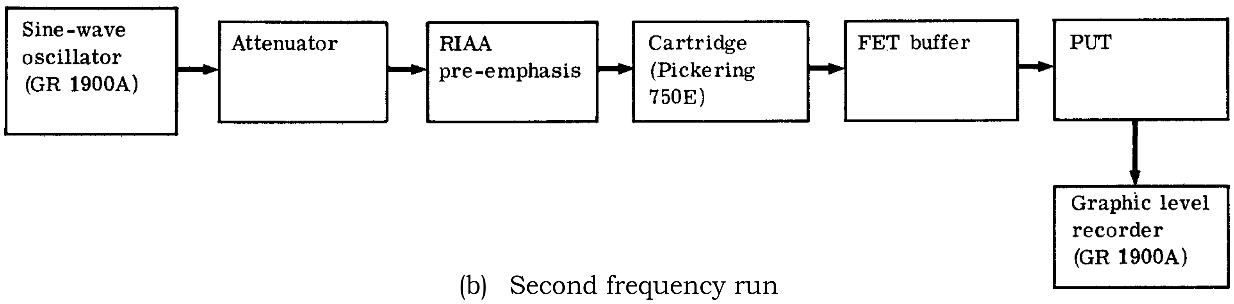
Square-Wave Test

The setup for this experiment is shown in Fig. 2. A 1-kHz square wave generated by a Hewlett Packard 209A oscillator and a type 4013 dual D-type CMOS flip-flop was fed to an attenuator, an RIAA pre-emphasis network, and the PUT. The flip-flop was used to create a highly symmetrical square wave with even harmonics more than 80 dB below the level of the fundamental.

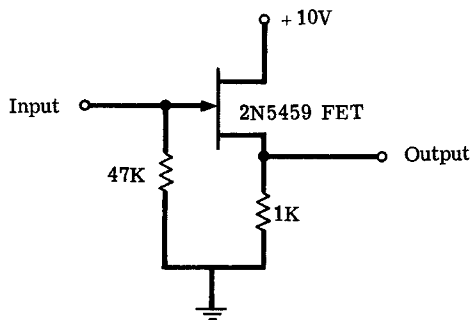
The output of the preamp should be a square wave of equal purity. To check this, the output of the PUT was fed to the tracking filter section of the GR wave analyzer and the harmonic structure was plotted.



(a) First frequency run



(b) Second frequency run



(c) FET buffer

Fig. 1. Setups for cartridge/preamp interaction experiments

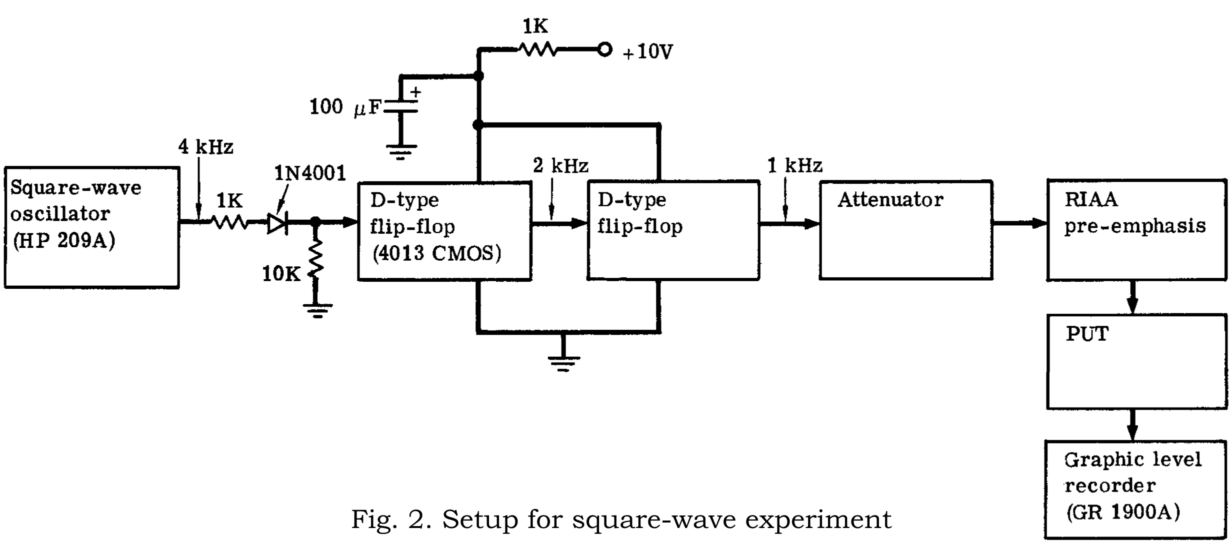


Fig. 2. Setup for square-wave experiment

The results are shown in tabular form in Table 2. The preamps are listed in order of performance in this test, best last. The level of each of the even harmonics through 18 kHz, relative to the level of the fundamental, is listed, along with the average of these nine figures. Also shown are. subjective comments on the audio quality of those preamps auditioned by Foster and the list prices of those units available commercially.

The setup used here is similar to that used by Tom Holman, although he used an active RIAA pre-emphasis network. The two networks were compared in the course of this test and found to give identical results when their peak outputs were the same. (See Fig. 3 for a schematic of the passive network designed by Davis.)

Figure 4 shows the waveform measured after the pre-emphasis network, as it is fed to the PUT input. It is essentially a square wave with a modest amount of tilt and a large amount of overshoot, the latter having a 1-microsecond rise time and a 6-microsecond fall time. Varying the length of the cable between the pre-emphasis network and the PUT affected the height of the overshoot, but not the rms level of the waveform, as measured with a Weston 4445 DMM. The early part of the test was conducted with fairly long cables, at which point the peak value was 600 millivolts (mV) and the rms value was 18.9 mV. Later, shorter cable and Tom Holman's pre-emphasis network were substituted. When the input level was adjusted to achieve the same even-harmonic content in a preamp tested earlier (the Pioneer SC-700), it was found that the rms level of the input was now only 6.8 mV but the peak level was still 600 mV, which would tend to indicate that it is the peak level that is important, not the rms level, although this was not checked with other preamps. Tom Holman used cables only a couple of inches long and a measured rms level of 3.5 mV, but he did not measure the exact value of the peak.

Subjective Reactions

The preamps that were auditioned by Foster prior to the test broke down into two groups: those that sounded "good" and those that sounded "edgy," as indicated in Table 2. The "good" preamps were extremely close in sound quality. The small differences that did exist were probably due to minor variations in frequency response.

The "edgy" preamps were tiring to listen to and can be described as sharp sounding. (See Part II of this article.) The preamps not commented upon in Table 2 were not auditioned by the authors.

Discussion of Results

For preamplifiers using bipolar transistors, there is evidently excellent agreement between Holman test results and subjective listening quality. It may be that one need only design a low-noise preamp to pass these tests in order for it to sound "good." Obviously, such transistor preamps already exist, and are indistinguishable from the best tube preamps.

The agreement between the results of the square-wave test and perceived audio quality for the tested FET preamps was poor, as both sounded "good." Perhaps the characteristics of an FET make the square-wave test invalid as a measure of audible quality of such preamps.

There are still many questions to be answered. The significance of the peak level of the square wave being 600 mV has not been explained, although it may be related to the base-emitter voltage of a silicon bipolar transistor, which is typically 600 mV. Most of the preamps showed no ill effects at input levels much below this, yet the output of a typical phono cartridge is not known to exceed 90 mV peak. Perhaps a subtle cartridge/preamp transient interaction is involved.

Although no explanation has been offered to account for the correlation between the results of Holman's square-wave test and a preamp's audio quality, we are satisfied that such a correlation exists.

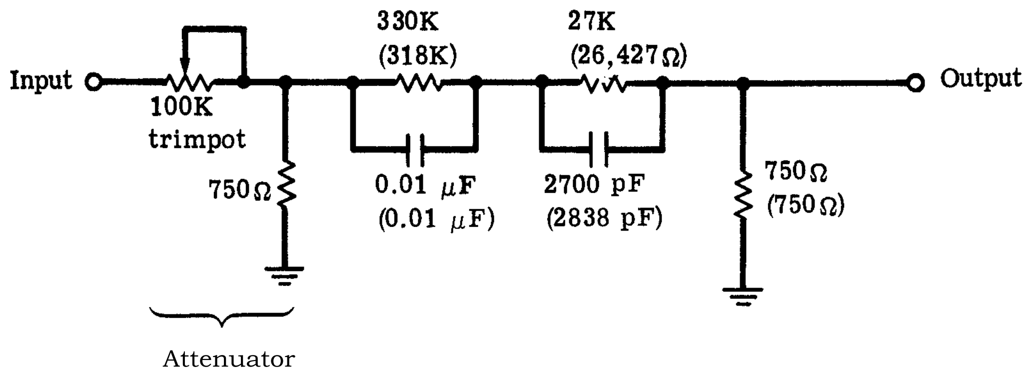


Fig. 3. Attenuator and RIAA pre-emphasis network used in experiments. Values used are nearest standard 5% values, giving a response ±0.5 dB. Calculated values are shown in parentheses. (Design by Mark Davis.)

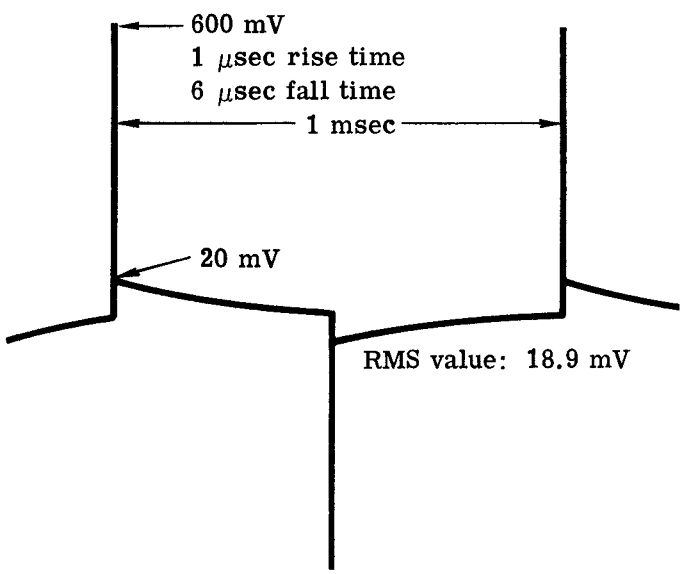


Fig. 4. Waveform at input of PUT

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Table 2. Square-Wave Test Results

Preamp and Serial Number	Even-Order Harmonic, kHz										Subjective Audio Quality	List Price
	2	4	6	8	10	12	14	16	18	Average		
	Distortion in Decibels Below Fundamental											
Bose 4401 000741	14	18	21	23	25	27	28	30	31	24	—	$599
Private FET Design	24	26	28	30	31	33	34	35	35	30	Good	Not in production
Mark Davis FET Design	20	24	27	29.5	31	33	34	35	37	30	Good	Not in production
Citation 11a 970-0526	23	26.5	29.5	33	34	35.5	37	38	39	33	Edgy	$395
Phase Linear 4000 1492	24	28	32	34	35	37	38	39	40	34	Edgy	$599
Dynaco PAT-4 18204328	25	28	32	34	35	37	38	39.5	41	34	Edgy	$199 assembled, $119 kit
Pioneer SC-700 QH 0H13570	27	31	34	36	38	40	41	42	42.5	37	—	$130 (discontinued)
SAE Mk 1B 22805	28	32.5	35	38	40	41.5	43	44	44.5	38	—	$825
Phase Linear 4000 4075	29	34	36.5	39	40	41.5	43	43	43.5	39	Edgy	$599
Pickering PP-1 Preamp	29	35	38	40	42	43	44	45	46	40	—	$30
Sansui 8 221060692	38	42	45	48	50	51	52.5	54	55	48	—	$600
Private Design LM-381A	40	44	47	50	51	52.5	53	51	51	49	—	Not in production

Table 2. Square-Wave Test Results (Cont.)

Preamp and Serial Number	Even-Order Harmonic, kHz: Distortion in Decibels Below Fundamental — 2	4	6	8	10	12	14	16	18	Average	Subjective Audio Quality	List Price
AR Receiver W00076												
(Input trim pot open)	50	50	50	50	50.5	50.5	50.5	50.5	50	50		$420 (discontinued)
(Trim pot 6 dB down)	67	68	68	68	68	68	68	68	69	68		
Radford ZD22 202131	43	47.5	50.5	52.5	54	56.5	58	59	59.5	53	Edgy	$499
Quad 33 40687	46	51	54	56	58	59.5	61.5	62	62.5	57	—	$250
Kenwood TK-140X 040369	50	54	58	69	62	64	65	67	67	61	—	$400 (discontinued)
Quintessence 2384	53	58	60	63	64	66	66.5	67	67.5	63	Edgy	$500
Dynaco PAT-5 33451185	58	61.5	65	67	68	70	71	73	73	67	—	$ 325 assembled, kit $199
Marantz 7C 10191	65	67.5	68.5	69	69	69.5	70	70	70	69	Good	$ 285 (discontinued)
Luxman 350 F5103992	73	75	76	76	77	77.5	77.5	77.5	78	76	Good	$495
All Test Preamp-25 (ATD) 43398	75	75	77	77.5	77.5	77.5	78	78	78	77	Good	$150
Yamaha CA-800 9137	76	76	76	77	77	77	78	78	78	77	Good	$580
Holman/Advent	75	77	77.5	79	79	79	79	80	79.5	78	Good	Not in production

PART II: THE HOLMAN TESTS—MISSING SPECIFICATIONS?

Alvin Foster

Like most audiophiles, I have been struggling with the anomaly that two or more phono preamps can measure alike but sound different; tubes versus transistors, for example. Both tube and transistor preamplifiers are capable of distortion levels well below the threshold of human hearing, but they often sound radically different despite similar harmonic distortion, intermodulation distortion, and similar accuracy of RIAA equalization.

My own research started some time ago when I measured the RIAA curve conformity of both my Marantz 7C and a Phase Linear 4000 preamplifier using a sine-wave generator. To simulate a more natural situation, I ran a second response curve on both preamplifiers with a Shure V-15 Type III cartridge and the CBS STR-100 test record. The Phase Linear was tested twice with its cartridge-input trim pots at their extreme positions, although because these adjustments affect only frequencies above 10,000 Hz, only the band from 10 to 20 kHz was measured the second time. The results are shown in Table 3.

After measuring the frequency response, I measured the total harmonic distortion of each unit with a Hewlett Packard 3300 distortion analyzer. The THD of the Marantz 7C was 0.02% (the residual of my sine-wave generator), while that of the Phase Linear 4000 was a respectable 0.15 percent. Both units were measured at their volume-controlled outputs and at a level of 2 volts.

The phono input overload of the Marantz 7C is 210 mV while that for the Phase Linear 4000 is 120 mV—both well above the levels theoretically encountered in disc playback.

With these measurements in mind, one could reasonably expect the two preamplifiers to sound more alike than different. In fact, they sounded very different from each other.

Irrespective of the trim-pot setting, the Phase Linear 4000 always sounded much brighter than the Marantz 7C, even though the 4000's frequency response curve would have suggested that it would sound duller particularly with the cartridge input trim pot at the maximum counterclockwise position. The Phase Linear 4000 tended to make cymbal clashes and brass sound as if there were more than twice the number of players required by the score. Very loud instruments, such as horns, drums, etc., sounded super-sharp. The effect on strings was that of an added number of players and of sonic edginess. Finally, the Phase Linear 4000 added a slight edge to attack transients, resulting in a "zippy" sound. On attacks, it sounded as if the amplifier were alternately clipping or overloading.

The Marantz was free of these peculiarities, and so while I had expected my tests to shed some light on the question of tube versus transistor sound, they instead convinced me that some parameter was being ignored in preamplifier specifications. The Holman tests seem to supply the missing specification.

The Crown IC-150 tested by Holman failed the square-wave test, and it is true that the IC-150 is not considered by audiophiles to be the Rolls-Royce of preamplifiers. However, even though the Audio Research SP-3a was not tested by us or by Holman, I would venture to predict that it will pass his tests simply because it sounds similar to those preamplifiers that measured well. Holman also feels, after examining its circuit, that the SP-3a should produce approximately the same -1 dB response at 20 kHz that the Marantz 7C demonstrated in the interaction test.

In my opinion, to the audiophile, the important thing about these tests—whatever circuit effects they may be unveiling—is that they correlate with what we hear. The best maximum level of even-order harmonic distortion isn't currently known, but perhaps all preamps with their second-order products 60 dB or more down will sound acceptable. For now, we have a new set of tools, and more research and listening are needed.

Table 3. Frequency-Response Data for Marantz 7C and Phase Linear 4000

Preamp	Frequency Response Using Sine-Wave Generator		Frequency Response Using Shure V-15 Type III and CBS STR-100 Record		Cartridge/ Preamp Interaction Data
	Frequency	Deviation	Frequency	Deviation	
Marantz 7C	20 to 20,000 Hz	-1.0 to +0.5 dB	20 to 20,000 Hz	-1.0 to +3.5 dB	17 kHz: -1 dB
	1000 to 20,000 Hz	0 to +0.5 dB	1000 to 20,000 Hz	0 to +3.5 dB	20 kHz: -1.1 dB
	1kHz	0 dB	1 to 16 kHz	0 dB	
	2 to 6 kHz	+0.2 dB	18 kHz	+1.4dB	
	8 kHz	+0.5 dB	20 kHz	+3.5 dB	
	10 kHz	+0.3 dB			
	12 to 20 kHz	+0.2 dB			
Phase Linear 4000	20 to 20,000 Hz	-1.2 to +1.4 dB	Trimpot ccw		
	1000 to 20,000 Hz	-0.8 to +1.4 dB	20 to 20,000 Hz*	-1.6 to +2.3 dB	10 kHz: +4.0 dB
	1 kHz	0 dB	1000 to 20,000 Hz	-1.5 to +2.3 dB	20 kHz: -4.0 dB
		-0.3 dB	1 kHz	0 dB	(crosses refer-
	4 kHz	-0.7 dB	2 kHz	-0.9 dB	ence level about
	5 kHz	-0.8 dB	4 kHz	-1.4 dB	15 to 16 kHz)
	10 kHz	-0.2 dB	5 kHz	-1.5 dB	
	18 kHz	+1.0 dB	10 kHz	-1.1 dB	
	20 kHz	+1.4 dB	14 kHz	-1.6 dB	
			18 kHz	0 dB	
			20 kHz	+2.3 dB	
			Trimpot cw		
			10 kHz	+3.7 dB	
			14 kHz	+1.0 dB	
			18 kHz	-1.3 dB*	
			20 kHz	+3.1 dB	

*Note dip below 1-kHz reference level.

PART III; THE HOLMAN TESTS—SOME QUESTIONS AND ANSWERS

James Brinton

Since Tom Holman's test techniques break some new ground in performance evaluation, their meaning may not be totally clear to all audiophiles. Therefore, we have tried to anticipate some questions that might arise and to answer them.

Q What is the relationship between the frequency-response curves in magazine reviews and in manufacturers' specification sheets and the Holman cartridge/preamp impedance interaction data?

A Typical frequency-response curves for phono-input stages are taken with a voltage source (like a sine-wave generator) and are more an indication of a phono preamp's RIAA deemphasis accuracy than anything else. These curves don't tell the frequency response of the preamp when it is used with a cartridge. Holman-test curves, if they were available, would be much more useful in this respect.

Q Which is more important, cartridge/preamp interaction or performance on the square-wave test?

A At present, cartridge/preamp interaction is more important, since the frequency response nonlinearities encountered in some preamps are so large as to mask the effect of relatively poor square-wave test performance. For example, the +4 dB interaction curve of the Phase Linear 4000 bears little resemblance to the flat frequency-response curve specified for the unit. From prior tests, we know that far smaller deviations in frequency response can badly color choices made in A-B tests. It now seems necessary to hold frequency response to within less than +0.25 dB across the audible band before any two components can be honestly and accurately compared. Therefore, in the immediate sense, it is interaction that is more meaningful to the audiophile, since it will have more effect on what he hears.

Q Does that make the square-wave test unimportant?

A No. It appears to be one of the few tests currently available which offers objective data that may predict subjective, or listening, impressions. It is expected that Holman's test methods will be adopted by manufacturers over the next few years, and that, therefore, cartridge/preamp interaction will become less of a problem as new designs are unveiled. As this occurs, square-wave test data will be an ever more important indicator of a given design's approach to audible perfection.

Q Can we look forward to the Holman tests becoming part of magazine review procedure?

A There would seem to be no reason why not; the procedures are inexpensive and take little time. It would require only about the same amount of time to perform cartridge/preamp interaction tests as to run a pair of frequency-response curves, and this procedure already is largely automated. As for square-wave tests, there would seem to be no reason not to expect these too, especially as Mark Davis has proven it easy to get square waves of extreme purity at little expense. Again, the time required would be about the same as that needed to run a frequency-response curve. Finally, Julian Hirsch has been a student of cartridge/preamp interaction for some time, and thus Stereo Review and Popular Electronics might be expected to be among the first to print such data if it is accepted as useful, and it should be.

Q Do the Holman tests obsolete frequency-response curves?

A No. It still is necessary that a preamp's RIAA deemphasis be accurate; remember the caution about frequency-response deviations and A-B testing.

Q Can I correct for cartridge/preamp interaction with my tone controls?

A Sometimes, but unless the interaction of your preamp's phono stage appears in this month's BAS Speaker, you don't know what to correct for. Assuming that you do know your preamp's interaction, it would be possible to correct only relatively gradual upward or downward slopes in high-end response—and then only if your tone control had an appropriate hinge point. In the case of a downward-sloping interaction curve, bringing it up to "flat" with tone controls would exact a small price in signal-to-noise ratio. And where an interaction curve rose and fell (as with the Phase Linear 4000's +4 dB at 10 kHz and -4 dB at 20 kHz), even a graphic equalizer might not be equal to the task.

Q Will preamps have to cost more to pass the Holman tests?

A Probably not. Passage of the tests is less a matter of the quality or quantity of parts used in a design than of the way in which they are assembled. Once engineers become familiar with these tests and the circuit-design rules needed to build preamps that pass them, even engineering time, and consequently a component's fixed cost, might drop slightly. On the other hand, units now manufactured cheaply, like a good many receivers, may have to use slightly more expensive power supplies and perhaps add a transistor or two to their phono-preamp sections. All in all, inflation will do more to increase prices than these tests.

Q How soon will preamps built using the "new design rules" be available?

A Some, like the Marantz 7C, have been available for years, although designed without knowledge of the Holman tests. The AR amplifier and receiver also approached the sort of performance that would be more widely available if the Holman tests are applied. Locally, two privately designed FET phono preamps are in advanced development, and Holman's own design may make its appearance as part of an Advent receiver due for announcement within the next year.

Q Why do some costly preamps fail the Holman tests?

A In some cases it may be the result of good intentions. McIntosh, for example, builds a good deal of RF suppression into its phono inputs, and while this is desirable from one point of view (your preamp is rno good. to you if it picks up rock radio while you are playing Brahms), as implemented, it may have a bad effect on (in this case) the square-wave test. In other cases, simply because these tests haven't been available heretofore, designers may have used large value capacitors where smaller ones might have helped cut even-harmonic distortion (say in RIAA deemphasis network feedback loops, or in output stages of phono preamps). Here the effect may have been compounded by the inability of a seemingly adequate power supply to supply the bursts of current needed to maintain charge in such capacitors during transients (or such is the theory at present). In a few cases, designers may have skimped on parts to keep costs down, and thus sacrificed high-frequency loop gain, but only with the interaction and square-wave tests has the result been apparent other than by critical listening.

Q Except for the FET designs, all of the good-sounding preamps have their even harmonics more than about 55 dB below the level of the fundamental. Since this isn't much in terms of percentage of distortion, why don't preamps with, say, -40 dB even-harmonic content sound about as good?

A There's no direct answer to this at present. For a little perspective, here is how dB levels correlate with percentage distortion:

-10 dB:	31.6%	-50 dB:	0.316%
-20 dB:	10.0%	-60 dB:	0.1%
-30 dB:	3.16%	-70 dB:	0.0316%
-40 dB,	1.00%	-80 dB:	0.01%

It would seem that distortion even as high as 3%/-30 dB might be masked by the distortion of a phono cartridge tracing a groove. But there is something going on in the worst preamps, or not occurring in the better ones, and the difference is apparent to trained ears in a controlled A-B situation. This is one of many areas needing more research.

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