

THE B.A.S. SPEAKER

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In This Issue

As we all know by now, hi-fi components approach the ideal in their designers' minds and almost nowhere else. (In the worst case, the union occurs only in the mind of the manufacturer's marketing director.) Jake Rabinow's Rabco SL-8E is one incarnation of such a dream -- a superb concept imperfectly executed. Dean Slindee suggests directions in which the perfectionist may go to carry his SL-8E toward Rabinow's goal and shows in the process that no magic is needed, only ingenuity.

Other highlights are short reviews of five brands of tape. And we have a couple of special record offers we're sure you'll like. John Schlafer reports on last month's meeting, featuring Dave Hadaway of DB Systems, and Treasurer Harry Zwicker details our financial status.

That's not the end, but we could still use more. Though we don't want to sound like a public television station, we do need your contributions (literary, that is). Help keep Box 7 filled.

Membership dues are \$14 per year (October 1 to September 30) or portion thereof. Dues include a one-year subscription to the BAS Speaker. (Note that almost the full amount of dues is allocated to production of the Speaker. The local activities of the BAS are strictly self-supporting.) For further information and application form, write to: The Boston Audio Society, P.O. Box 7, Kenmore Square Station, Boston, Mass. 02215.

For Sale

- *Marantz 7C with case, \$300; Marantz 125 AM/FM stereo tuner (the least expensive tuner in the super-tuner class), \$200; AR FM tuner, \$125; Dyna Stereo 70 power amp with a solid state rectifier for longer life, \$100. Andy Petite, (617) 661-9500 x290 or 492-1997.
- *Nakamichi 700, \$530, Phase Linear 700B, \$530, both in excellent condition; Grace 707, used one week, \$100. Jeff Stake, 304 W. Iowa St., Urbana, IL 61801, (217) 328-2487.
- *AR tuner, Ohm F's, AR 7's, Superex electrostatic headphones, Thorens TD-125 turntable with ADC-XLM, best offers. David Doyle, (617) 471-4389.
- *B&W DM-70, walnut, \$1,000 pair, mint; Phase Linear 700B, mint, \$500; Tapco 6000RCF, sealed, \$300; Bose 901-11, ebony, \$300 pair with equalizer; many old Marantz, McIntosh, and Dyna tube pieces; lots of other old and new equipment for sale. Bob Heenan, (617) 734-2727.
- *Citation 12 power amp, \$180; Advent Model 100 Dolby unit, \$130; Dyna FM-5 tuner, \$125; Heathkit XO-1 electronic crossover, two mono units for \$75. Crawford Best, 1809 Mason Smith Ave., Metairie, CA 70003, (504) 887-0215.
- *Pair Ohm F's with new drivers; original packaging and warranty cards included; superb condition, \$675. Gerry, (617) 453-1410.
- *Futtermann H-3a stereo amplifier, 100 w/ch., \$250. L. Wald, Pittsburgh, PA, (412) 682-3054.
- *Formula 4 tone arm, latest version, new in factory box, \$115; Supex SD900E cartridge with RB pre-preamp, excellent matched combo, 150 hours, \$115; Bozak 929 amp without meters, 1 yr. old, recently factory tuned, as new, \$475; 4 KEF B-139 bass speakers, latest version, as new, \$85 per pair; 4 Celestion D. M. 500 2" mid-range drivers, Celestion's finest mid-driver, as new, \$110 per pair; Decca Kelly horn ribbon tweeter with crossover and acoustic lens, never used, \$65. Louis Kalamaras, days (201) 772-8202, evenings (201) 727-7115.
- *Pair of Large Advent speakers, walnut finish, excellent condition, \$185; pair of walnut-finish AR speaker stands suitable for above, \$15. Best bet is to call Michael at (617) 742-5495 weekdays; weekends and evenings call (617) 661-8693.

Wanted

- *Good 10 1/2" recorder -- 15/7 1/2 ips half track, such as Revox, Teac, Sony, etc. ; Presto 1D cutting head and other disc cutting goodies such as 6N lead screws, microscope, hot-stylus rig, radius equalizer, etc. I'm cutting 78 rpm discs. Call Ted Dyett, 876-5876 days, 527-7923 evenings.
- *Sansui 4-channel rear amp Model SQ-100 or equivalent, or any other unit which has four channel decoder and integrated amp built into it. David Kunz, (617) 481-1219.
- *ThermoElectron 814 microphone capsules. David White, 9 Lancaster Dr. , Nashua NH 03060.
- *Someone who can help me get decent tapes of the Boston Symphony Orchestra concerts, as well as of the N.Y. Philharmonic, Cleveland Orchestra, etc. (The local WPLN in Nashville gets an "A" for effort but an "F" for the audible aberrations in their taped BSO concerts.) Tom Groom, P.O. Box 766, Murfreesboro, TN 37130.

Otala vs. Davis

The debate between Matti Otala and Mark Davis on the existence of TIM (transient intermodulation distortion) is now available on three cassettes. For \$15 you can hear four hours of "bare-knuckles" engineering on the hottest potato in audio today. Just send your name, your address and a check to The Boston Audio Society's Box 7 address.

Fulton's Ark

The BAS has obtained an offer from Fulton Electronics for a discounted group purchase of ARK recordings. The cost per disc will be \$4.50 if picked up locally, \$5.00 plus a self-addressed

mailing label if we send it to you. However, we urge you to send in group or multiple purchases, in which case the charge is \$4.50 per disc, 50¢ for the mailer (any number of discs), plus postage -- 25¢ for the first disc and 10¢ for each additional disc. We hope insurance will not be necessary. All discs will be sent fourth class (slow!) and mailings are restricted to USA (sorry, but Canadian members should feel free to send alternate recommendations to us). Orders will be placed when 12 or more paid requests come in. (The advertised cost for records direct from Fulton is \$5.95, plus \$1 per order for mailing.)

A list of Fulton discs follows, and you can write to Fulton Electronics, 4428 Zane Ave. N., Minneapolis, MN 55422, for a complete listing and descriptions. Also, anyone with ARK recommendations, please send good and bad comments at once to P.O. Box 7.

<u>Number of Discs</u>	<u>Total Cost if Mailed in USA</u>
1	5.00 (4.50 + .50)
2	9.85 (9.00 + .50 + .25 + .10)
3	14.45 (9.85 + 4.50 + .10)
4	19.05 (14.45 + 4.60)
5	23.65 (19.05 + 4.60)
etc.	Add 4.60 per disc

Available ARK Recordings

Organ Music from Westminster - 10251-S (\$4.50)
 Choral Music from Westminster - 2123-S (\$4.50)
 Organ Sounds from Mount Olivet - 1094-S (\$4.50)
 Carmina Burana - 4773-S (\$4.50)
 Handel's Dettingen Te Deum - 3134-S (\$4.50)
 University of Minnesota Symphonic Chorus and Orchestra - 3125-S (\$4.50)
 Robbinsdale Concert Band - 5112-S (\$9.00)
 Robbinsdale Concert Band - 5164-S (\$4.50)
 Robbinsdale Concert Band - 5155-S (\$4.50)
 Anoka Concert Band - 2144-S (\$4.50)
 Armstrong Choirs - 41872-S (\$4.50)
 Armstrong Choir - 4224-S (\$4.50)
 Armstrong Choir - 5195-S (\$9.00)
 Bethel Choir - 5243-S (\$4.50)
 Bethel Choir - 6204-S (\$4.50)
 Augsburg Choir - 4215-S (\$4.50)
 North Park Elementary Choirs - 4185-S (\$4.50)

Newest Releases

Armstrong Choir - four sides: classical, mod, madrigals, and chamber. Live concert, no limiting, said to be trackable on a good system without distortion and with super highs - 5176-S (\$9.00)
 Robbinsdale Band, 1976: Live, stage band and 300-strong Stars and Stripes - 5136-S (\$4.50)
 Bethel Woman's Choir: not hard to track, mixture of Handel (Awake Trumpets) and American songs - 4106-S (\$4.50)
 Special disc made for 25th anniversary of a local church: excellent tenor voice said to disclose bass boom or over-brightness. Men's quartet, "kids" choir, piano, and small group said by some to be ARK's "best effort ever" - 7254-S (\$4.50)

Afka Records

Afka Records will make available by mail to BAS members the following four records:

SK-274, "New Angle on Harpsichord," solo rags and traditional jazz, played by Donald Angle.

- SK-298, "Pieces de Clavecin, " harpsichord works by Balbastre, Couperin and Duphly, played by Angle.
- SK-299, "Sonatas for Baroque Violin and Harpsichord," sonatas by Le Duc and C. P. E. Bach, played by Angle.
- SK-301, "Donald Angle, Harpsichord, " solo arrangements from Fats Waller to Lennon and McCartney.

I have sold more than a hundred records for \$5.00 each at BAS meetings. All are accurate, two-microphone recordings with a minimum of processing from performance to end product, and the musicianship they capture is fitting to their fidelity. BAS members can order by sending a check or money order to BKM Associates, Box 22, Wilmington, MA 01887. Records are \$5.50 each, including postage and mailer. If you buy three or more at once, the price drops to \$5.25 each. Massachusetts members should add \$.25 sales tax for each disc.

-- Scott Kent (Massachusetts)

Advent Shows a Profit

Although financial news about the hi-fi industry is not common in The Speaker, local readers may be interested in the progress of a Cambridge company, Advent. In an unusual second quarter report, Advent lists a profit for a change. But it is to be noted that sales of audio products were down, and, in fact, were lower than sales of video products. We wonder what Peter Sprague will do about this?

Harry Zwicker (Massachusetts)

BAS Finances: Fiscal Year 1975 and the Current Year to Date

Our "tax-exemption" form has been filed with the IRS for the fiscal year ending September, 1976. This note contains a summary of the activity reported there. It is intentionally short, but additional information will be supplied on request. (SASE please.)

For the past year, the increase in net worth of the BAS was \$819.06; this can be interpreted as a "profit," if you wish. This is compared with a net loss of \$23.60 for Fiscal Year 1974. The difference in these sums, \$795.46, was transferred into the current year's budget. The past year closed with 968 membership requests, including 775 for FY75 and 193 for back issues from FY74. The FY75 surplus resulted largely from this sale of back issues, which were typed and partially printed in FY74, and which were mailed in bulk rather than individually. A summary of operations for FY75 follows at the end of this note.

For the current year we are in good shape financially. As of this writing (January 17), BAS membership stands at about 625, versus 400 at this time last year. Total expenses thus far are \$3,058.33 for 3 1/2 issues of The Speaker at a press run of 1,000. A selected listing of expenses follows:

Paper	\$ 400.00
Envelopes	79.02
Printing	568.00
Postage	1,302.51
Typing	212.50
Photocopying	177.45

The sore thumb in this list is obvious, but it appears we shall make it through the current year without another postal increase. The impact of a 28¢ mailing rate throughout the year was described in discussing the suggested dues increase at the September meeting. Additional increases we then feared have not occurred thus far, and at this time I feel we will close the year with a surplus. The large surplus from last year will not recur, however, unless we decide to grow again, but we will not close this year "in the hole." A definite projection is beyond my predictive powers, but I will keep the membership informed if we become too wealthy: that is not our purpose.

The apparent financial stability has produced a bit of bravery on the part of the officers. An example is the purchase of Sheffield discs for mailed distribution to members (see AI Foster's note in the previous issue). Should some discs be destroyed by the postal "service" the BAS feels it can absorb the loss. (See the similar note with regard to Fulton ARK records in this issue.)

We have no present plans for funding equipment purchases for the Society, but the treasury is willing to provide operating funds for any project voted worthy by the executive committee; past examples have included microphone capsules, bucket-brigades, and the BAS-Mitchell oscillator kit (in part). Anyone with a good suggestion who is willing to run the purchase and distribution tasks should talk with an officer.

Two final items. First, although we are non-profit, the above figures show that we are not about to run aground. Therefore, please do not send in excess monies with requests for back issues, tape dubs, etc.; all overpayments will simply be refunded, and we will not accept gifts. Second, please make out all checks on non-American banks "in US funds;" this includes Canadian members.

A computerized listing of all expenses for the past year and for the current year to date is always available from the treasurer. Just ask at a meeting.

Fiscal Year 1975 Summary of Operations

I. Expenses of publication and operations	\$ 7,435.17
II. Honoraria paid to five officers according to constitution	3, 872.00
III. Other expenses (goods and services)	
Cost of goods	2,441.24
Gross income	<u>5,061.58</u>
Net BAS income	2,620.34
IV. Other income	
FY75 membership dues	9,288.06
Interest	<u>217.83</u>
	9,505.89
V. Summary	
Expenses from I and II	11, 307.17
Income from III and IV	<u>12,126.23</u>
Funds transferred to FY76	819.06

-- Harry Zwicker, Treasurer

Q Query

Figure 8 in the December Shure article is labeled trackability vs. damping, but the description says Q vs. damping. Which is it? The units are wrong for Q, although I can see that trackability and Q are related (at resonance). It would appear that this curve argues in favor of no damping, except for possible problems at resonance. If the system resonance is raised to around 15 Hz (as suggested by Victor Campos) the undamped system should be hands down the best. Kates of AR, on the other hand, suggests that damping is necessary, but he assumes an undamped stylus assembly (and Decca freaks already knew that they needed damping). This is still unresolved in my mind, and I would appreciate any comments from people who have new information on the subject.

-- Thomas Martin (Rhode Island)

It's trackability. The damping controversy is not a simple one: there are various trade-offs,

one of which that curve suggests, i.e. , amplitude of the resonant peak vs. trackability at ultra-low frequencies. One can overdamp an arm. In general, however, we've found pivot damping, judiciously applied, to be beneficial. Anyone interested in this topic should read Leigh Phoenix's article "The Role of Damping in Tonearm/Cartridge Performance" ([The BAS Speaker](#), January 1975). One of the points he raises is that no stylus assembly really contributes much damping to the system. --Ed.

Another Modification to the 814 Mike Preamp

Those who are using the Mark Davis version of Peter Mitchell's ThermoElectron 814 microphone op-amp preamp might wish to try the following values:

.68 μ F	100 Hz
1.50 μ F	47 Hz
6.80 μ F	10 Hz

The unit I constructed works superlatively. The results are most noticeable on live voices, making them sound perfectly natural. -- David M. White (New Hampshire)

Information Swapping on Electrostatic Loudspeakers

Those in the Boston area who are interested in building electrostatic loudspeakers or in swapping information on them may contact me. I have built the Hermeyer redesigned speakers and ELS amplifier described in [Audio Amateur](#). -- David M. White (New Hampshire)

Three Mail-Order Firms Recommended

In case any members are not aware of them, I would like to recommend three excellent mail order firms.

[Saxitone Tape Sales](#), 1776 Columbia Rd. N.W., Washington, D.C. 20009, supplies many brand name tapes in cassettes, reels, and cartridges. They also sell a few tape decks and many hard-to-find accessories, such as Atlas mike stands, calibration tapes, erasers, Nortronics heads, empty reels and boxes, etc. Their prices are generally low, although not necessarily the absolute lowest, and their mail order service is fast, reliable, and honest.

[Soundd Investment Co.](#), P.O. Box 338, Dunwoody, GA 30338. Yes, I've spelled it right! They mainly supply bulk paks. (A bulk pack, or pancake, is tape supplied on a center, or hub, without the reel flanges. It is 10 1/2" reel size or larger, meaning 3600' for 1-mil tape. You either buy flanges separately or run the tape onto empty 7" reels.) In addition, they carry some accessories and some specials on other types of tapes. They are the only source I know of for Ampex 345/906. Doug Wilmer, who runs the show, is very honest and bends over backwards to be fair to his customers. Like Saxitone, Soundd Investment Co. is fast and reliable and has some very low prices. If you own a 10 1/2" reel machine, you owe it to yourself to write to them.

[Sound Affair](#), 364 Mission Ct., St. Louis, MO 63130, supplies both tape and equipment, including high end equipment. Excellent service and advice. They're especially worth writing if you plan to purchase equipment. (Mention the BAS.) -- Bob Sellman (New Jersey)

Chrome, Come Home

Nakamichi Research, Inc., recently reversed its recommendation against using chromium

dioxide cassettes in their decks. That recommendation, which was published as a letter in the June 1976 issue of Stereo Review, contradicted the original statement by Advent Corp. (in the March issue of the same magazine) that chrome and iron tapes were of approximately the same abrasiveness. Nakamichi found five times greater head wear with CrO₂ and went so far as to say that they had "taken steps to relabel the tape-selector switches" on their cassette decks.

E. I. duPont Co., the manufacturer of most of the raw CrO₂ tape stock, apparently convinced Nakamichi to reconsider, in an August letter, for, at the end of September, the latter company said that it had revised its opinion: the latest samples of CrO₂ it had tested had produced head wear similar to that caused by ferric oxide formulations. Advent reports, though, that there has been no change in CrO₂ formulation that would make new samples any less abrasive than it has ever been.

Whatever Became of Coboloy?

In 1971, Graham Magnetics announced that it was seeking a patent for its cobalt alloy "Cobaloy." This substance, to be used in all types of magnetic tape manufacture, was claimed to increase by more than a factor of four the recording density of tape, allowing, for example, quarter-speed audio recording with equivalent fidelity. Not having heard much about it since then, it is interesting to see (in the October 4, 1976 issue of Television Digest) that the company has agreed to pay an \$822,000 settlement of a stockholders' lawsuit, said stockholders having claimed that their investments were prompted by Graham's misleading statements in 1971 and in later corporate reports.

-- Andy Petite (Massachusetts)

Five Brands of Tape Compared

DAK Tape Warning

I strongly urge members to avoid buying DAK tape. I recently purchased one hundred 1800' reels of their low-noise tape, type 1150-07Y, and it is by far the worst tape I have ever used. The sensitivity of the tape varies from reel to reel, creating many problems and a real headache if you have to add tape to the end of a reel for an extra long recording (50-54 minutes/side) as I have had to do. Very poor tape slitting has made many reels unusable because of large variations in left-channel signal level. I discovered one reel slit so wide it wouldn't even fit into an Editall splicing block and one so narrow it wouldn't stay in the splicing block. The crowning example is the reel with the section of tape with the scalloped edge -- periodic variations in width from the normal 1/4" to as narrow as 1/8". Try to run that through your recorder. Many reels apparently weren't dried properly, as looking along the length of the tape reveals it is warped. This warp-age can cause the tape to slip out of the guides and creates havoc with signal level, as it can eliminate tape-to-head contact, especially on the outer track. Some reels have widely varying output (2-4 dB), probably caused by varying oxide thickness. To some degree these problems occurred on over fifty of the one hundred reels.

Just about the time I ordered the DAK I received the latest issue of Stereophile, in which DAK was not recommended. I talked to J. Gordon Holt, who said he had encountered varying oxide thickness, which caused problems at slow speeds.

I plan to use as many reels as I can and then return the remainder to DAK for a refund. When I do, I will report their cooperation or lack of it.

Other Brands of Tape

As you may have guessed from my involvement with DAK tape, I am continually looking for low-cost tape (reels, cassettes, and cartridges) that are good to very good quality -- in other words, the best values in tape. For high-quality recordings, I have found that reel tapes need only be low noise, but cassettes should be of the low noise/high output/extended range type. Car-

tridges should also be LN/HO for both improved high frequency response and better mechanics.

In addition to DAK, I have used Capitol, Audio, Ampex, and Audio Magnetic tapes enough during the last two years to comment about them.

Before I do so be aware that I do not have test equipment (other than a signal generator), so my comments are primarily subjective, based on use.

Capitol: Learning Tape cassettes are inexpensive, fair mechanically, fair S/N, fair high-frequency response. Capitol C120 cassettes, both in Music Tape and Learning Tape, are far too low in output to be of much value. Music Tape cartridges sound good, but fail too often, not by jamming, but mainly by having excessive wow and flutter. This could be caused by too much lubrication in the tape.

Audio: These are "professional" tapes available only in bulk pak. They are made by the same company that makes Capitol tapes. Audio 15, now called, I think, Q15, is low noise. It is good tape, causing few problems, and I used it as my standard tape until the price was raised about 35% last year. Audio 13 (now Q19?) is the LN/HO backcoated version of that tape. It is also good tape, but costs much more than Audio 15. With last year's price rises, however, neither tape is a true bargain anymore.

Ampex: Ampex 641 is a standard tape and not very good compared to low noise tape. Ampex 345 (also called 906) is very good LN/HO tape without backcoating (which I don't like, anyway, because it worsens tape-to-head contact, causing loss of high frequencies at slow speeds, and is usually enough thicker that 1800' barely fits on a 7" reel. 345/906 is only available in bulk paks but at a good price (\$5-\$6).

Audio Magnetics: XHE cassettes (LN/HO/extended range) are the best values I've found to date in cassettes. They have excellent high-frequency response, very good S/N, a good cassette mechanism, and a low price. The C120 XHE has higher output than any other C120 I have used and is the best I have encountered. Tracs LN 1800' reels are good, inexpensive tapes, which use bias/equalization compatible with standard tape. I purchase these tapes in bulk from a local supplier (not mail order), and if any members are interested I could supply them at the following prices: XHE cassettes, C90, \$2.40 each, C120, \$2.85 each; Tracs LN 1800' reels, \$2.95 each. Add shipping, but deduct 7% if you order by the case (48 cassettes, not mixed, or 24 reels) and save me the hassle of repacking. -- Bob Sellman, 14 Station Ave., Haddon Heights, NJ 08035

Sonus

Peter Mitchell recently made a comment on "Shop Talk" to the effect that among his acquaintances who had purchased Sonus cartridges, the failure rate had reached 100%. Such scare statements are meaningless unless we know the following:

(a) How many samples are involved? For example, two samples of a cartridge failing is not statistically relevant. Twenty samples probably is.

(b) Over what time period have the failures occurred? Failure in two years isn't too surprising. Failure in two weeks or two months is.

(c) What was the failure mode? There seem to be two "normal" failure modes with the Sonus Blue Label. The first is a tendency of some early models to literally come unglued and fall to pieces. This allegedly stems from a supplier problem which has, according to Pritchard, been corrected, and these defective units should be off the market by now. If you are unfortunate enough to have purchased one of these, the warranty should cover it. Inconvenient certainly, but no reason to damn the cartridge.

The second common failure mode in the Blue Label is collapse of the stylus cantilever. Again Pritchard claims that the cantilever has been beefed up in current production. The repair for this failure is simply to replace the stylus. Not too terrible if it occurs every six to nine months; you

probably ought to change the stylus anyway. If the cantilever fails with greater frequency, it is surely a problem, but one that might be alleviated by using a different tonearm (the Blue Label is reportedly very arm-dependent) or by modifying your method of handling the tonearm (lowering it by hand is a definite no-no).

But this is still no reason to damn the cartridge. Consider that the price of this cartridge puts it in a class where it will be bought mainly by serious audiophiles and by dilettantes. The serious audiophile should be prepared for a certain amount of fragility (delicacy?) in a state-of-the-art cartridge such as the Sonus Blue. And I really can't work up much sympathy for the dilettantes; they probably won't even notice that it's failed.

-- Bob Borden (Massachusetts)

Phono Capacitance and Component Variations in the PAT-5

Since I am leaving Dynaco, I thought I'd bring you up to date on some recent work. You may want to explore some of it on your own.

I took four PAT-5's to one of the "underground" reviewers. The first preamp was the one originally reviewed, with no change other than that one phono input was provided with 220 pF across it. As originally reviewed, the preamp had no added capacitance. The feeling was that the sonic quality through the unchanged input would still be reported essentially as was originally described. But when the other input was used, there was a "marked" improvement. A second preamp, which was current production, likewise had 220 pF on one phono input. The results were considered to be, for all practical purposes, the same as with the first preamp. Both of them used Microsystems IC's, and the second had Siemens phono transistors. Then we took a third unit, which was the first one submitted to the magazine for review, and one that had been returned to us as not up to the sound quality of a kit they had purchased -- a comment we subsequently agreed with. The only change from that point to what was now auditioned were capacitors as noted below and the use of Signetics IC's. The Signetics IC's were picked because when tantalum capacitors were installed, the feeling was that they sounded slightly better than the Microsystems units. This is a small difference, however, other things being equal. In any case, the result was what the reviewer called "like listening to a different preamp," and I agree it was no subtle change. It was better in all ranges. I would say it was closely comparable to the Audio Research in the middles and highs, and on the low end it wiped it out.

This unit also had 220 pF installed. Our limited investigation indicates that more cartridges than not need the added capacitance. (That 220 pF is in addition to whatever is added by the arm wiring, of course.) The problem is most cartridge manufacturers either don't know or are reluctant to indicate any preferred value.

It may be that you will want to try modifying a stock PAT-5 as we did, but first you should verify differences attributable solely to inserting the proper shunt capacitance on the phono input. The 220 pF we used was picked as an "average" value, and for the tests at the magazine we were using the new \$275 Grado cartridge in the Infinity tonearm. I don't know whether that was optimum, but we liked the sound. Grado did not give any specific recommendations. (I don't know what the impedance of the cartridge is; some people believe that low impedance cartridges are not critical in this regard.) The PAT-5 capacitor changes are as follows: C301, C307, C314, C321, and C322 -- tantalum; C207 -- mylar or tantalum; C204, C205, C318, C319 -- dipped mica. In addition, capacitor C206 on each PC-33 board is doubled. The easiest way is to add another similar capacitor on the board, which has provisions for either a stand-up or a lay-down version, of which only one is normally installed.

We now have fairly definite indications from a number of replies that the big differences in preamps, which the reviewers of the underground press sometimes noted, were caused by IC variations, and that these were considerably greater than phono variations. I must admit we weren't prepared for the variations which were sonically apparent in IC's and possibly in some transistors. But it is still questionable whether the public is best served by spending considerable extra funds on tantalum capacitors, for instance, and raising the price that much, when measurements show no difference, and most listeners won't even know of it. Dyna has tried to opt

for the "masses" interested in quality if that isn't self-contradictory. As Dave Hafler put it, what we build is what we would want to listen to -- and pay for.

-- Robert H Tucker (Pennsylvania)

Other Dyna-notes

Word has it that Dyna will soon bring out a new integrated amp, the SCA -50. Presumably this will be a second-generation SCA-80, with PAT-5 preamp circuitry and scaled down ST-150 power amp circuits. If their numbering system remains consistent, it should have a rated output of 25 watts per channel.

Frank Van Alstine of Jensens has sent me replacement phono boards for my modified PAT-5, which I have installed, along with a new volume control. Al Foster has since tested the unit and found it fit in all respects. The phono equalization is now very linear, and the volume pot tracks within about 0.5 dB over its entire range. Dyna claims that's typical but that the control's tracking is specified only to 2 dB.

-- Michael Riggs (Massachusetts)

A Reply to Comments on Tone Arm Damping

I am writing to respond to editorial comments made in the reprint of my letter to the BAS (October 1976 Speaker). It appears that your automobile example is an argument against damping in arms which are otherwise properly designed. Stiffer competition shocks, or no shocks at all, will yield a ride which is uncomfortable on rough roads because the interior of the car is following more exactly the violent undulations in the road. [This depends on whether the car is sprung or unsprung. The former is the analogous case. Under such conditions, it's doubtful that removing the shocks would make the car follow the road better. --Ed.] The elements in a cartridge should follow the undulations in the record groove. The arm should be light enough that record warps are not a problem. The shock absorbers in a car smooth out the ride but also remove "feel" of the road to an extent. This should not happen in a cartridge.

The editor states that it has been reasonably proven to several members that high quality cartridges perform and sound better in properly damped arms. Almost all mass-produced arms are ridiculously heavy and yield too low resonant frequencies with modern cartridges. The cartridge will usually weigh about 4 to 10 grams, and the arm need not weigh 8 or 10 times that in order to control it in a stable fashion. It is likely the case that the undamped arms you listened to were poorly designed in the first place. [If an SME 3009 is poorly designed, yes. Also, although Shreve seems unaware of it, his arm's vertical pivot bearings are damped to a degree by their lubricant. --Ed.]

I have more information regarding vertical tracking angle. With high-quality speakers (Magneplanars, Magnepans, Fulton its), we have heard the effect of a change in VTA of less than one minute. Also we are beginning to hear the difference between records, after making a change in the geometry of the arm and cartridge relative to the record. The correct height of the arm for one record may not be correct for another. This could be due to differences in cutter heads or to the records themselves. The audible differences are most noticeable on tympani, massed strings, and wire brushes on cymbals.

My statement that several companies have my arms should not be construed as an endorsement of the arm by those companies, nor was it intended as such. -- David Shreve (Wisconsin)

In the Literature

Audio, February 1977

- *Build a Class A amplifier: 20 watt/channel design from Threshold Corp. (p. 28)
- *Construct a Wide Bandwidth Preamplifier: Marshall Leach presents a design to accompany his power amp from a year ago. (p. 38)
- *Low TIM Amplifier, Part II: Leach corrects and updates his design, and adds a protection circuit. (p. 48)
- *New Tests for Preamplifiers: Tom Holman reviews his findings. (p. 58)
- *Cheap and Dirty Inverse RIAA/Square Wave Generator: Uses LM387 dual op-amp. (p. 65)
- *Equipment reports on McIntosh MR-78 tuner and Dual 1249 turntable. (p. 70)

db, The Sound Engineering Magazine, January 1977

- *Broadcast Sound column on audio and the FM process. (p. 14)
- *Random Noise in Acoustical Measurements: United Nations staff supervisor explains details of acoustic measurements. (p. 24)
- *Check Your Tape Tension: How to measure tension and the effects of improper adjustment. (p. 28)
- *AES Convention Report: John Woram and Larry Zide hit the highlights. (p. 31)

Design News, October 25, 1976

- *A short article on p. 66 describes a system that uses closed loop motional feedback to provide flatter loudspeakers frequency response and lower distortion. The design uses the speakers' back EMF to supply feedback information to the power amp.

EDN, January 5, 1977

- *CCD's Improve Audio System Performance and Generate Effects: Reticon engineer explains the use of CCD's; several circuits and a bibliography are included. (p. 55)

Electronic Design, December 20, 1976

- *A novel method of generating sine wave bursts in the air (for testing microphones) is described on p. 78. Rather than pulsing a single loudspeaker, which requires a speaker with good transient response, two loudspeakers are driven simultaneously with sine waves while the phase between them is switched 180°, thus producing cancellation and addition at points in the room. A suitable phase switching circuit is included.

Electronic Engineering Times, December 20, 1976

- *A short discussion on p. 21 answers (?) the question "Why are so few IC's used in high quality audio equipment?" The reasons are that better noise and distortion specs can be obtained with discrete components at audio frequencies; that audio freaks seem to like large equipment, while the use of IC's makes the innards seem too bare (sic); and that testing is more difficult for the large variety of possible IC's than for discrete transistors. The exception has been the phase-locked-loop IC MPX decoder, where cost savings over a discrete board are very large, with excellent performance.

FM Guide, January 1977

- *Profiles in High Fidelity: The Sony story. (p. 6)
- *Norman's Notebook: Norman Eisenberg reviews several speakers: TSI 100, Design Acoustics D-1A, Bose 901 Series III, Ohm C-2, EPI 200, and Sony SSU-2000. (p. 10)
- *Feldman Lab Reports on Miida 3140 receiver and Phillips GA -222 turntable. (p. 28)

High Fidelity, February 1977

- *Equipment reports on Kenwood 600-T tuner, Teac Esoteric Series PC-10 portable cassette deck, Pickering XSV-3000 phono cartridge, Garrard GT-55 turntable, and Akai GXC-570D cassette deck. (p. 27)
- *What Test Reports Don't Tell You About Blank Cassettes: Robert Angus goes into the mechanical design of the cassette shell. (p. 58)
- *Will the Elcaset Make It?: Larry Zide doubts the new format will affect the cassette market, but it may fill special needs, e. g. , live recording. (p. 64)
- *HF expands its pop coverage with a new 24-page section called Back Beat; it replaces The Lighter Side. One wonders now how long it will be before the lucrative mass market pop scene drives the classical reviews to the back pages, as happened with Stereo Review.

Popular Electronics, February 1977

- *News Highlights notes that Audio-Technica will be marketing direct-to-disc albums under the Umbrella label for \$12.95. (p. 15)
- *Stereo Scene column on three AES papers on acoustic simulation. (p. 17)
- *Julian Hirsch explains tape recorder headroom and tests the Pioneer CT-F8282 cassette deck and Acoustic Research AR-16 speaker. (p. 23)
- *Multimeters for Electronics, Part 2: Digital multimeters. (p. 31)
- *Test of Heath IM-2202 digital multimeter. (p. 78)

Radio-Electronics, February 1977

- *Amplifier/Speaker Interface -- A New Concept: Len Feldman looks at the BIC Formula 7 loudspeakers. (p. 64)
- *Len Feldman tests the Soundcraftsmen PE2217 preamp/equalizer and Bigston BSD-300 cassette deck. (p. 67)
- *Analog Voltmeters, Part II. (p. 75)

Reel News, October-December 1976

- *Barclay-Crocker is still on the air, if at low volume. Prices are up, as is the promise of quality, while selection is poor and consists mainly of close-outs. Ambiphon/Sonar has new releases; RCA, London, and DGG should soon be available again in open reel; and MHS/Barclay-Crocker tapes have yet to be produced. Perhaps next month ..

Reel Society

- *Russell Fields announces new releases remaining from the demise of Ampex' open-reel plant, including a preliminary announcement of London tapes at \$7.50 each. This company is at P.O. Box 651, Arlington Heights, IL 60006.

Stereo Review, January 1977

- *Julian Hirsch gives a short tutorial on amplifier classes. This is especially appropriate with new class "A" and class "G" circuits coming onto the market. (p. 34)
- *Reviewed in this issue are a Marantz integrated amplifier, a KLH loudspeaker system, and that Micro Seiki three-arm turntable: read carefully the discussion of turntable isolation (p. 51) and test this unit completely if you are tempted to buy, as J. Hirsch leaves one very loose end in his review.

Stereo Review, February 1977

- *Ads on p. 12 (pink and blue KLH), p. 20 (Phase Linear loudspeaker), p. 25 (the SAE 5000 impulse-noise suppressor), and pp. 90-91 (Advent chrome cassettes) are to be noted.
- *The Advent 300 receiver is reviewed on p. 24; we visit Tokyo on p. 54; records of the year appear on p. 65; and Arthur Fiedler is marketed on p. 70.

Wireless World, November 1976

*Advanced Preamplifier Design: All discrete components in the audio stages, a noise gate for muting at zero signal, low distortion and high phono overload, peak and clipping LED indicators, and selectable tone controls mark this build-it project for the advanced audiophile. (p. 41)

*Audio at Harrogate: News from the British exhibition: high in editorial content and philosophy. (p. 77)

Wireless World, December 1976

*Acoustic Noise Units: About a year ago, before the BAS dropped out of the "models for human hearing" wars, we promised a piece on phons, sones, and hearing thresholds (Fletcher -Munsen versus Robinson-Dadson, etc.). WW has saved us the trouble with this four-page discussion of hearing curves (A-, B-, and C-weighted noise spectrum curves) and other measures of human audio response. (p. 48)

*Letters on pp. 53-54 discuss phono overload and distortion in the human hearing process.

*Part four of a series about grounding and shielding in electrical equipment discusses reducing hum from phono pickups. (p. 65) -- Dana Craig and Harry Zwicker

January BAS Meeting

Mike Riggs indicated that the backlog of articles for The Speaker is running low and urged members to write about their experiences with new pieces of equipment, unusual test methods, particularly impressive recordings, reviews of books on music, recording, etc., or other topics of interest to BAS members. There is no need to feel you must be an accomplished author as the editorial staff of The Speaker will assist you in assembling your material into an appropriate form for publication. It is an easy and rewarding experience to become a contributor to your publication, so why not try it?

Dr. Brian Leeming announced that interest in the overseas record buying service has been sparse, requiring many purchasers to wait months before enough orders accumulate to make up a shipment. In the past fifteen months, only four orders have been sent. From now on there will be a new ordering procedure in which four orders will be placed each year. An announcement will be made one month prior to an order mailing; with the anticipation that the more regular ordering schedule will precipitate enough interest to justify continuance of the service. The quality of the recordings and their relatively low cost make this service well worth considering.

Scott Kent noted that contributions to WGBH radio must be made specifically to the radio station. If not, they are likely to end up supporting WGBH-TV, Channel 2. So, if you want to support the radio station, you must make out your check to WGBH Radio. Checking the box on the contribution form is not sufficient.

Meeting Feature -- DB Systems

It seems that preamps have been looked at, listened to, and tested from just about every possible angle. Yet a satisfying and well understood correlation between audible performance and objective testing remains elusive. David Hadaway, founder and president of DB Systems, has a design philosophy which may disperse the air of mysticism which currently pervades preamp characterization. In his presentation to the January meeting of the BAS, he reviewed sources of noise and distortion in common preamp circuitry. He showed how and, more importantly, why distortion should be minimized, not only within the audible band but considerably beyond it as well.

Preamp Circuit Types: For the purpose of discussing noise and distortion, preamp circuits may be generalized to two basic connections, parallel and series, as illustrated in Figs. 1a and 1b. The series connection is widely preferred because it is typically the lower noise configuration. Though the parallel connection suffers from the noise limitations set by the series resistor in the input, it has the important advantage that all the distortion is reduced by feedback returned completely around the amplifier. In the series connection, however, feedback is applied to the

inverting (negative) input, while the signal enters the non-inverting (positive) input. Any difference between these two inputs, resulting, say, from distortion-producing nonlinearities in the two input transistors, will not be reduced by feedback. In operational amplifier terminology, this difference between inverting and non-inverting inputs is called common mode error and, in general, becomes worse with increasing frequency.

The single-ended input stage of Fig. 1c, popular in simple preamps using two or three discrete transistors, is an example of the parallel connection. Negative feedback (NFB) is returned to the emitter of the input transistor, thus including this device in the loop. The differential input stage of Fig. 1d, found in all integrated circuit preamps, exemplifies the series connection, with NFB being fed to the base of the second transistor. The first transistor is outside of the loop, so feedback does not reduce its distortion. The circled elements constitute the important sources of noise in these amplifying stages. These include the shunt cartridge-loading resistor at the input, the series RF suppression resistor in the base, the transistor, the emitter resistor, and the RIAA feedback circuit (NFB). Theoretically speaking, then, the differential circuit should be 3 dB noisier, because it has one more transistor than the single ended stage (all other noise sources being the same). In practice, however, Hadaway indicated that other sources of noise, such as the series base resistor or cartridge, may dominate.

Ultrasonic Distortion: In addition to noise, there are many other factors which must be considered in preamp design. One, which Hadaway believes has not received adequate attention, is distortion outside of the audio band. It may be correctly argued that the harmonic distortion products for signals above 10 kHz are beyond audibility. The same is not true for intermodulation (IM) distortion, however, where the nonlinear mixing of two signals beyond the audio band may produce an audible difference frequency. With present recording practices and technology, it is possible and probable that some frequencies beyond 20 kHz are cut on normal stereo records. Close miking techniques and the steady 6 dB/octave rise in the RIAA pre-emphasis beyond 2 kHz augment spectral energy content above 20 kHz. Cutter stylus geometry allows record velocities of up to 50 cm/sec or more in this region. Cartridge electrical response can extend well beyond 100 kHz. This is indicated in Fig. 2, showing the unequalized response of two cartridges, measured by a spectrum analyzer (10 ms sweep, 1 kHz bandwidth), when fed an electrical impulse through a 10 ohm resistor in series with the cartridge.

After adding the ultrasonic garbage generated by stylus-groove mistracking to the above modulation-induced signals, it is evident that the first stage of the preamp may be called upon to handle significant amounts of ultrasonic energy. According to Hadaway this has been verified experimentally by observing, on a spectrum analyzer, the output of a cartridge playing some difficult record passages. Fig. 3a and b show the outputs of a Denon 103S and of a Shure V15-II playing a cymbal crash from the Sheffield Lab 2 series.

High-Frequency Circuit Nonlinearities: Hadaway contends that if the intermodulation products of these ultrasonic frequencies are not to end up in the audio band, linearity of the preamp to well beyond 20 kHz is mandatory. In the design of the DB Systems preamp each possible source of non-linearity was examined and steps were taken to minimize its effect on the signal over the full operational bandwidth of the preamp, he said.

One common distortion mechanism is the loading of the output stage at high frequencies by the RIAA de-emphasis feedback network. In Fig. 4a a section of circuitry, similar to that used in the PAT-4, shows an RIAA network with a 600-ohm impedance at 20 kHz, decreasing to even lower values at frequencies above this. In this case the output stage is not capable of linearly driving this low impedance with any appreciable signal level. One possible solution is to increase proportionally all of the impedance levels in the feedback network, as shown in Fig. 4b. This is not a completely satisfactory approach, however, as the larger emitter resistor introduces more noise. A better arrangement is to maintain the lower impedance values and to drive the RIAA network with an emitter follower, as in Fig. 4c. This connection is capable of supplying the required current to low impedance loads but will require an additional transistor.

Fig. 4c also illustrates the remedy for nonlinearities introduced by bipolar transistors operated with too little current in the collector or emitter. Current starvation, which may occur at certain signal levels, can be cured by forcing a fixed current to flow at all times using current-

source (the circled arrow) loading of the transistor. One realization of a current source is illustrated in Fig. 4d. The two diodes establish a fixed voltage drop across the resistor, which maintains a constant current.

Another source of nonlinearity in amplifying circuits is the variation of transistor collector-base capacitance, C_{cb} , with collector voltage. Fig. 5a is a simple two transistor circuit which shows the effective connection of C_{cb} , an internal capacitance of the transistor. This forms a voltage divider with the cartridge impedance, Z_s , which at high frequencies couples signal from the collector back to the base. With a typical collector bias voltage of 1.4 V, the signal voltage appearing on the collector (up to 100 mV) can be an appreciable fraction of the collector bias. This signal modulates the value of C_{cb} while being coupled through C_{cb} to the base, producing a nonlinear element, which causes signal distortion. The complementary design in Fig. 5b employs a larger collector voltage on the first stage, reducing both the value of C_{cb} and the percentage variation in collector voltage caused by the signal. This achieves about a factor of ten reduction in nonlinearity over the previous circuit but is still not adequate for extremely low distortion levels.

What is required is an arrangement that maintains the voltage across C_{cb} at a constant value, independent of signal variations, so that no signal current flows in the capacitor. The circuit of Fig. 5c produces this result by bootstrapping the first stage emitter to the collector through a second transistor. The collector voltage must now follow the emitter voltage, and thus the base voltage, which is tied to it through the constant drop across the base-emitter junction. This connection, sometimes called a cascode pair, then drives the base of the next stage. An alternate embodiment of this circuit, in Fig. 5d, uses an FET as the first stage collector load, reducing the number of passive components required.

Yet another nonlinear phenomenon in bipolar transistors is the Early effect. Here also, a small fraction of the variation in collector voltage appears at the base because of modulation of the base width by the collector voltage. This is depicted in Fig. 6 as a generator $h_{re}V_{ce}$ in the base circuit, where h_{re} is the feedback factor and V_{ce} is the collector-emitter voltage. This is a nonlinear generator, however. As h_{re} is a weak function of V_{ce} , the amount of feedback varies with the signal on the collector. The result may be seen in the upward curve of typical transistor collector characteristics at large collector voltages. External feedback does not reduce this effect, for the generator is outside of the loop. Fortunately, the cascode connection described above also resists changes in V_{ce} with signal and is effective in reducing Early-effect nonlinearities by a factor of 1000.

Passive Component Distortion: In a thorough search to ferret out all possible sources of distortion, passive components must not be overlooked. Hadaway reported that tests at DB Systems show small but measurable amounts of distortion can be generated by capacitors, fixed resistors, and variable resistors. Certain types of component construction were found better than others. The rankings are given in Table 1.

Table 1 -- Relative Distortion from Passive Components

I. Capacitors		Best - polyester, polystyrene, polypropylene
		Next best - polycarbonate
		Next best - mica
		Poor - ceramic
		Poorer - aluminum electrolytic, tantalum
II. Resistors		
A. Fixed		Best - wirewound, metal film
		Next best - carbon film
		Next best - carbon composition
B. Variable		Best - wirewound
		Fair to very good - carbon film, cermet (both element and contact wiper can be nonlinear)

Harmonic distortion in the best capacitors was less than 0.003%, while in the best resistors it was measurable but negligible in terms of its effect on a preamp. For best performance with variable resistors, however, wiper current should be minimized by feeding it to an impedance level higher than the total resistor value. Distortion measurements were made by feeding the component from a signal generator having approximately the same source impedance as the component and looking at the voltage across the component with a spectrum analyzer. Electrolytic capacitors were operated with an appropriate polarizing voltage.

Feedback: In a final stroke to excise distortion remnants not taken care of by other means, the designer usually applies feedback around the entire preamp circuit. The feedback loop typically contains the network responsible for shaping the RIAA de-emphasis characteristic, varying the amount of feedback with frequency. At high frequencies the feedback is increased, reducing the overall gain of the amplifier to achieve the RIAA treble cut. At low frequencies the reduction of feedback to obtain bass boost reduces its ability to fight distortion. Table 2 shows gain and distortion data taken from three preamps.

Table 2 -- Distortion of Several Preamplifiers

	20 Hz			1 kHz			20 kHz*		
	PAT-4	SP3-a	DB Systems	PAT-4	SP3-a	DB Systems	PAT-4	SP3-a	DB Systems
Open loop gain (dB)	69	66	145	70	66	126	52	52	106
Closed loop gain (dB)	53	53	53	34	34	34	14	14	14
Feedback (dB)	16	13	92	36	32	92	38	38	92
Distortion (%)	.03	.04	<.0006	.008	.004	<.0004	.05	.004	<.0004

*Measurements made with 19.5 kHz and 20 kHz mixed 1:1.

Open loop gain is the amplification with the feedback circuit disconnected; closed loop gain is the normal amplification with feedback. The difference between these two numbers is the amount of feedback at the three test frequencies. One can see that for the PAT-4 or the SP3-a the amount of feedback at 20 Hz is less than half of that at 1 kHz, accounting for most of the ten-fold increase in distortion at 20 Hz. The increase in distortion at 20 kHz in the PAT-4 is caused by the loading of the output stage by the RIAA network, as illustrated in Fig. 4a. The SP3-a avoids this by driving the network with a cathode follower stage. The low distortion of the SP3-a at 20 kHz and above is also a result of the inherently high linearity of tubes. Note that the DB Systems preamp maintains a constant high level of feedback for all frequencies in the audio band by using frequency contouring networks in the amplifier to shape its open loop gain to match the RIAA de-emphasis characteristics.

The circuit diagram of Fig. 7, similar to that of the DB preamp, features the circuit techniques described above for low distortion operation. A resistor in series with the base, flanked by two ferrite beads, and a capacitor to ground provide RF suppression at the cascode input stage. The RIAA feedback network, driven by an emitter follower, has an extra series resistor, which keeps its impedance from becoming too low at frequencies beyond the audio band. Although this preamp could have been designed with FETs in the gain stages, Hadaway feels that bipolar transistors offer the combined qualities of lower noise, better linearity, and higher gain at a lower price.

Measuring the Preamp: Once a preamp has been designed to cope with the various sources of distortion, the success of its implementation must be determined by measurement and listening. In order to measure the resulting low distortion levels, DB Systems found it necessary to modify extensively a Heathkit IG-18 signal generator to obtain a test signal having significantly lower levels of distortion (two parts per million second harmonic) than the preamp. (See [Audio Amateur](#), 4/75.) Output of the preamp was monitored with a spectrum analyzer so that both harmonic and intermodulation products could be detected. To increase the dynamic range of the analyzer, a notch filter was used at the input to cut down the fundamental components by 60 dB. Low frequency measurements were made with the fundamental at 24 Hz so the harmonic components would fall

equally on either side of 60 Hz. In some measurements anti-phase hum was injected to cancel residuals at the power line frequency. The measurements at 20 kHz were of the 500 Hz 1M distortion product of mixing 19.5 kHz and 20 kHz signals. At 90 kHz and 95 kHz the 5 kHz 1M component in the DB Systems preamp was less than 0.01%. Although this number is not readily related to some subjective criterion of distortion audibility (because the fundamentals are inaudible) it indicates the excellent high frequency linearity of the design and the absence of slew-rate limiting.

Banishing distortion to the realm of parts-per-million in the audio band may seem like overkill, but these vanishingly small numbers actually come as a natural fringe benefit of the design procedures employed to insure negligible distortion at ultrasonic frequencies. The requirement for low ultrasonic distortion (derived from the cartridge tracking tests described earlier) seems also to be justified by the results of Al Foster's wideband white noise preamp tests (BAS Speaker, June 1976). Here a judgment of preamp quality based on the existence of audible changes in white noise tonal quality (due most probably to IM products of frequencies above 20 kHz) was found to correlate well (although not 100%) with music listening evaluations.

Peripheral equipment malfunctions prevented the BAS audience from listening to the DB Systems preamp. However, if Harry Pearson's rave review in The Absolute Sound, (Vol. 2, No. 8) is a true reading of the sonic qualities of this preamp, it may indicate that because of DB Systems research the gap between subjective evaluation and objective measurement (and characterization) of preamp quality is rapidly being closed. -- John Schlafer

NOISE SOURCES IN COMMON PREAMP CIRCUITS

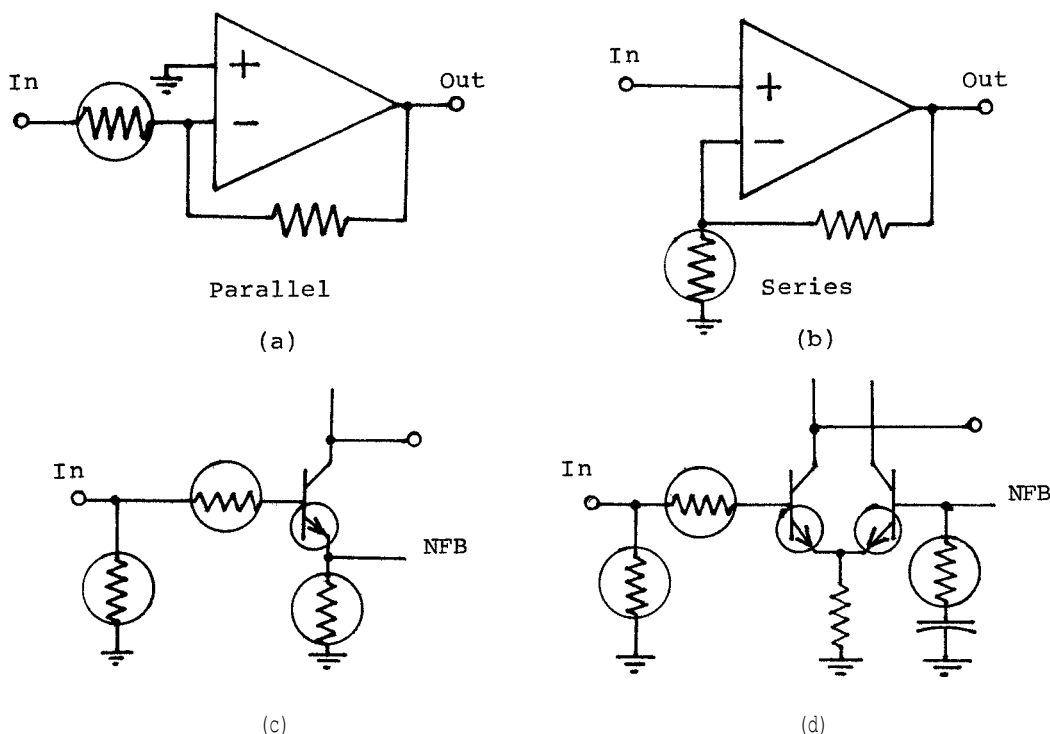


Figure 1

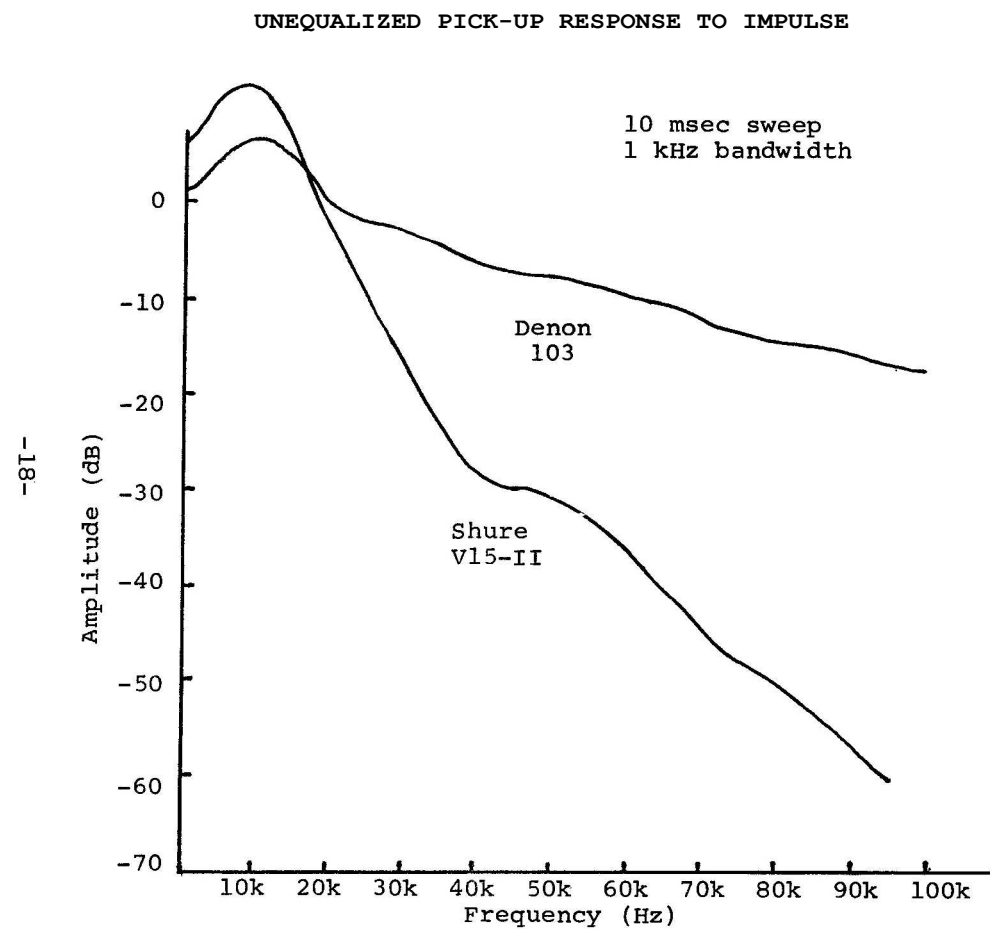
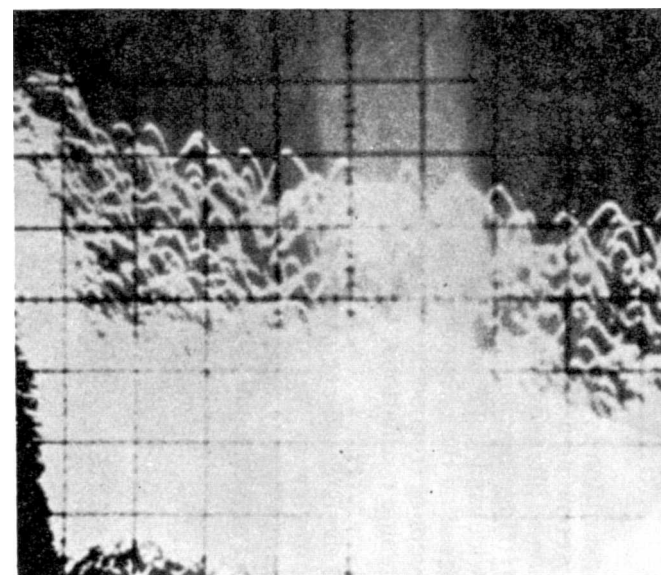


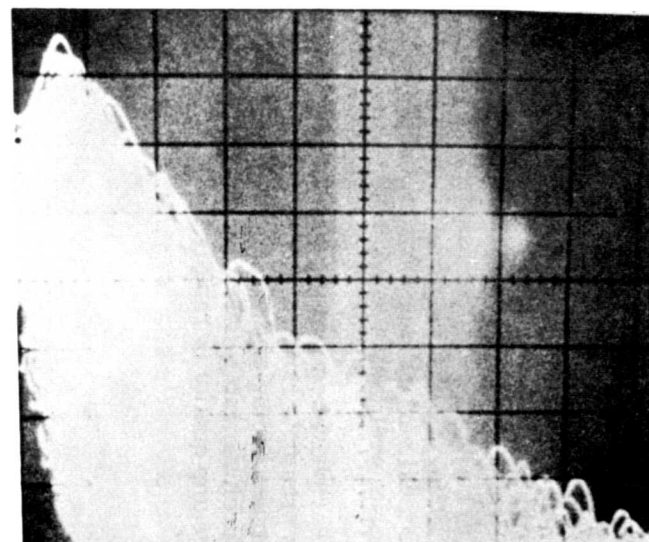
Figure 2

CARTRIDGE OUTPUT WHILE PLAYING CYMBAL CRASH



(a)

Denon 103



(b)

Shure
V15-II

Figure 3

RIAA NETWORK LOADING

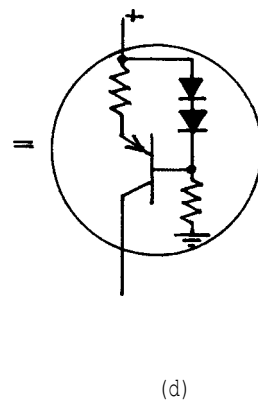
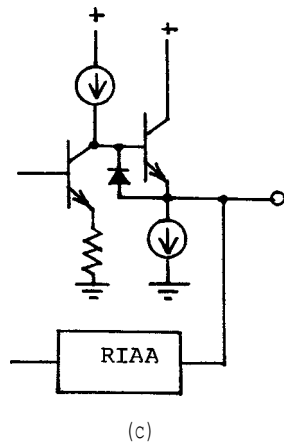
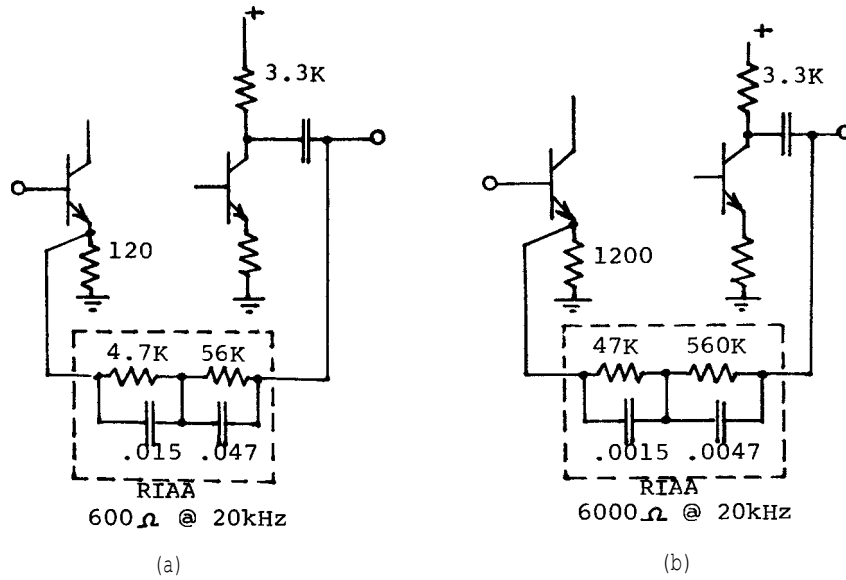


Figure 4

COLLECTOR-BASE CAPACITANCE NONLINEARITY

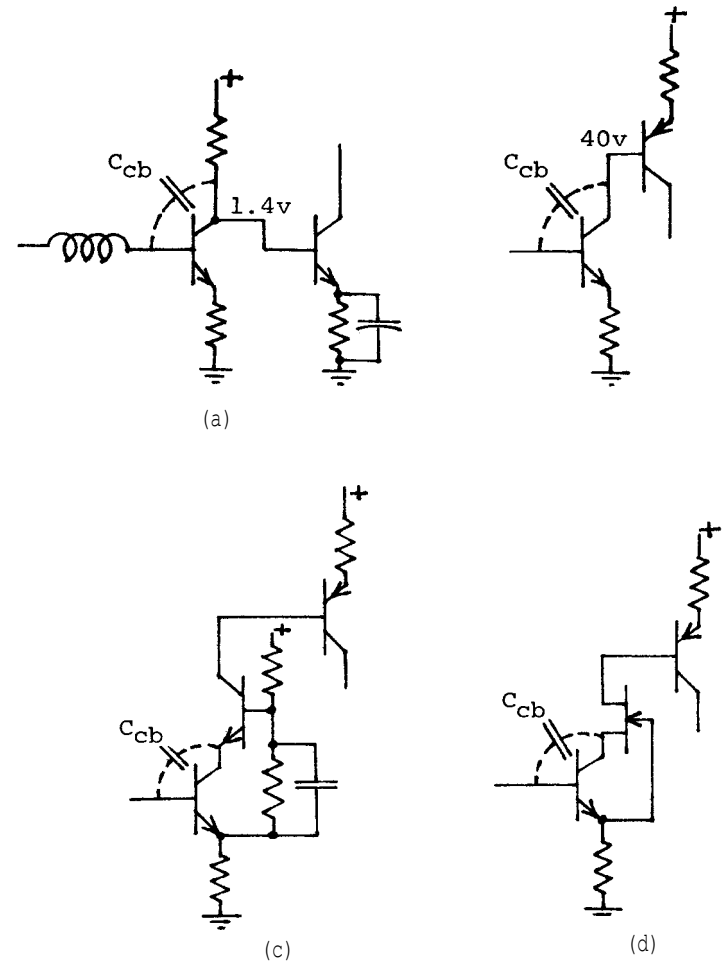


Figure 5

EARLY EFFECT

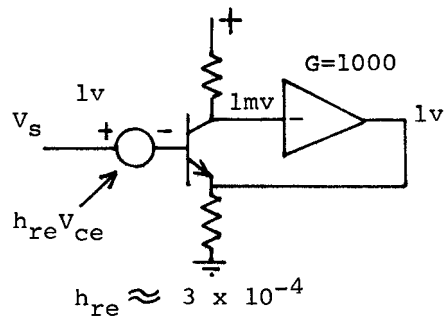


Figure 6

LOW DISTORTION PREAMP CIRCUIT

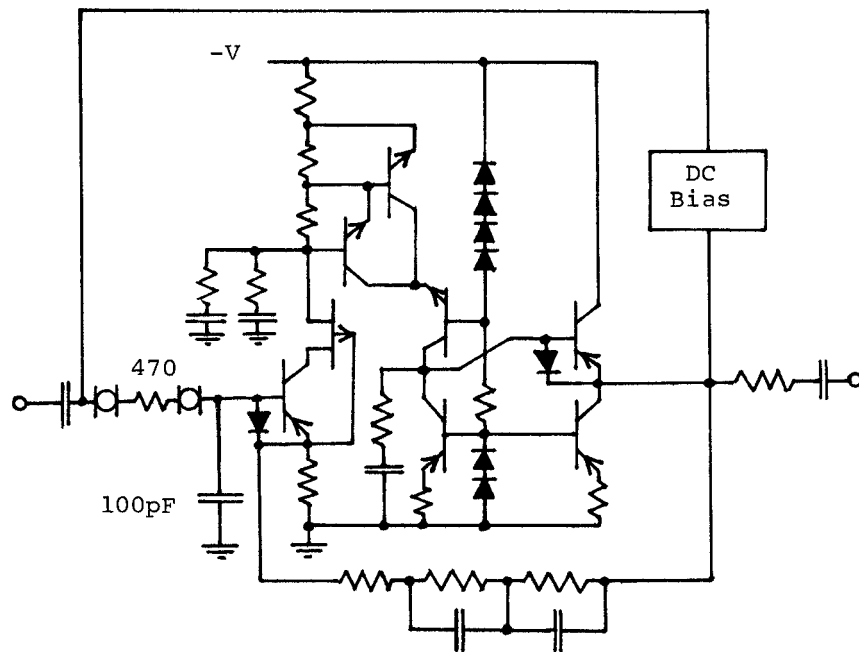


Figure 7

MODIFYING THE RABCO SL-8E

Dean Slindee

"To modify or not to modify?" This is a question which seems to face more and more Rabco SL-8E owners these days. It is a question which may have followed initial doubts as to whether the SL-8E still measures up when compared with newer, lighter tone arms. And I'm sure there are those who have been considering "ditch" as well as "modify."

This article is directed at those of you who are leaning toward the "modify" route. It is not a "how-to" article, but rather an attempt to familiarize the reader with the SL-8E, its deficiencies, and what can be done to remove them. For any BAS member who is really serious about following through with some modifications, I will make myself available for questions at Box 55, Lansing, Iowa 52151. Also, for \$2 I will provide four color photos of an SL-8E with the modifications described in this article. The drawings at the end of the article should help you see how I've done it.

Original SL-8E

In all fairness to the SL-8E, it should be stated at the outset that the arm is not necessarily doing anything really wrong. Stated in a more positive manner, the theoretical premise on which the SL-8E is built (straight-line tracking) is as valid today as it was yesterday and will be tomorrow. A straight-line arm will always have the theoretical edge over a curved arm, no matter how attractive the curves. True, the size and weight of the SL-8E can be a disadvantage on some turntable mounting boards and suspensions. But the arm does offer both horizontal and vertical adjustment provisions (especially vertical) that are hard to beat and easy to make. When it was introduced some seven years ago, it was indeed a worthy contender for "state of the art" But seven years is a long time in audio, even longer for those audiophiles in quest of the holy hi-fi. Now is the time to bring the SL-8E back up to date, even back to "state of the art"

Deficiencies

So why doesn't the original SL-8E measure up to today's standards? There are a number of reasons, some of them are knots, some of them are nits. To begin, the SL-8E can be viewed today as being a rather crude expression of a precision idea. The precision idea might be stated succinctly as follows: low mass, low friction, resonance and bias-free straight-line tracking of the record groove. The original SL-8E can qualify on the last two counts. It is bias-free. It is a straight-line tracker. But it does not have low mass or consequently, low friction. And that metal cartridge shell is bound to resonate. On top of that, it comes to the owner in a state of adjustment where the arm can literally be twisted and turned around inside the arm's own pivots. That is not precision.

"Traditional" Modifications

Perhaps the first attempts at improving the SL-8E were made in an effort to dampen the metal shell resonances. One approach was to fill the rear end of the shell (around the amphenol plug) with a tar-like substance. This will dampen the resonances of the metal shell, but it will also add significantly to its mass: a trade-off of more mass for less resonance, not a clear improvement.

Often the next step was to discard the adjustable metal end of the cartridge shell and to substitute a piece of wood in its place. Balsa has been used because it is light, easy to locate, and

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easy to shape. Balsa both eliminates the metal resonance and cuts down on the mass at the same time -- definitely a step in the right direction, and not all that difficult to do either. Visually, it may lack a certain amount of professionalism, but it works. Well, if some mass can be eliminated by discarding part of the metal cartridge shell, why not eliminate all of the metal in the cartridge shell? At least two commercially available modifications do exactly this. The original amphenol plug is re-used by surrounding it with an all-wooden cartridge shell. Painted balsa is used in one mod, oiled redwood in the other. The counterweight is also resized to remove about one-third of the mass. Both of these mods may be considered attractive in their own way. Both of them offer a very substantial reduction in the arm's mass along with eliminating the metal shell resonances. Both are affordable.

Until recently, this was the extent of the SL-8E modifications. But, within the past year, a number of inventor/experimenter types have succeeded in pushing the technology further. You may want to do the same.

A significant observation to make at this point is that, up to now, modifying the SL-8E has involved no major changes of the arm's inner working parts. The previous modifications have been, for the most part, relatively easy to make. But this is as far as the easy modifications go. Before proceeding on to the next paragraph, please remove your experimenter's hat and now don your inventor's hat. From now on the sledding gets tougher.

Advanced Modifications

You might do well to ask yourself at this point whether or not you really have the time, energy, patience, and equipment to proceed. You will need almost infinite amounts of the first three (so it seems at times). A dash of enthusiasm always helps, too. For equipment, you will need wood-working and metal-working shops, plus the skills required to operate the machinery found therein. Be forewarned though, that you might just find the whole project rewarding and educational, even fun at times. Get help or borrow what you don't have. There's no reason for you to do it all yourself.

OK, so you've decided to push on. What to do? The obvious answer is to get rid of that massive tone arm with its 16.4 gram knurled knob (off-center, no less), the 9 gram amphenol plug, the 40.2 gram aluminum body mounting block, the 27 gram inner gimbal and contact arm (also off-center), the 142 gram counterweight, and the 8.9 gram counterweight screw. That ought to do for starters.

The Design Approach

But just what will you replace the original parts with? It is now time to take out the old drawing board, pen, paper, and some inventive imagination. Your approach will be dictated by the type of pivot system you choose for your new arm. Two basic systems have been tried thus far with success (perhaps a third with the Vestigal graft). One approach uses a uni-pivot, the other a refinement of the original vertical and horizontal pivot design. Perhaps you can come up with yet another. For the sake of brevity, let's follow through with only the vertical/horizontal pivot approach as it is more in keeping with the original design of the SL-8E.

Tone Arm Parts

Once the approach is chosen, it is all a matter of design and implementation of the design. It is time to select the parts and materials to be used. We're already familiar with using wood in the cartridge shell, so let's use it again, only more of it this time, almost all the way back to the pivots, about 5 grams. For the pivots, we'll use cones fitting into tiny ball bearing races to keep the pivot friction at an absolute minimum. The ball bearings will need to seat into a material harder than wood, so a lightweight metal block is called for here. Magnesium or aluminum will work nicely, about 9 grams. Drill out two wells for the ball bearing races and a third threaded well for the counterweight screw. Use a threaded nylon rod here, about 2 grams. Machine yourself a set of counterweights of various sizes, from 20 grams to 100 grams. This will allow you to match the counterweight to any cartridge on the market. (Here, matching means positioning the counterweight as close to the pivot points as possible in order to minimize the

moment of inertia associated with the mass of the counterweight). That's about it for the tone arm proper. Now on to the pivot system.

Pivot Parts

The pivot system is comprised of four major parts: the inner gimbal, the cones, the ball bearing races, and the precious metal contact wire. Perhaps the inner gimbal from the original SL-8E could be cut down to remove excess mass, but you will probably be better off to locate some square magnesium or aluminum tubing for the inner gimbal, about 4 grams. Drill two wells and seat the vertical ball bearing races. Re-use the original cones, but not until you have ground and polished those rough surfaces to a fine, smooth finish. The top cone is re-used in the same position. The bottom horizontal cone may be used in the same position, or it may be flipped upside down so that it points upward, toward the center. You'll have to locate a source of supply for the ball bearing races, and the smaller the races the better, say about 1/8 inch. And finally, the precious metal contact wire is epoxied to the inner gimbal. Use the contact post from the original arm.

Summary

To summarize what has happened, the original SL-8E has now become a low mass, low friction, resonance and bias-free straight-line tracking arm. The moving mass (disregarding counterweight) has been reduced from an original total of 125 grams to a newly modified total of 20 grams. The original counterweight had a mass of 142 grams. A new counterweight mass of 45 grams will work with most cartridges now available. This mass reduction and the new ball bearing pivot assembly have contributed to making the arm's pivot friction ultra-low (so low that, when set at zero balance, wind currents will deflect the arm into tripping the lift motor). Its other desirable attributes result from the earlier mods.

Cost

Is it worth all the trouble? The answer lies in how much of a perfectionist you are. Admittedly, it is extremely expensive to design and build just one unit. Will anything like this be commercially available? Yes, two versions are at present available, at a cost of \$350 to \$400 each. In reality, these arms are not, and probably never will be, "manufactured." Each is individually made by a precision craftsman. Many, many hours of labor go into the assembly of just one arm. Is it worth the expense? Again, how much of a perfectionist are you? Once you've used one of these arms, every other arm either looks too massive or has too many design compromises. This is a no compromise arm that once again competes for the title "state of the art."

Additional Improvements

Regardless of whether or not any other modifications are made, the up and down cycling of the arm can be easily improved. This can be important if the too slow lift cycle occasionally causes the stylus to drag across the run out grooves at the end of the record as the arm raises and centers. A faster cycling time also helps when you are rapidly cueing to find your favorite demonstration groove. It is at these times that the original SL-8E can seem interminably slow. Once you become accustomed to a faster cycling time, the original arm seems almost sluggish.

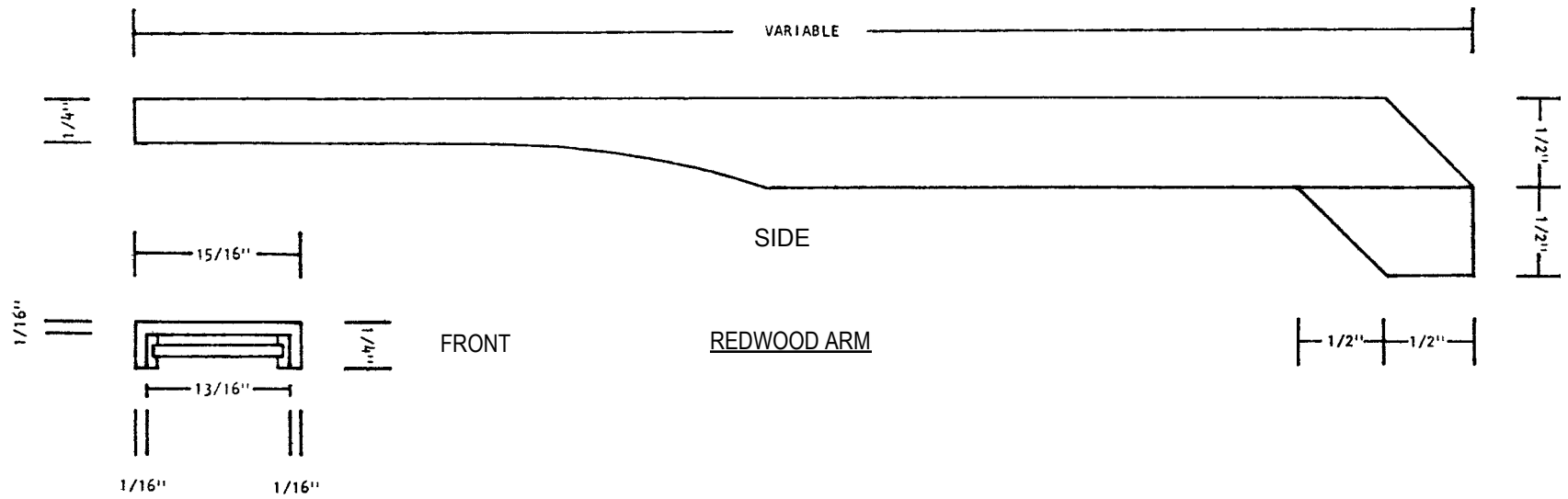
The original SL-8E uses a 1.5 Volt battery to lift the arm in 10 seconds and to lower it in 7 seconds. The simplest way to speed up the cycle time is to make the motors run faster. This can be done by using a higher voltage battery. A good range is from 2.0 to 3.0 Volts. For instance, a 2.7 Volt battery (Eveready E132N) will lower the arm in 7 seconds and lift it up again in 5 seconds. Cycling times shorter than this are possible but are somewhat more difficult to adjust. Visit your local photographic supply shop and check out their selection of batteries.

Because the motors are now moving faster, their inertia carries them farther along after power is interrupted. In the case of the vertical lift motor, one more adjustment is needed if this modification is to be successful. The detents on the cam wheel attached to the vertical lift motor must be widened. A 3/4-inch diameter grinding wheel will do the job just right -- not deeper, just wider. Caution should whisper in your ear to try grinding away a little at a time until the

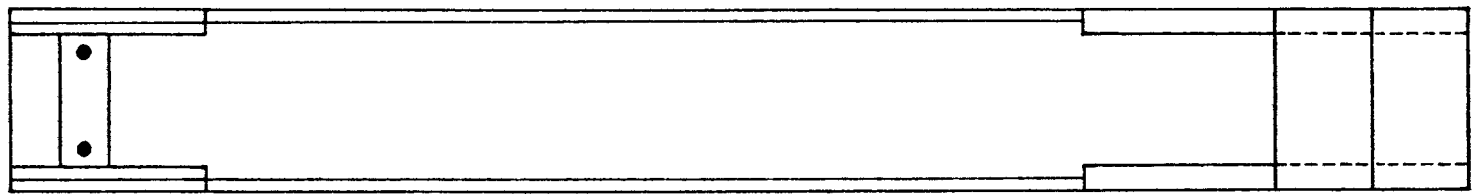
arm lift stops and starts reliably each time you activate it.

Finally, here's an idea for a modification which has not as yet been done, Maybe you can figure this one out yourself. The idea is to replace the precious metal contacts with something more reliable. Try opto-electronics, discrete light emitting diodes that emit and detect infrared or visible light. Be prepared to add a resistor, a transistor and possibly a different battery again to make the circuits work. A battery on/off switch will probably be necessary here too. I am working on the development of such a system myself (with BAS member Ray Kilmanas of Detroit) and expect to have it completed soon.

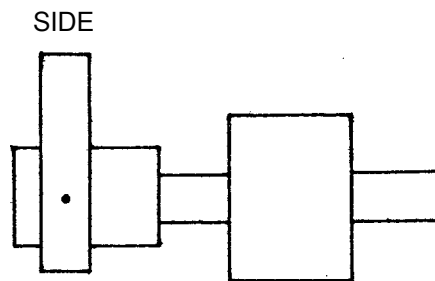
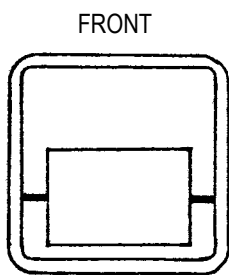
(Ed. Note: Members may also wish to see Kilmanas' Rabco-mod article in The Audio Amateur, 3/1976, p. 10, and to reread his communication printed here earlier this year.)



BOTTOM

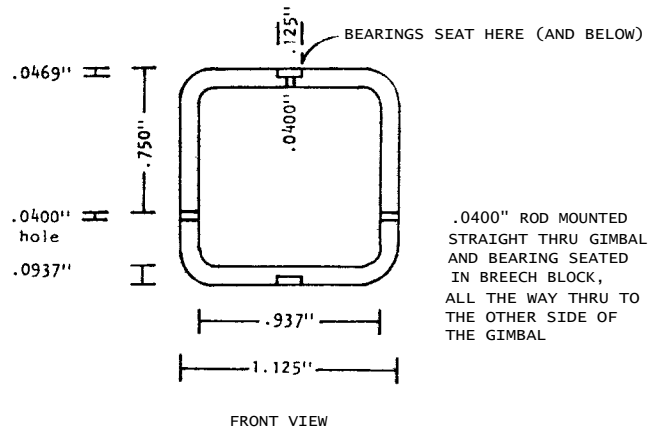


GIMBAL



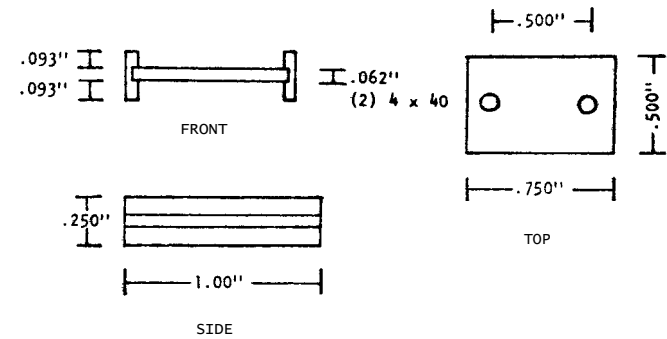
GIMBAL

(1/4" PLATE)



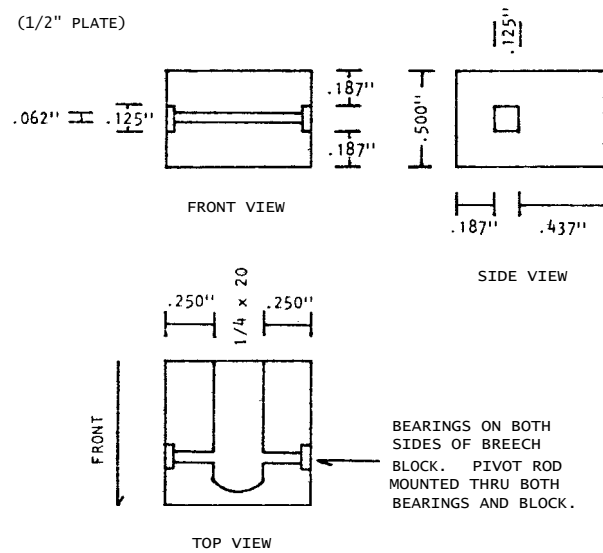
SLIDE ASSEMBLY

(1/16" PLATE)



BREECH BLOCK

(1/2" PLATE)



WHEEL BEARING MOLD

