

THE B.A.S. SPEAKER

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THIS MONTH'S PUBLICATIONS. Back again to those fidelity-limiting music sources. We all know that there are no pops, swishes, or warps in the tenth row at Symphony Hall, yet somehow the record companies continue to provide such sounds even in the best imported pressings straight from the plastic lined envelopes. And Father Time treats our discs to further sandstorms and stickies right from the first playing, even on a Dust Bug equipped turntable. The stylus imbeds the dirt into the vinyl, and it resists even such heroic measures as the dishpan treatment described in "Clean Records for Cleaner Sound" (Speaker, May 1973). This month, in a landmark article for the BAS, a BAS member describes his solution to at least one important part of the problem, that of removing and keeping removed all of the household gook that threatens those delicate black surfaces.

No dry dust remover can do the job of a detergent washing, and no washing is effective unless the residue in suspension is completely cleared from the surface. Bob Borden's machine does the complete job, and with delicate perfection. We have seen this device in operation, and hold absolutely no reservations as to its performance. By way of evaluation, we took a pressing of Handel's "Israel in Egypt" to Borden's and cleaned it on his machine. Formerly it sounded as if the music had been recorded over a bad shortwave link from a tin shack in a hail storm. The record had been cleaned by hand to the extent possible, and still sounded grim. Bob's system made it sound first rate. Consider that if you are as fed up with disc quality as most of us are.

Furthermore, although the device must be constructed from scratch by the audiophile, this is a very doable task, and the major problem is that of parts procurement rather than assembly. Read this article carefully before deciding that it is beyond your capabilities. It is not, and the results are very real.

By the way, the beautiful illustrations in this month's publication are by BAS member Peter Watters, a Cambridge, Mass., based architect. They just may be some of the cleanest and most carefully done drawings you'll see published anywhere, commercial publications included. Our thanks to Peter Watters.

In the BAS publication for January 1973, "How To Decide Which Tape To Use," Al Foster beat all the major hi-fi publications into print with a detailed performance comparison of the seven most popular open-reel tapes. Perhaps it was only chance, but two magazines copied his article in 1973 and one quoted him. Now Al has done it again, this time with a report on two new

high-performance tapes that have excited controversy not only about their performance but also about their cost. The tests made on these new tapes are identical to those used in AI's earlier evaluation, and again, as then, his conclusions are something other than what the advertising hype would lead you to expect. We think this is a valuable item of information for anyone seriously considering the best in recording tape; read it before paying \$100 for one case of the new supertapes. (Since the test details and background material contained in the earlier piece are still highly valuable, the BAS is making available free reprinted copies of AI's earlier article to members who weren't with us in 1973. Please request these through Box 7.)

PUBLICATIONS UPCOMING. Dan Shanefield, a New Jersey BAS member and an engineer at Western Electric, has sent us a manuscript on techniques for AB component comparisons. The manuscript was received too late for inclusion in this issue, but as it outlines not only some of the prejudices (unsuspected) and pitfalls (overlooked) in AB comparisons, we thought you might be interested in knowing that it's coming. It arises out of an exchange of letters and a phone call between Jim Brinton and Dan Shanefield, as triggered by Dan's comments about The Absolute Sound, published last month.

Expected sometime this fall is a piece from BAS member Leigh Phoenix, a professor of mechanical engineering at Cornell University. Leigh treats the important role played by tonearm damping, and there are strong suggestions that damping may be as important if not more so than such parameters as pivot friction and mass. The latter two are currently getting all the manufacturers' attention (see the Transcriptors Vestigal [sic] tonearm), in what seems to be a faddist approach to technology. One of Leigh's points is that development may have already gone too far in these directions, while the importance of damping has been overlooked. There may also be some tips on the addition of damping to existing tonearms for the technically inclined.

Both Al Foster and Al Southwick have also promised articles on tape and on equipment overload, and Southwick is tracking down tape data sheets for distribution. It would seem that one article on any technical subject spawns creative ideas on the part of several other readers. What is needed is for this enthusiasm to last long enough to result in a written article. We urge all of you who are so inspired to act while the urge is strong, and suggest that group projects (e.g., ABC tuner or tape machine comparisons) are a lot of fun, and the results are of great value to the members.

On the debit side of the ledger, there have been no offerings of articles on musical topics, and the promised ones still haven't appeared. Again, we want to encourage those musically inclined to suggest topics and to volunteer to write.

MEMBERSHIP DUES. For those of you who have not renewed your BAS membership for the 1974-1975 season, this newsletter is your last. Dues are \$12 per full year. Checks should be made out to and mailed to the BAS at the address on the first page. Announcement of the November meeting will be sent only to those whose checks are received by November 1. One year's membership includes all issues for the year (October through September). First class postcards will be mailed to all in-state members and to out-of-state members who request a monthly announcement on their membership form. (This newsletter was distributed at the October meeting to those members in attendance, and was mailed to all other members, paid and unpaid, after the meeting.)

EDITORIAL: YEAR NUMBER THREE. This is the first complete issue under the new regime, where the editorship will rotate among those who have volunteered—and among those who we hope will volunteer to join the publication staff, as described in last month's newsletter. Overall coordination still resides with our outgoing president, Peter Mitchell, and with our new president, Jim Brinton. The incoming staff applauds these two members who, along with the founder of the BAS, Al Foster (Recording Secretary), and Joyce Brinton (Corresponding Secretary), initiated this

publication some two years ago. It is a tribute to their imagination, planning, and hard work that this publication exists, and we hope that with their continued consultation, the quality of the newsletter will remain high.

In addition to the new organization, this issue (Vol. 3, No. 1) includes several trial balloons. One is the listing of several articles published in limited circulation periodicals which we feel merit the attention of members who may not subscribe to all twenty or so sources of high fidelity information. Contributions for this column from the members are solicited, and can be sent monthly via postcard to Box 7. Reprints of the mentioned articles are not available from the Society; you are urged to find associates who do subscribe and to pool your resources to remain well informed. Here the BAS library could assist you in keeping up to date, if members ever organize it and keep it well stocked with literature.

The BAS in Review. Another new slant is in the realization of the national audience that has grown up around this journal. This leads to a short editorial on the intent, history, philosophy, and future role of the BAS. As founded by Al Foster in a hot, jammed room at Boston University on May 21, 1972, the intent of the organization was to provide a forum for the informal exchange of ideas among Boston audiophiles, with industry speakers providing the bulk of the meeting content and hopefully some insight into high fidelity information not found in the usual publications. From the original thirty local "Charter Members" in 1972, the Society closed out its second year with more than 200 members, many in industry, and spread about equally through the Boston area and through the rest of the USA—and even several members in Canada and South and Central America.

This publication, The BAS Speaker, initially consisted of the minutes of the previous meeting and the announcement of the forthcoming one. But immediately its content began to change. First came announcements of Boston-area events along with classified ads for used equipment, suggestions for good records as compiled by members, and reviews of special events such as an AR tour and a tape recorder clinic. In November 1972, the executive committee announced that manuscripts for review and publication by the BAS would be encouraged, and the first feature articles were published: a commentary by Peter Mitchell on the evaluation of records and an extensive test report on recording tape (still a valuable reference) by Al Foster.

It rapidly became obvious that such articles were welcomed by the members, especially since they could be trusted as unbiased personal judgments. The scope and depth of submitted material grew, and the monthly Speaker became more and more of a publication. After a couple of free plugs in national magazines, the Society began to receive out-of-state applications for membership, where the intent of the audiophile was obviously to obtain a subscription to a journal rather than to attend meetings or exchange ideas in person with fellow enthusiasts. The membership of the BAS has grown proportionately more national ever since, and this year the Society may in fact become more national than local. The executive committee welcomes this change in the Society as long as out-of-state members continue to be satisfied with The Speaker. Its \$12 per year cost may appear high when compared with discount subscriptions to other monthly national magazines, but not only is its content far different, but over a year it can compare favorably with most of the specialized \$8 quarterlies.

The Future. The BAS newsletter must in the future remain a forum for the exchange of ideas among the members, not a product of the executive committee for the readership, and thus we come to the real point of this message. We see out-of-state members as potentially a very valuable source of fresh equipment reviews, new general articles, and regional information of interest to all of the Society. All readers are therefore strongly encouraged to submit articles, ranging from short notes to full manuscripts, for possible publication in The Speaker. For example, short notes discussing highly satisfying equipment infrequently found in Boston are very desirable (so long as they are honest personal opinions and are not submitted as advertising ploys). These

notes (of up to four to six double-spaced typed or legibly written pages) should be sent to the BAS at Box 7, where they will receive immediate attention. We will edit any material before publication, but always for the purpose of clarification or condensation, never for the purpose of changing the content from that intended by the author. One example of a short note submitted for publication is Al Foster's discussion of Sheffield Volume III, included in this issue.

For longer articles, it would be best if a short outline or synopsis of the proposed article could be sent to the BAS for initial comments before a great deal of work is expended on the final draft. The BAS has occasionally declined to publish submitted material when the subject treated was too esoteric for wide interest, but the breadth of the articles that have appeared in the publications section should indicate how varying in content your contribution can be. (Incidentally, amateur radio communications are available from Boston to the author to expedite discussion of your article, provided that an assisting operator can be found in your area. Please request a schedule in your letter to the Society.)

It is a very satisfying feeling indeed to find one's words in print, to have helped your fellow enthusiasts to find additional enjoyment in their systems, or to steer people clear of clinker items offered for sale by less than reliable manufacturers (for example, the terrible TV adapter offered by Rhoades National Co.).

The Speaker can be a superb avenue for national information exchange, but only the interest and effort of all the membership can make this Society's publication excell. Please take the time to make your contribution to The Speaker. — Harry Zwicker

ERRATA. Some typographical errors crept into last month's article on IC op amps. On page 7 near the bottom, the line output impedance of the Advent 201 is 1500 ohms, not 1000. In Figure 15, the first stage of the circuit is identical to Figure 14, so the resistor going to ground from the 0.047 capacitor should be 33K, not 39K. And at the top of Figure 22, the feedback capacitor should be 0.033 μ f, not 0.01.

BAS OSCILLATOR. Jim Richardson announces that Delta has finally come through with the pots for the oscillator, but other parts are still in the procurement phase. He is accepting \$10 deposits for possible November delivery. Please make checks payable to the BAS and mail to Box 7.

SIGHT AND SOUND SHOW. Sources at both the hi-fi and at the photo areas of Lechmere have stated that there will be no Sight and Sound Show this year. So, for all of you who are out of tape for the 94th BSO season and who were waiting for the annual super-prices on Scotch, here is another item to add to your escalating cost of living.

BSO. Peter Mitchell informs us that there will be no four-channel discrete (WGBH/WCRB) Saturday BSO broadcasts this year, and furthermore not all of the Tuesday concerts will even be broadcast, much less Victorized. Looks like Saturday is tape night. Let WGBH know what you think of the new system. See Prime Time for concert schedules.

IHF SHOW. During the weekend of November 1-3, many manufacturers will be displaying their newest products at the IHF High Fidelity Show in the Statler Hilton Hotel, Park Square, Boston. The hours are Friday 6-10 p.m., Saturday noon to 10 p.m., and Sunday noon to 7 p.m.

CASSETTE RECORDER FOLLOW-UP. The Advent 201 ("sample one") used in the tests reported by Mark Davis in the August issue has been found to have a worn and misaligned head, which may explain Mark's disappointing results. The head has since been replaced and aligned, which has made a dramatic improvement in the sound of prerecorded cassettes and has improved the compatibility of cassettes recorded on one machine and played back on another.

There is an additional lesson here. In many cassette decks it is tempting to place the machine in play/pause to gain easy access to the heads for cleaning, and then to make the mistake of inserting a cassette without first retracting the heads. Pushing the cassette down into the well bends the protruding head mount, causing permanent misalignment. This mistake had been made with the 201 in question. Be careful !

Incidentally, after you become accustomed to the quiet background of a good modern cassette deck, it is hard to tolerate the high hiss level of one's old homemade or prerecorded non-Dolby iron oxide cassettes. Many instruction manuals, including Advent's, suggest playing these old cassettes with the Dolby on to cut the hiss, but I find that this makes the sound unacceptably dull because the Dolby attenuates all frequencies above about 1000 Hz. I find that the ideal way to play non-Dolby iron oxide cassettes is with the Dolby off but the CrO₂ switch on. The special CrO₂ playback equalization curve, which was developed by Advent and recently adopted by Philips as a world-wide standard, makes an excellent hiss filter, as it rolls off the highest frequencies very steeply while having little effect below 6000 Hz. — Peter Mitchell

SLEW RATE. The latest fad in power amplifier advertising is to specify the maximum slewing rate of which the amplifier is capable. It is the maximum rate of change of the output voltage, and it turns out to be basically another way of stating the upper frequency limit of the power-bandwidth curve of the amplifier. In other words, at ultrasonic frequencies an amplifier cannot put out as much low-distortion power as at lower frequencies, and the slew rate states the relationship between frequency and power capability (at low distortion). The standard equation for slew rate is $SR = (6.28 \times 10^{-6})VF$, where V is the peak output voltage, F is the maximum undistorted frequency, and the factor 10^{-6} is because slew rate is specified in volts per microsecond, i.e., how much the output voltage can be made to change in one microsecond. Knowing the relationship between power and voltage, we can derive from this a more convenient equation:

$$SR = (8.9 \times 10^{-6})F\sqrt{PZ},$$

where Z is the speaker's impedance and P is the continuous power. If we stick to an 8-ohm impedance and adopt 20,000 Hz as the highest frequency at which undistorted power is desired, the equation for slew rate is further simplified to

$$SR = 0.5\sqrt{P}$$

It is instructive to apply this equation to any power amplifier claims which you may encounter. For example, the slew rate required in a 100-watt-per-channel amplifier, assuming that you really want to be able to deliver the full 100 watts at 20 kHz without distortion, is only 5 volts per microsecond. A higher slew rate may provide some sort of engineering advantage (minimizing instability, perhaps), but it cannot provide any direct audible benefit. — Peter Mitchell

MONEY MAGAZINE. In self-defense, I would like to point out that the list of recommended systems published in the September issue of Money is only an excerpt from a larger list of recommended components which I had suggested. In abbreviating the list, Money managed to completely omit Advent—some of whose products are outstanding performance-per-dollar values—and to give Pioneer components a larger share of the list than they deserve.

Peter Mitchell

TAPE TESTS. In addition to the tapes tested by Al Foster in this month's publication, I have compared a reel of Scotch 177 with Scotch Classic, Scotch 207, and Scotch 212 (formerly 203), utilizing similar professional quality equipment and an identical biasing technique. Two items of interest were noted: First, Scotch 177 appears to live up to rumors that it is the "sleeper"

of the 3M audio tape line—comparable or superior in most respects to Scotch 212 at a lower price. (Scotch 177 is the tape that the BAS purchased in bulk last spring. —ed.) Second, I found some differences between Al's and my high-level saturation data. A report on a joint investigation of tape saturation and other parameters, as measured on several different types of machines, will be forthcoming. — Alan Southwick

ORIENTAL HI-FI. In August my work took me to Japan and Hong Kong. Of course I couldn't overlook that opportunity to stock up on the latest hi-fi and optical items. Two things impressed me: (1) Japan has high prices and they are going higher, so it would seem appropriate to expect major jumps here in prices of Japanese hi-fi gear soon. (2) It was difficult to trust any Hong Kong merchant. I was offered used, obsolete, inappropriate, or unsuitable items, incorrect prices, and items lacking warranties, factory packing, or instructions. As a result I am re-evaluating my desire to achieve low prices through overseas mail order. Have others had either good or similar unhappy experiences? — Rudy Boentgen

SHEFFIELD VOLUME III. Sheffield's third venture into direct-disc recording is sonically superior to the first two albums. It is distinctly cleaner and more trackable. The instruments are not unnaturally forward as in Volume II, and there seems to be more definition among the various instruments. For my taste, the musical merit of Volume III is also superior, providing a delightful rendition of "You Are the Sunshine of My Life."

I suspect that what accounts partially for the albums cleaner sound is the unusually high peak-to-rms ratio, not to be confused with dynamic range. Dynamic range is the difference between the maximum recorded level and the residual noise (or the minimum acceptable signal level). This album does have terrific dynamic range, but more importantly it has the highest peak-to-rms ratio of any record that I own.

This ratio, expressed in dB, refers to the ratio of the maximum transient (or peak) level encountered in *a* short musical segment to the corresponding rms (or, roughly, the average) value. Because an rms meter (e.g., an AC-VTVM) is designed to "average" and not to respond rapidly to peaks, any instantaneous transient levels are not indicated. To obtain a reading of these electrical peak levels, you must use an instrument capable of responding to signals of a few tens of microseconds duration. An oscilloscope is just such a device. The ratio of the two readings near any transient then gives the peak-to-rms ratio.

Normally in producing a phonograph disc, all master tapes are recorded so that the highest rms level found anywhere in the work is recorded at or slightly above 0 VU in order to keep the noise as far below the signals as possible. Transients above the rms level are then left to exceed the point of tape saturation, where the amount of "headroom" (above 0 VU) is normally less than 15 dB. Even smaller values occur at high frequencies, above about 5 kHz. The peak-to-rms ratio on loud passages is therefore restricted to 10 to 15 dB at best.

It is the intent of the Sheffield direct-discs to eliminate this constriction by recording directly on the disc master, thus eliminating all tape from the mastering chain. See High Fidelity for October 1974 (p. 42) for further discussion.

On this basis, suspecting that Volume III has the highest peak-to-rms ratio of any record I have ever heard, I measured it for several of my best sounding albums. My suspicion was confirmed (see table). Volume III was fully 3.5 dB more demanding than either Lincoln Mayorga's own Volume II, or the Nonsuch disc acclaimed in Audio for June 1974 (p. 16).

Record	Peak-to-RMS Ratio in dB
Sly and the Family Stone, "Small Talk," Epic X698	10
"A Baroque Festival," Nonesuch H7-12	10
Steinberg, "The Planets," DGG2530102	12
Raymond DesRoches, "Percussion Music," Nonesuch 11-71291	16.5
Sheffield Volume II	16.5
Sheffield Volume HI	20

The implications of these results are twofold. First, Sheffield has indeed produced a disc with superb high-level transients but with no decrease in the average signal-to-noise ratio, i.e., the average cutting level has not simply been reduced by 3.5 dB. And second, if both Volume II and Volume III are played back at the same average listening level, Volume III may require 3.3 dB, or about a factor of two, more amplifier power to prevent clipping than does Volume II. Furthermore, this danger of clipping affects all other stages in the audio chain as well. I decided that this disc would therefore be an ideal one for use in exploring the questions of phono input overload and clipping of my Phase Linear 700 driving a pair of LST's. Data obtained in this study will be reported in a future article. — Al Foster

IN THE LITERATURE

Radio-Electronics, Oct. 1974

- Build-it project: Three-IC SQ decoder with "full logic and wavematching," kit of parts (no cabinet or PS) available for \$37.50. (p. 33)
- RC coupling in audio circuits. (p. 42)
- Low noise hi-fi: A three-page discussion of the Dolby-FM method, with a discussion of changing your de-emphasis circuits. (Not too complete—ed.) (p. 57)
- For readers unfamiliar with this publication, it is about one-half TV repair and about one-half everything else. The October issue is a special on four-channel. Normally, the non-TV content contains one or two build-it articles, often digital devices (character generators, counters, meters) or new offerings from SWTPC, a "kit" company in Texas with several inexpensive hi-fi items in their catalog. Len Feldman is the hi-fi contributing editor.

Radio-Electronics, Sept. 1974

- Announcement of BASF Unisette, a 1/4-inch tape "cassette" for 17/8 through 7½ ips, with tape motion parts external to the package. (p. 6)
- How to measure hi-fi amplifier performance: describes some audio test gear. (p. 61)

Popular Electronics, Oct. 1974

- Promises for 1975: A review of the new equipment, including logic-aided decoders, frequency synthesizing tuners, and signal processing preamplifiers. (p. 22)
- How to evaluate tape recorder specs. (p. 46)

Popular Electronics, Sept. 1974

- Stereo Scene (a monthly column): Noise reduction—dbx discs and other playback processors (Burwen, Pioneer RG, Phase, Infinity). (p. 22)
- Ampzilla: A 200-watt-rms-per-channel, home build or kit (\$340), stereo amp. (p. 33)

Wireless World, July 1974

- Audio FET power transistors: Very short discussion of the new Yamaha FET's. (p. 223)

Wireless World, Aug. 1974

- Bridge oscillators. (p. 303)

Electrical Engineering Times, Sept. 23, 1974

- Rating audio equipment: Rates Bose 1801 and Phase Linear 700B below their reference, JBL SE400S amp. Rates Crown DC300A "open" with "better definition" than the JBL; SAE IIICM "noticeably warmer"; and Dual 51 and 76 as better sounding than any solid state unit into Quad electrostatics.

Audio Amateur, Issue 4, 1973 series (current)

- Modifying the Advent 101 Dolby B.
- Power doubler for solid state amplifiers.

Playboy, Nov. 1974

- The Big Picture: Article on Advent's Videobeam TV.

Stereophile, Winter (4) 1973/74 (sic)

- Short reviews of Phase Linear 4000, Harman Kardon 14 and 15 tuners, Supex 900E, Ohm F, PAT-5, 18 more.
- A-Z tape recorder setup, part 3.

Stereo Directory and Buying Guide 1975

- Now available, for \$1.50.

EQUIPMENT FOR SALE. Shure/SME model 3009 Series II tonearm complete w/all hardware & mtg. instructions - \$60; Empire 999 TE/X cartridge used 6 mos. - \$15; 2 Electro-Voice T-350 tweeters (16-ohm) - \$50 each, 2 for \$95; 2 Electro-Voice T-35 tweeters (8-ohm) - \$25 each; 2 Electro-Voice X36 crossovers (8-ohm) - \$12 each; 2 Dynaco ST-35 basic stereo power amplifiers, modified for improved performance, reliability, & long life, brand new - professionally assembled & tested - \$70 each; Dynaco PAS-3X preamp, recently overhauled - \$50; pair of Electro-Voice Wolverine 2-way, 8-ohm, loudspeakers w/tweeter level control, mounted in tuned, damped, bass reflex enclosures, will finish enclosures (paint or veneer) to suit buyer - \$65 each, \$120 pair. John Laynor, c/o BAS, Box 7, or home 369-6436 (Concord), work 862-5500, ext. 5432.

SEPTEMBER MEETING

Business and Open Discussion Session. About fifty members met at BU on September 15. BAS treasurer, Jim Brinton, presented the happy news that the treasury is about \$300 ahead of last September. Although a higher balance (\$510) was reported at last year's General Business Meeting, several unpaid bills were outstanding at that time, so that the true balance was only about \$90. For the past fiscal year, however, all bills have been paid and the treasury still contains \$394. See the treasurer's report below for a full financial breakdown.

In other items, the refreshments available at meetings were discussed. Mrs. Schecter suggested that one way to break out of the coffee-and-cookies rut without attacking the treasury would be for various members to donate refreshments once per year. To start things off she offered to bring cheese and crackers to the October meeting, an offer which was heartily received.

The members present also felt that the meeting summaries should be as complete as possible for the benefit of those who are unable to attend each month. Al Foster took further orders for Sheffield Volume III records. Jim Richardson took firm orders for the IC oscillator project with a \$10 deposit. He also reported a delay in obtaining cheap (50¢) dual potentiometers from Delta Electronics of Lynn, Mass, who claimed that the shipment had been lost by United Parcel Service. (The pots have since arrived — ed.) Both Keith North and Mark Davis reported similar losses, yet UPS still seems to be the preferred way to ship equipment since they are far more gentle with packages than either Railway Express or Partial [sic] Post.

Al Foster gave a brief report of the new TDK Audua and Scotch Classic reel-to-reel tapes. The Audua is the brightest of any tape that he has tested so far, but has high dropout counts. The Classic, which is back coated, has the lowest dropouts of any tape tested and has higher output and brighter high end than Scotch 207, for about the same frequency response curve as 203 but at a greater level. Al noted, however, that the back coating tears apart pressure pads, and Classic therefore should not be used on machines so equipped. A full tape report appears as a BAS publication in this issue of The Speaker.

Continuing the open discussion session, Peter Mitchell, by now noted for his incisive perusal of technical articles, pointed out another illustration of how the equipment reviewers in High Fidelity misinterpret their own test data. In the October report on the TEAC 2300S deck, they noted a "strikingly low" level of IM distortion. High Fidelity in the past has reported falsely high IM figures on tape machines simply because the high frequency component of the test tone was recorded near saturation on the tape. But in this test they used Maxell UD tape, which has more high-frequency headroom than the tape they normally use, and thus is less prone to distortion at high levels. Moreover, the TEAC's meters read 6 dB high, so that the recorded level was actually 6 dB lower than usual. Thus, while High Fidelity has in fact finally produced a measurement technique free of the previously measured saturation effects, and one which therefore reflects more normal IM distortion values at normal recording levels, their application of the results to the TEAC alone is highly misleading.

Turning to the business portion of the meeting, the officers who will serve the BAS during its third year were elected by unanimous acclaim. They are President Jim Brinton, Treasurer Harry Zwicker, Recording Secretary Al Foster, and Corresponding Secretary Joyce Brinton. Carl Covell then proposed that outgoing president Peter Mitchell be granted a full, free, and absolute pardon. He accepted, on the condition that he be permitted to keep his tapes of past meetings!

In a more serious vein, at the suggestion of Al Foster as amended by others, Peter was also elected a lifetime member of the BAS in honor of his contribution to the society as president and organizational nucleus during its first two years, and for his substantial stream of contributions to the newsletter. In addition to these services directly to the BAS, he also conducts a weekly ninety-minute program on Boston University's FM station, WBUR. Called "Shoptalk," this service to Boston's audiophiles is entirely about hi-fi, and aims each week at an audience ranging from beginners buying their first system through the most knowledgeable audiophiles interested in interviews with the leaders of the hi-fi industry. Our thanks to Peter.

Discussion of Phase Shift. Mark Davis, who gave a program on psychoacoustics at the August 1973 meeting, stated that he has changed his opinion that phase distortion is inaudible. Cautiously, Mark now notes that phase distortion, although not audible in steady-state tones, may be audible in certain types of transient sounds. Much work will need to be done to determine if this is indeed so.

Continuing the phase-shift controversy, a surprise guest speaker, Henning Mohler of Bruel and Kjer (B&K), described a new instrument for measuring phase shift in loudspeakers. He backed up the value of this instrument by referencing a paper that found that phase shift, along with room response and acoustic power response, are the three most significant objective factors involved in a listener's subjective evaluation of an audio system. (The validity of this conclusion is, however, open to question — ed.)

The device measures phase by inputting both a direct electrical test tone signal and also the output of a microphone placed within the listening room (in the direct field of a loudspeaker) to two Schmidt triggers, and determining the percentage time difference between the arrival of the trigger pulses (expressed in degrees of phase angle) for display on a strip chart recorder. As the test tone is swept through the audio range, the phase shift as a function of frequency is thus recorded. An offset (time delay) is included to allow setting the point of zero phase shift anywhere within the sweep range. (The unit gives only the primary phase angle, from 0 to 360 degrees, and does not distinguish between phase shifts separated by multiples of 360 degrees.)

Since the instrument is not yet commercially available, it has had no effect so far on speaker design. A clinic held by B&K on the Monday following our Sunday meeting attracted only a few of the loudspeaker manufacturers in the eastern Massachusetts area. (Although interesting, Mr. Mohler's presentation was not entirely convincing — ed.)

Meeting Feature: Comparisons of Recorded Performances of Music. For the talks on comparing interpretations of recorded music, given by Dick Goldwater and Dave Ranada (a music student at Harvard), Bob Graham provided a pair of very interesting loudspeakers in the form of a pair of custom modified AR-1x's supplemented by a pair of home-constructed Ionovac tweeters. The AR-1x employed the classic AR-1 woofer (which, with small modifications, is still being manufactured by AR for use in the current LST, 3A, and π /one units) along with a 5-inch midrange driver. Bob replaced the original 5-inch driver with a 5-inch Philips unit, modified by removing the whizzer cone and stiffening it with several coats of polyurethane varnish. The crossover was placed at 300 Hz, with a second crossover placed at 3,500 Hz for transfer to the Ionovac tweeter.

This tweeter, although it has been around the audio world in various forms for 20 years (it was described in the January 1961 issue of High Fidelity) gained an early reputation for being fragile and short-lived, a reputation that lingered long after these problems were solved about a dozen years ago. In operation, the Ionovac creates a cloud of ionized gas inside a quartz chamber by means of a high-voltage ultrasonic generator. This cloud is modulated by a superimposed audio signal, which causes the ions to vibrate. The acoustic energy so generated is then coupled to the listening room through a flared horn. The original design of the quartz chamber has been improved by DuKane, the American licensee, and neither of Bob's units has failed after several thousand hours of use. TV sweep tubes used in the ultrasonic generator do, however, require occasional replacement. Further operation and construction details of the Ionovac may be supplied by Bob in a future newsletter.

After Bob's brief discussion of the audio system, Dick Goldwater spoke on subjectivism and objectivism in music. Beginning with the image of music as occurring at the boundary between subject and object (discussed in his recent BAS essay), he raised such issues as the subjectivity of judgments of musical performances, the validity of objective critical criteria, personal expressiveness versus literalism in performing or conducting, whether a composer is the best judge of performances of his music, and whether the performance which is most faithful to the written score is necessarily the best. For illustration he played performances of Bach's chorale prelude BWV 645 by Karl Richter (London) and Marcel Chapuis (the new Telefunken set, which has magnificent sound). They are startlingly different, the Chapuis quite slow, Richter almost exactly twice as fast but with rather choppy phrasing. Dick suggested that the Chapuis performance, perhaps less accurate musicologically, is the more satisfying because of its

expressiveness. He also played two recordings of Vivaldi's "Four Seasons," the classic Vanguard disc by I Solisti di Zagreb and the newer Argo record by Neville Marriner and St. Martin's Academy. The latter is distinctly superior in purely musical terms, while the older performance is more literally pictorial as program music.

David Ranada suggested that when we evaluate records we should assign praise or blame to the correct people. If we decide upon a first hearing that we don't like a piece of music, are we perhaps blaming the composer when we should blame the conductor for a bad performance, or the producer for a strident or opaque recording? (Has our image of Bernstein as a conductor unduly devoted to showing off all the details in the music been influenced by the spotlight miking employed by his record producer, John McClure? And might we have the same image of Haitink if he were similarly recorded?) David noted that performance characteristics such as pitch, tempo, phrasing, articulation, and note-to-note dynamics are more or less specified by composers and are the responsibility of the performers; neither the record producer nor the audiophile can alter them usefully, so we should try to judge the musical merits of a record primarily in terms of those aspects. But characteristics such as the balance among instruments and voices, their placement in the sonic image, the hall ambience, the sonic timbre, and the overall dynamic range are dominantly the responsibility of the record producer, with the last two also subject to the vagaries of transmitting and reproducing media as well as to the whims of audiophiles.

For instance, David contends that the Telefunken series of Bach cantatas has been seriously over-praised by reviewers; he noted that in most of the cantatas it is impossible to distinguish the words the chorus is singing. You might blame the performers for poor articulation, but he suggested that the major blame probably rests with the producers, specifically with their choice of recording hall and mike placement, which favor the orchestra and soloists at the expense of the choir. As in this example, David proposes that in general when criticizing records we should attempt to be just this specific in identifying the source of our dissatisfaction.

On the subject of fidelity to the score, Ranada pointed out that in the case of Baroque and early Classical music, the score doesn't tell the whole story and must be supplemented with a historical understanding of the composer's unwritten assumptions about normal performance styles. To illustrate, he played recordings of an orchestral suite by Bach, conducted by Richter (moderate tempo, literal score reading, sterile, and joyless), Harnoncourt (an "authentic" performance with correctly off-beat dotted rhythms, but at a moderate tempo with little sense of forward motion, and shrilly recorded to boot), and Marriner (lacking in some of Harnoncourt's scholarly touches, but at twice the tempo, giving an excellent feeling of exuberant motion and speech-like phrasing).

On the subject of phrasing, David played and discussed three recordings of the minuet from Mozart's Symphony No. 40, performed by Britten (in which the rapid tempo and the emphatic phrasing make very clear the unusual structure of this minuet in three-bar groups), Marriner (who adopts a more normal tempo but still makes the three-bar phrases audible, if not overly dramatically so), and the Collegium Aureum (whose "original instruments" performance is so slow that the music seems to stop at the end of every phrase). As another illustration of the importance of musical phrasing, David played a harpsichord piece by Couperin, as performed by Puyana (in a tempo so rigid and unwavering that the music sounded chaotic, lacking in overall form) and by Curtis (whose retards and accelerations of tempo lent the piece a shape and flow which pull the listener along). Curtis' Vox recording is also technically excellent.

Next, David played recordings of Walton's "Facade" conducted by Walton (whose inaccurate matching of vocal and instrumental rhythms shows that composers' recordings aren't all they are cracked up to be) and Marriner (clear, precise, lively, articulate, and well recorded). These were followed by four versions of Mozart's overture to "The Marriage of Figaro," illustrating correct and inappropriate tempos (the score is marked "fast") plus good and bad balancing of

woodwinds with strings introduced by the record producers. David preferred the Colin Davis recording. but some members found the Klemperer or Szell versions more to their taste.

To close the meeting, David played the opening movement of Haydn's Symphony No. 22, an episode of sheer beauty, from an outstanding Philips recording conducted by Leppard. — Keith North, Peter Mitchell

Treasurer's Report: 1973-1974. At the end of the 1972-1973 fiscal year, the BAS had on hand about \$510. This year the figure is nearer to \$394. That sounds like less, but in this case, as in 1984, less is more.

That \$510 figure was artificially high since it included some funds allocated but not yet spent, as well as some dues from out-of-state members for the forthcoming year. Out-of-state memberships accounted for some \$265 back then, or about half the amount on hand. Also, last year's honoraria for officers had not come out of the account.

By contrast, this year *we* have no liens on the treasury; all honoraria have been paid, and there are no outstanding memberships. When all is said and done, the BAS is therefore about \$360 ahead of its cash position last year, giving us the cash cushion we need to continue publishing into the first quarter of the coming fiscal year. It means that no increase in dues is necessary for the foreseeable future, and that we can proceed with the upgrading of our printing. The upgraded Speaker is going to cost from \$145 to \$155 per month for a 20-page issue, with a production run of about 225 copies. Figures for both page count and production run may increase slightly in the coming year, and if they do, publications costs should rise pro rata.

The cost of publishing the Speaker must come out of membership dues. Obviously, we can't project new memberships as easily as renewals, but we can expect a five percent increase in membership based on our traditional growth rate, not counting out-of-state memberships that may be renewed for the first time this year. Local renewals already look good, and last year we had an 82 percent renewal rate—very good for any kind of publishing venture, and quite high for a group with a large number of transient members. Many who moved out of Boston asked that they be kept onboard as out-of-state members, and we have been happy to oblige them.

Renewals from out of state are also coming in at a high rate, and some of the forms contain complimentary comments about the content of the Speaker, for which all associated are grateful. More importantly, these comments, together with a high rate of return of the BAS questionnaire, hint that out-of-state renewals also will be high.

Since our breakeven point on projected publication costs is only about 150 memberships, we figure to be in excellent financial health for the 1974-1975 fiscal year, and so hope to bring you a little more than in the past for your \$12. (Note to out-of-state members: refreshment costs - do not come out of dues, but rather from on-the-spot contributions — ed.) — Jim Brinton

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A BAS Test Report

Scotch Classic and TDK Audua:

How the New Open Reel Tapes Compare

Alvin Foster

TDK and Scotch have just released what they consider to be the ultimate in open reel tape—but at a new ultimate price. Are they worth it?

To find out, I used a ReVox A77 Mk. II to measure the same performance characteristics that I reported on in my previous articles (see the January 1973 issue of the BAS Speaker and the October 9, 1973 Phoenix). At that time, in comparing seven high performance open-reel tapes available then, I concluded that Maxell UD35 supplied the best combination of performance and price. Decide the new winner for yourself.

DROPOUT

The first characteristic that I measured is dropout. Dropout occurs during playback and is defined in 3M's publication 101 Terms, as ". . . the instantaneous loss of a recorded signal due to imperfections in the tape ... Most commonly these imperfections are high spots on the tape surface which push the tape away from the magnetic head . . ." Since the dropouts are more easily heard at higher frequencies, the audible effect with music will often be an intermittent "dulling" of the sound for up to a second or two.

To test for dropout, I used a procedure similar to the one described by Julian Hirsch in Stereo Review (September 1971) on "Laboratory Tests of Cassette Tapes." The procedure requires that you record a 10-kHz tone at 7½ ips for three minutes and observe the playback on an AC-VTVM. The playback amplitude variation in decibels gives a rough guide to the dropout qualities of that particular tape. Table 1 gives the results of my findings using new reels of tape. Scotch Classic was best here, with Sony and TDK Audua coming in last.

Table 1. Dropout Characteristics of New Tape in dB

Maxell UD35-7	1.0
BASF LP-35LH	1.2
Sony SLH-180	4.0
TDK 1800-SD	1.2
Memorex 1800	1.2
Scotch 207	1.0
Scotch 203	3.0
Scotch Classic	0.5
TDK Audua	4.0

Dropout is particularly severe in the first and last few feet of most open reel tapes, due mainly to the mistreatment that these sections receive in normal loading and unloading of the tape. This is the reason why some manufacturers include a few feet of leader tape and why a tape recording perfectionist never records a signal on the first or last few feet of tape. Of the tapes included in these tests, only Scotch 203 and Memorex were without leader tape.

The type of reels supplied with a tape also affect the long-term resistance to dropout. Takeup reels that cover the tape with only one or two small holes for threading protect it because the larger plastic area inhibits pinching as the reel is handled. TDK, Maxell, Sony, and Scotch Classic, in that order, come with the best designed reels for minimal handling abuse and actually are easier to thread than the other Scotch and Memorex reels.

SENSITIVITY

Tape sensitivity is the amount of output for a given input. The tape sensitivity can be measured easily by recording a 1000-Hz tone at a fixed input level on each tape and afterward measuring the relative outputs on an AC-VTVM. A high output signal usually means a higher signal-to-noise ratio, i.e., less tape hiss. This is because the recorded signal is further above the tape's inherent hiss level. Table 2 gives the results. Scotch Classic wins here, while Scotch 203 ranks lowest in this test, just after the new TDK Audua.

Table 2. Output Level in dB Using 1000-Hz Tone

Maxell UD35-7	-1
BASF LP-35LH	-1
Sony SLH-180	0
TDK 1800-SD	0
Memorex 1800	-0.8
Scotch 207	-0.3
Scotch 203	-1.8
Scotch Classic	+1
TDK Audua	-1.2

FREQUENCY RESPONSE

Tape recorder frequency response is a measure of the recorder's sensitivity at selected frequencies. To perform this test, all tones were recorded at -20 VU at 7½ ips. The machine was adjusted initially for Maxell, the hottest of the previous tapes. The results are shown in Table 3. (Output below 1000 Hz did not vary with the tape being used.)

I was concerned here more with which tapes exhibit rising or falling levels at high frequencies than with the flatness of the response of the various tapes. A rising high frequency response could indicate a tape with a low hiss level after playback. As shown in the table, TDK Audua has the most desirable rising response, starting at +0.5 dB around 2500 Hz and increasing drastically from there. Reduced hiss level using Audua occurs because the tape machine's high frequency playback de-emphasis can be increased to flatten frequency response and concurrently to reduce the high-frequency hiss level of the tape.

At this point, I re-adjusted my deck's equalization for Scotch Classic to see how compatible the Classic series is with 207 and 203. The results given in Table 4 clearly point out that whereas the Classic's bias and equalization are different, the differences may be almost inaudible with the 203 settings. However, Classic is clearly incompatible with 207.

Table 3. Frequency Response in dB at -20 VU, 7½ IPS

Tape Recorder Adjusted for Maxell

Frequency, Hz	Maxell	TDK Audua	Scotch Classic	Scotch 203
1,000	0 (-1)*	0 (-1.2)*	0 (+1)*	0 (-1.8)*
2,500	0	+0.5	-0.5	0
5,000	0	+0.6	-1.5	-0.5
8,000	0	+1	-2	-1
10,000	0	+1.2	-2.5	-1.5
12,000	0	+1.3	-2.7	-2
15,000	-0.5	+1.6	-3.5	-3.5
16,000	-0.5	+1.4	-3.5	-3
18,000	-1	+1.2	-4.5	-3.2
20,000	-1.5	+1	-5	-4

Table 4. Frequency Response in dB at -20 VU, 7½ IPS

Tape Recorder Adjusted for Scotch Classic

Frequency, Hz	Scotch Classic	Scotch 203	Scotch 207
1,000	0	0	0
2,500	0	+0.2	-0.4
5,000	0	+0.5	-0.8
8,000	0	+1	-1
10,000	0	+1.1	-1.3
12,000	0	+1.2	-1.5
15,000	-0.5	+1	-2.5
16,000	-0.5	+0.2	-3
18,000	-1	-0.5	-5
20,000	-1.5	-1	-7

HIGH FREQUENCY SATURATION

A test that separates the men from the boys is a measure of a tape's retention of high frequencies recorded at 0 VU. All tapes experience high frequency saturation of varying degrees when recorded at levels above -20 VU. That is why tape recorder manufacturers recommend that all frequency response tests be run at -20 VU or below. But a frequency response test at that level doesn't represent the way a recorder is actually used when recording music. When recording, you will probably permit your VU meter to read slightly below 0 VU at average levels and above 0 VU on the peaks. And when saturation occurs on peaks, the recording can sound dull.

*Relative sensitivity from Table 2.

The test I designed to measure tape saturation at high frequencies was to record 10-kHz, 15-kHz, and 18-kHz tones at 0 VU. One kHz was used as the reference frequency. In the results listed in Table 5, a correction factor is included to compensate for the tape's response to the same frequencies at -20 VU; in other words, if Scotch 207 was down 2 dB at 10 kHz when recorded at -20 VU, 2 dB were added algebraically into the results for 0 VU record levels.

Table 5. Saturation Test at 0 VU in dB
Tape Recorder Adjusted for Maxell

	10 kHz	15 kHz	18 kHz
Maxell UD35-7	0	-1.5	-2.8
BASF LP-35LH	0	-1.0	-2.5
Sony SLH-180	-1	-1.7	-4.0
TDK 1800-SD	-1	-2.3	-4.7
Memorex 1800	-0.4	-1.2	-3.0
Scotch 207	-1.3	-2.0	-4.5
Scotch 203	-0.7	-1.5	-3.3
Scotch Classic	-1.0	-2.0	-4.0
TDK Audua	+1	0	-2.0

TDK Audua is again the clear winner of this test, while TDK SD and Scotch 207 are the losers. Audua's retention of high frequencies at 0 VU playback level indicates that the dulling experienced at high record levels may be less of a factor in selecting record levels with this tape.

COSTS AND CONCLUSIONS

The typical selling price in Boston for an 1,800-foot reel of the various tapes is:

Maxell UD35-7	\$5.75
Scotch 207	6.00
TDK Audua	7.50
Scotch Classic	9.90

Scotch Classic is a clear winner when it comes to glossy packaging. It is enclosed in a soft plastic and cardboard box which feels and looks luxurious. But for my taste it is over-packaged, which contributes to its abnormally high selling price. On top of this, the height of the new package does not permit the tape to fit into my tape shelves, an additional inconvenience, and the thickness of the box results in a further loss of space.

Which tape should you buy? As I concluded in my previous article, there is no clear winner. With TDK Audua you get a high end that will be more difficult to saturate, which translates into cleaner highs at higher recording levels. The benefits here will be particularly useful when recording live performances, especially of works employing many percussion instruments. But you also get far more dropouts, which will be readily audible at the slower tape speeds and which will drastically degrade the performance of Dolby and dbx noise reduction gear.

The Classic series offers increased output in the mid-range, where you need all the help you can get for low signal-to-noise ratios. It also offers virtually zero dropout, but at a price that is unbelievable! For my recording future, I think I will stick to Maxell unless a local hi-fi store starts to sell Classic at a more reasonable price.

A Vacuum System for Cleaning Records

Robert C. Borden

The need for cleaning records has been well established, but the means have lagged far behind the need. Special cloths and sprays have proven worse than useless. Watts' Preeners, Parastats, and Dust Bugs do a good but limited job. Various washing methods have been suggested, but I, at least, have never been able to adequately dry a record after washing, with the result that more dust accumulates while the record is playing wet or while drying in air. The best solution so far has been provided by Percy Wilson in the form of a disk washing machine that dries the record by vacuum, but at a cost of well over \$500.

The record vacuum-cleaning system described here is based on a similar device described by Kurt Wiley in "The Audio Amateur" (Issue 3, 1973), * which is in turn based on Wilson's commercial machine. The main difference between the homemade and commercial machines is that Wiley's and mine cost about \$70. Secondary differences include elegance (you can get a lot of elegance for \$500), speed, and size. Wilson's does the job in about 45 seconds; mine takes a bit less than 2 minutes. Wilson's and Wiley's are rather bulky monsters to have in the living room; the business end of mine fits nicely on a bookshelf right next to my turntable.

HOW IT WORKS

The system operation is quite simple. The record to be washed is placed on the turntable and a cleaning solution is sprayed on. The turntable is started and a Watts' Wash Brush is held manually against the record to distribute the solution and clean the grooves. An arm carrying a vacuum nozzle is manually positioned at the center of the record and is driven radially across the record surface to remove all traces of dust and moisture. (Cleaning is done from the label out to the edge of the record. It just seems to work better that way.) The record is then immediately placed on a turntable and played, using a Dust Bug to take care of dust accumulation during playing. Before applying the vacuum nozzle to the record, I use it to clean the Dust Bug, and while the vacuum is sweeping over the record (about 1 minute), I moisten the Dust Bug with distilled water and clean the stylus. The entire operation is fast enough that I clean each side of every record just before playing.

If this cleaning procedure is followed with new records, they will probably sound new for a great many playings. An older record may require several passes to get accumulated crud out of the grooves.

*Anyone seriously contemplating building one of these units should read Wiley's article. He suggests approaches to some problems that differ from mine; our different solutions are mainly the result of materials and facilities available to us. His solutions may better match your circumstances, or provide a clue to another approach.

One warning: no amount of cleaning is going to reduce noise due to vinyl defects, nor can cleaning do anything for grooves that are already damaged by dust.

COMPONENT SUBSYSTEMS

The record cleaner breaks down into four subsystems:

1. Washing solution, applicator, and brush
2. Turntable
3. Vacuum subsystem
4. Arm to carry vacuum nozzle across record.

These subsystems are discussed below. In each there is plenty of room for different approaches and imagination. The accompanying photographs show the overall system and details of various parts.

Washing Solution, Applicator, and Brush

The washing solution I use is a mixture of distilled water and Kodak Photo-Flo 200, a photographic wetting agent available in most camera stores for less than \$1.00. Use only a few drops of Photo-Flo, just enough to produce a hint of sudsing. Others have suggested a 50/50 mixture of distilled water and grain alcohol. This might be needed for deeply imbedded crud, but the simple water and detergent mixture seems to me to be safer and is certainly adequate for records that have been washed since new.

For an applicator, I use a plastic spray bottle available for about \$1.50 in the housewares department of any department store. (Wash it with distilled water before using.) These are usually adjustable from a mist to a stream spray. Adjust it near the transition point, slightly toward the stream side. Other possibilities that could be built into the system include model airplane fuel pumps and modified automobile windshield washer systems. I investigated the windshield washer idea but abandoned it as being too expensive (about \$12 for the washer plus a 12-volt power supply). But if elegance is your thing, this is probably the way to go.

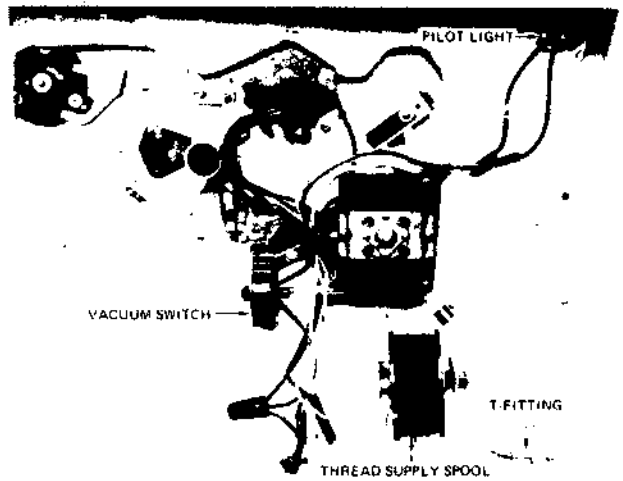
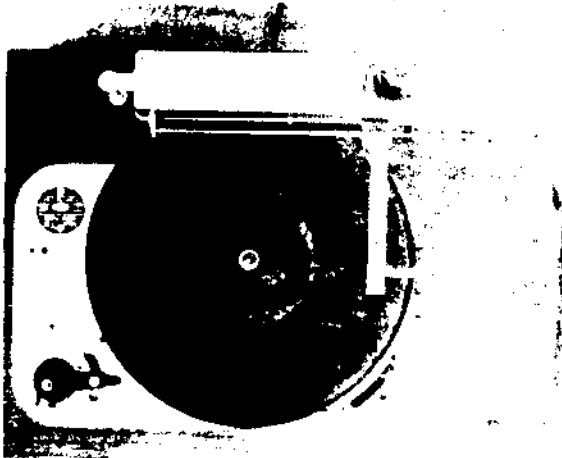
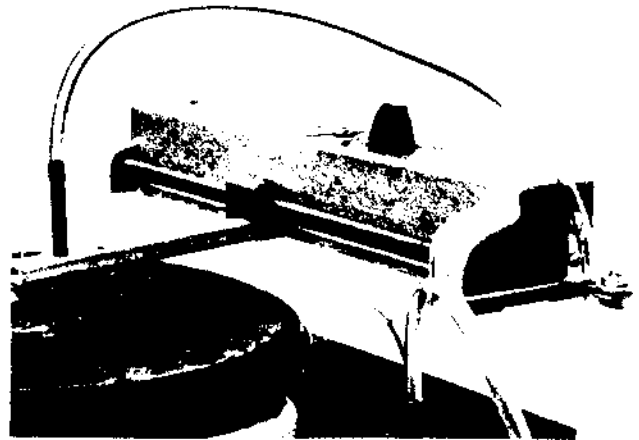
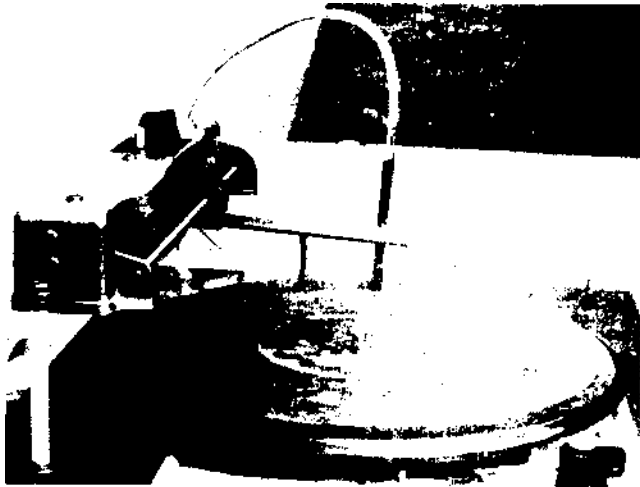
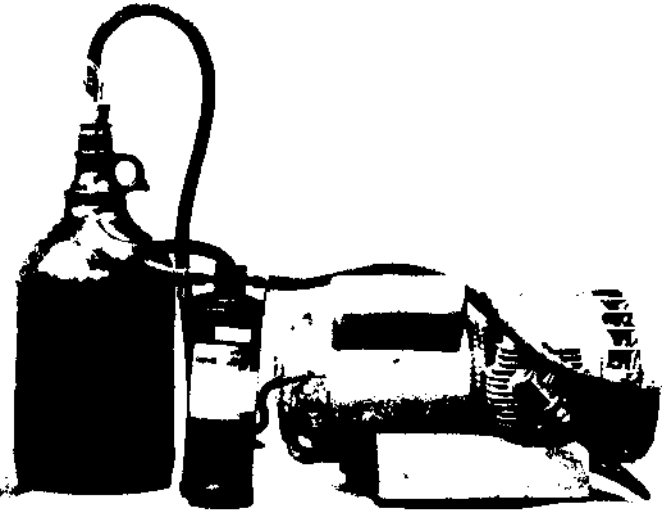
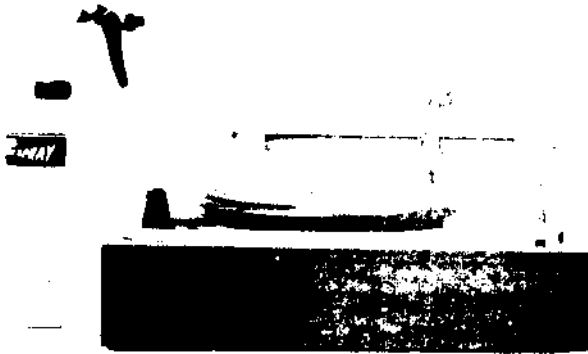
The brush is a Watts' Wash Brush or the brush from your Parastat (you're not going to need your Parastat anymore anyway). This brush is designed to reach into the record grooves and loosen dirt, thus eliminating any need for high pressure sprays for washing.

Turntable

Almost any old three-speed turntable or changer can be used, so long as the table rotates. The main consideration is motor torque; it must be high enough to overcome the drag of the Wash Brush and the vacuum. Thus AR turntables probably wouldn't work. I used an old (circa 1955) Garrard model T single play turntable.

Three speeds are preferred because different functions can be accomplished more effectively at different speeds. Washing, like Preening and Parastating, should be done as slowly as possible (33 or 45 rpm), while vacuuming should be done as rapidly as possible (78 rpm). (High speed vacuuming presents more record surface to the vacuum nozzle in a given time.) All but the most severely warped records can be vacuumed successfully at 78 rpm with my system, and if a record were so badly warped that it couldn't be vacuumed at that speed, I doubt that there would be much point in playing it.

Strip all hardware that doesn't contribute to the rotation of the table and mount the turntable rigidly to a mounting board. I used 3/8-inch plywood, with the table mounted well to the front to allow room to mount the vacuum arm.



A nice touch for a turntable with a four-pole motor would be a reversing switch so that the record could be washed in both directions. I haven't tried this, but I suspect it would be worth the effort if the motor windings are accessible.

Vacuum Subsystem

The vacuum subsystem is, of course, the heart of the record cleaner. According to Wilson, * a vacuum of 20 inches of mercury is needed to remove the water and dirt from a washed record. Household and shop-type vacuum cleaners, even those that are designed to pick up moisture, can't provide a vacuum anywhere near 20 inches of mercury. Refrigeration compressor pumps can provide adequate vacuum, but they may require messy oil recirculation devices (see Wiley, TAA). Commercial vacuum pumps generally cost \$100 and up, mostly up.

After much searching, I found the "perfect" pump (see Sources, below). It pulls a vacuum of 27 inches of mercury almost instantaneously, its output is completely oil-free, it is practically maintenance-free, and it costs only \$35. It had two problems, but these turned out to be blessings in disguise.

First, it was NOISY, so much so that there was no way this was going to be allowed in the living room! (100-dB SPL at 1 foot.) But the thought of running down to the cellar to clean records between sides was definitely not appealing. This led to the most important design decision of the project: the pump and its ancillary equipment would reside in the cellar and only the turntable and vacuum arm unit would be located in the living room.

Second, the pump's advertised 1/4-inch input fitting was missing. By extraordinary good luck, I found a 5/16-inch fitting that fit. This turned out to be a standard size for automobile air conditioner hoses and parts, which make up part of the system (3/8 and 1/2 inch are also standard air conditioner sizes and will work nicely).

In addition to the pump, the vacuum subsystem consists of a crud collecting bottle, an automobile air conditioner filter/dryer, and connecting hoses and fittings.

The combination of water, detergent, and dirt that is vacuumed off the records would quickly ruin the pump if it were allowed to reach it. Thus a means to protect the pump is required. The first stage in this protection chain (Fig. 1) is the collection bottle. This consists of a two-gallon glass bottle, a No. 5 rubber stopper, a 10-inch length of 3/16-inch outside diameter (o.d.) brass tubing, a three-inch length of 5/16-inch o.d. brass tubing, a small piece of nylon stocking, and a rubber band. The inlet tube extends further into the bottle than the outlet tube to reduce the chances of dust jumping from the inlet to the outlet. The nylon stocking filter is an additional precaution. Holes for the brass tubes are easily made in the rubber stopper by filing the ends of the tubes and twisting them slowly into the stopper.

A plastic collection bottle is ruled out because the vacuum would collapse it in a few seconds.

The rate of crud buildup in the bottle depends, of course, on how many records you vacuum and their condition. Weekly visual inspection is more than adequate for washing two or three records a day. I haven't had to empty mine yet after about three months of use.

The automotive air conditioner filter/dryer is the final insurance against any moisture getting to the pump. It may even be superfluous, but I don't want to run the tests to find out.

*Percy Wilson, Disc Pollution, How To Fight It, "The Audio Amateur," Winter 1970.

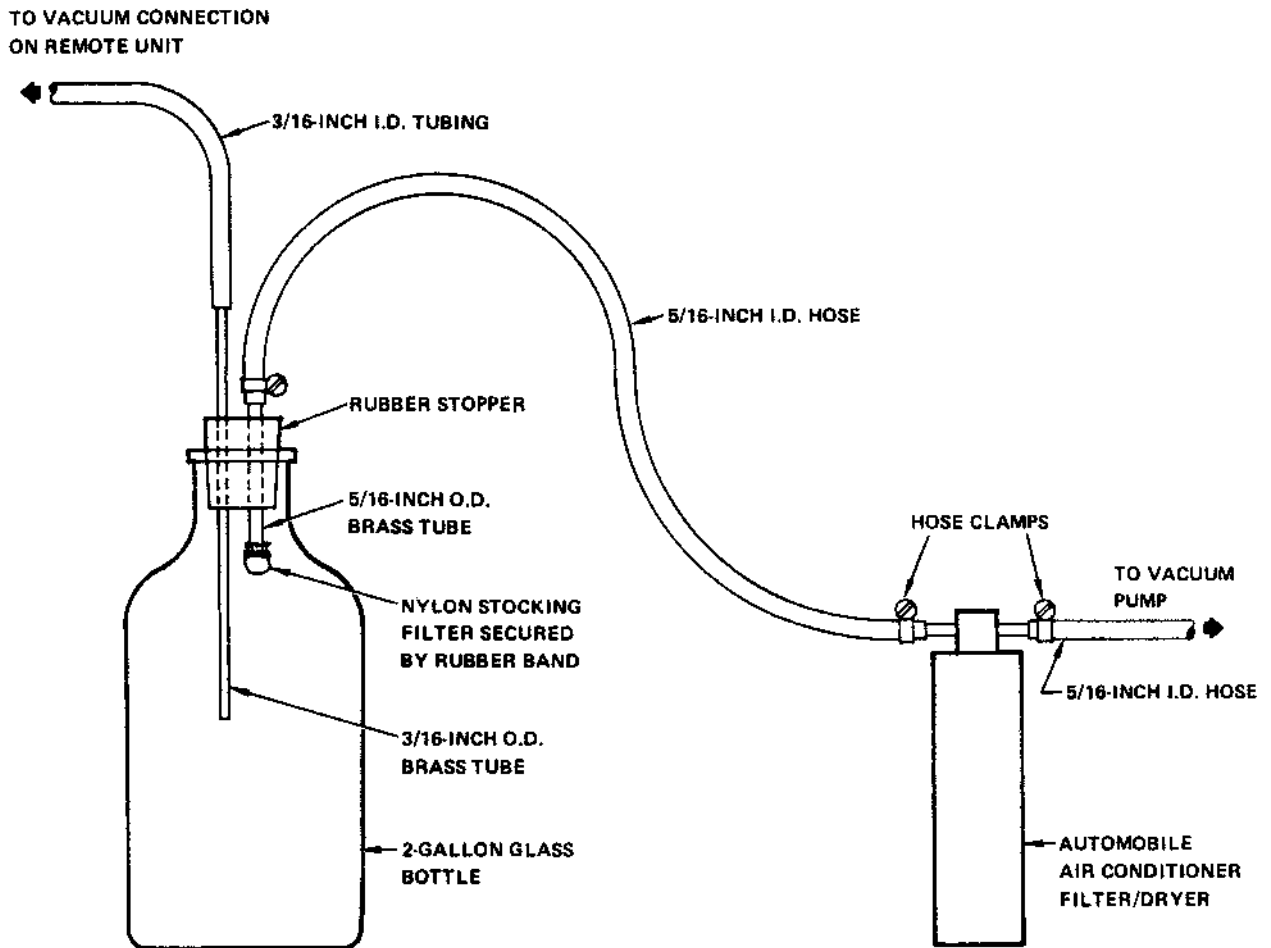


Fig. 1. Pump protection chain

The hoses from the pump to the filter/dryer and from the filter/dryer to the collection bottle are 5/16-inch inside diameter (i.d.) auto air conditioner hose. Rubber gas line or vacuum hose will do as well. Lengths are not critical, but hose clamps should be used at all connections to prevent air leaks. The hose from the bottle to the remote turntable unit is 3/16-inch i.d. tubing.

To monitor the vacuum at the turntable, I used a vacuum switch to activate a panel light. When the pump is turned on, the vacuum actuates the switch and turns on the light. You don't need an indicator to tell you that the pump is running. Even buried away in the cellar, you can hear it! But if a hose comes loose or a leak develops, the vacuum indicator won't come on. Details of the vacuum monitor are shown in Fig. 2. The T-fitting shown in the diagram also provides the connecting point for the tubing from the collector bottle.

Interestingly enough, after hanging on all the filters, collectors, 20 feet of tubing to the turntable, and the vacuum switch, the pump pulled 25 inches of mercury instantaneously and got up to 27 inches within 15 seconds. So don't be too concerned about long lengths of tubing to your remote unit. (An automotive vacuum gauge is a very handy device to have when setting up the vacuum system.)

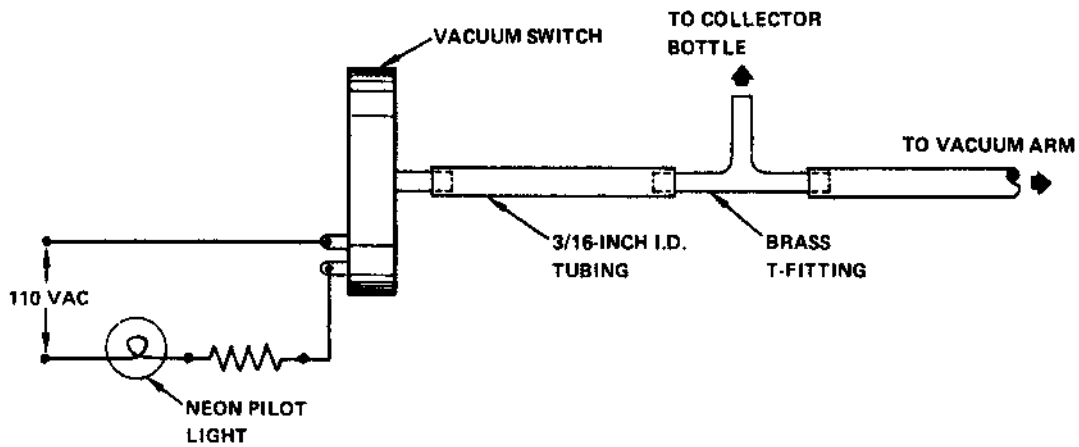


Fig. 2. Vacuum monitor

The pump is switched on and off by means of a relay located close to the pump to avoid running heavy wiring from the pump to the turntable. Lamp cord is adequate between the relay and the turntable. The cord plugs into a convenience outlet on the back of the turntable unit, which is controlled by a toggle switch on the turntable unit.

Vacuum Arm

The vacuum arm proved to be the most frustrating part of the system. This unit must drive a vacuum nozzle radially across the rotating record. Wiley used the original arm of the turntable driven through a clutch mechanism by a 4/15-rpm clock motor. I abandoned this approach for several reasons, mainly because a 4/15-rpm motor was not readily available and because Wiley's description of the clutch mechanism was something out of a nightmare. Besides, I was fascinated by the idea of using a lead screw mechanism to drive the arm. After getting a rough idea of what that would cost to make, I was ready to go back to FM. But then help arrived in the form of a Meshna Surplus Co. flyer that prominently featured a "Reading Pacer."

This most unlikely device was originally promoted by a book club to increase reading speed. It consists of a battery powered (two D cells) motor that drives a lead screw that carries a pacer down the page. Pacer speed is adjustable. When you turn one of these on, you find out why they are surplus; nobody could read with that racket. But for my record cleaner it seemed made to order, or at least after a few modifications it was.

First I cut the pacer arm to about 4 inches and reinforced it by gluing a piece of rigid rectangular plastic box beam to it. This plastic beam material is available at hobby shops under the tradename of Plastistruct.

Next I added an on/off switch next to the speed control. This really isn't necessary, as the speed control has an off position, but it allows me to leave the speed control at the correct setting (as slow as the lead screw can turn without stalling).

These reading pacers cost \$1.00 each or six for \$5.00. Buy at least two. The arm is held to the lead screw by a simple spring clip, a device that is less than adequate for this application. Using two of these clips greatly increases the arm's stability. Buying two pacers is admittedly an expensive way to get a second spring clip, but it is the easiest way. Also, the second unit provides a ready source of spare parts if they are ever needed.

The only other modification consisted of bolting right-angle brackets onto each end to mount the unit to the base. Mounting was accomplished as shown in Fig. 3. The lead screw should be about 1³/₄ inches above the turntable surface to provide clearance for records. The cosmetic white plastic tube shown covering the bolts is also made by Plastistruct.

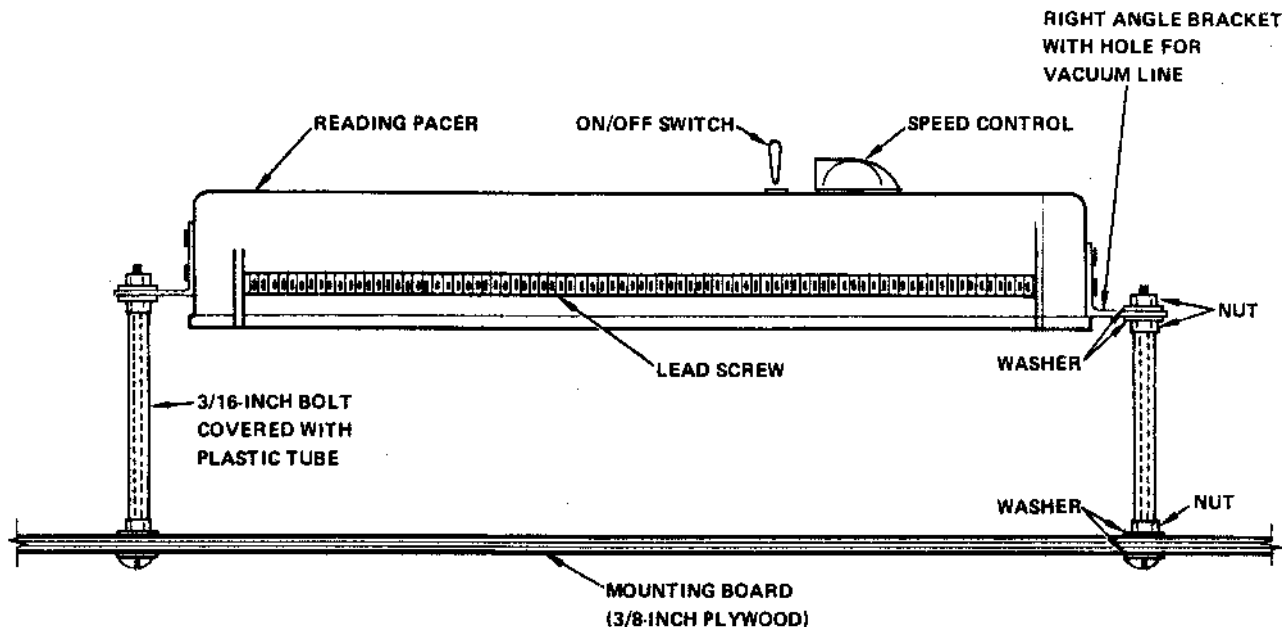


Fig. 3. Lead screw mounting

The unit has to be removed to change batteries. This is not difficult but it is a nuisance. Since only the top nuts have to be removed, no height readjustment is necessary. If you incorporate the windshield washer idea with a power supply, it might be worthwhile to include a 3-volt supply to drive the arm.

The actual vacuum nozzle (Fig. 4) is a piece of 3/16-inch o.d. rigid plastic tube about 2½ inches long. I used a piece of material that I had available, but the same material as used to cover the mounting bolts but in 3/16-inch o.d. should work, although it would be necessary to drill it out to 1/8 inch i.d. Taper the top of the tube to ease the attachment of the vacuum line, and round the bottom so as not to present any sharp edges to the record (see detail in Fig. 4).

The nozzle should be located so as to track along the centerline of the record with minimum arm overhang, and its length should be adjusted so that it stands perpendicular to the record (see Fig. 4). It is attached to the arm by force fitting through a hole drilled in the arm. This allows for height adjustment.

A critical adjustment here is the loop in the vacuum line. It is supported at the top of the vacuum nozzle and at the right hand end of the lead screw unit by passing it through a tight hole in the mounting bracket. This adequately supports the tube and allows for adjusting the length of the loop. Too short a loop will cause a forward pull on the arm; too long a loop will tend to push the arm back toward the center. Either condition can skew the arm enough to unhook it from the lead screw and send it skidding across the record. Considerable experimentation may be required. (Use only old records when testing your machine!)

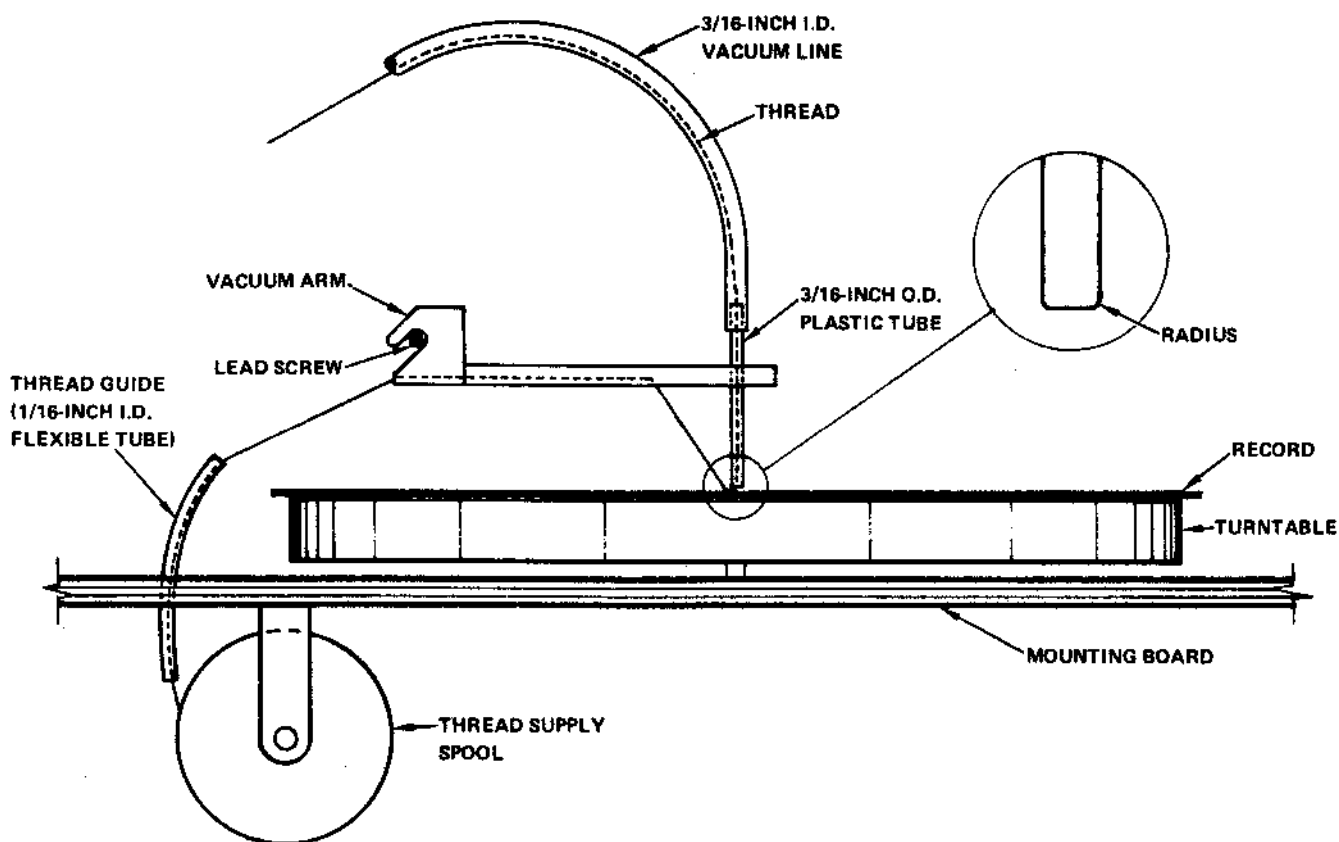


Fig. 4. Vacuum arm

The thread shown in Fig. 4 keeps the vacuum nozzle from attaching itself to the record and acts as a bearing for the moving nozzle. I use thin braided nylon fishing line. This is soft enough that it causes no damage to the vinyl record surface. (Cotton thread tends to flatten out.) The thread, fed from a spool under the mounting board, passes through a flexible tube guide (which keeps the thread from tangling with the edge of the record), through the hollow arm, out a hole in the bottom of the arm, up the nozzle, and into the vacuum line. The thread is advanced manually about 1/2 inch between cleanings to present a clean bearing surface. It was originally planned that the thread would be self-feeding, but there is just too much friction in the system. Since it is so easy to advance the thread by hand, it didn't seem worthwhile to pursue the self-feed feature.

Since the arm pivots freely in the vertical plane over a very large range and has sufficient mass to prevent bouncing, warped records are easily accommodated.

Before settling on the thread approach suggested by Wiley, I experimented with a guide rail that engaged the overhang of the arm to keep the nozzle from contacting the record. The guide rail introduced more problems than it solved. Its mounting position made it almost impossible to insert or remove a record without scratching it on the spindle. This was solved by making the rail removable during these steps. But the main problem was that the record had a disconcerting tendency to jump up and attach itself to the nozzle, causing a most hair-raising shriek as the nozzle was ground into the record.

MISCELLANEOUS

I made the base from 3/8-inch plywood covered with wood grain plastic laminate. Size will depend on the turntable you use, but mine measures about 16½ by 12½ by 3½ inches. Overall height of the unit is about 8 inches. I used plastic laminate because cleaning solution from the record sometimes splashes onto the top of the base. This can be minimized by care in applying solution and in washing, but it's nice to have a waterproof finish on the base.

I also use the vacuum cleaner to clean my playing turntable. The vacuum line is disconnected at a fitting on top of the turntable and replaced with a length of hose with a ball point pen barrel on the end to serve as a nozzle.

The vacuum pump can also be used as an air compressor with the addition of an air tank. The outlet side of the pump produces about 90 psi, which is adequate for a great many jobs requiring compressed air.

SOURCES

The vacuum pump is a Bell & Gossett unit available from John Meshna, 19 Allerton Street, P.O. Box 62, Lynn, Mass. 01904 (71S-27, \$35.00) and B&F Enterprises, 119 Foster Street, Peabody, Mass. 01960 (B&GPC, \$39.50). The pumps are identical from both sources. They are used, but the price is right (B&F indicates a new price of \$189.50, which seems about right for a pump like this). An early September phone call to Meshna indicated that he had about 40 in stock. The vacuum switch (35t) and the relay (\$1.50) are also available from Meshna and B&F.

Apartment dwellers or others who can't locate the pump remotely and who can't tolerate the noise should try to find a diaphragm-type pump or refrigerator compressor. Diaphragm pumps are used in the electrostatic copier industry and for servicing auto air conditioners, among other places.

The filter/dryer is available from J. C. Whitney, 1917-19 Archer Avenue, P.O. Box 8410, Chicago, Ill. 60680 (15-2540, \$5.39 plus shipping) or from an automotive parts store for about \$10.00.

The reading pacer lead screw is available from Meshna (72S-7, \$1.00 each or 6 for \$5.00) and B&F (RPM, \$1.25 each). If you have access to a machine shop, you could probably build a much better lead screw device. B&F have some interesting looking motors that could probably be used to drive such a unit. But it will surely cost more than \$1.00.

The 5/16-inch i.d. hose can be obtained from an automotive supply store. The 3/16-inch tubing and the T-fitting for the vacuum switch are available from pet shops that sell aquarium supplies. This aquarium tubing seems to be more flexible than model airplane fuel line and chemical laboratory tubing and is cheaper than either. Its flexibility makes it the best choice for the loop on the vacuum nozzle.

Brass tubing, plastic box beam, rigid plastic tubing, and 1/16-inch i.d. flexible tubing can be found in most hobby shops.

For those who would like to have a vacuum record cleaner, but who don't want the hassle of parts procurement and construction, I am willing to do same. The tentative price is \$195, or \$175 if you supply an old turntable or changer. A nonreturnable deposit of \$95 or \$75 and old turntable will be required with your order. Anyone interested can contact me at 276-3417 (Lexington) from 8 to 4:30 weekdays.

ACKNOWLEDGMENT

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