H.W. HELLYER ON TAPE RECORDERS

AUDIO

APRIL 1972 60c

The Authoritative Magazine About High Fidelity ® A

23602

BUYERS GUIDE TO OPEN-REEL TAPE RECORDERS

Tape Recorders—A View From The Crystal Ball

Refacing Tape Recorder Heads

Microphones—Quo Vadis?

Scott components always get good reviews!

Why?

It could be their performance.
The professional reviewers' findings may be best summarized by a respected test engineer who said, "In the nearly twenty years I've been evaluating audio components, Scott units have consistently met, and in many cases, substantially exceeded, their published specs." No one should be surprised at this. Hermon Scott and his colleagues planned it that way from the very beginning. Scott components are intentionally rated conservatively to provide a safety margin, so that, even with normal tolerances in piece parts and production techniques, every Scott product shipped will meet or exceed its published performance claims.

It could be their advanced design features.
When the present Scott line of audio components was first shown to dealers and the press, a reviewer from a non-audio-buff magazine commented, "My readers and I are more interested in what the equipment does than in how it does it. These Scott components seem to me to have all the controls and convenience features the serious listener needs." That, too, should be no surprise, for H. H. Scott is traditionally the first to use advanced design concepts in circuitry, function and appearance, but only where such advances contribute demonstrably to user convenience and satisfaction.

It could be their value for the price.
Reviewers have the edge on audiophiles, and even most dealers, because reviewers get the opportunity to critically evaluate virtually every product on the market, and compare it with everything else in its price class. After they've made a spec-for-spec and feature-for-feature comparison of everything available, they know which products represent the best value to the buyer. When a reviewer says of a Scott product, "This receiver offers an unexcelled value for the price," the audiophile can purchase the unit with the certain knowledge that he is getting his money's worth.

Professional audio equipment reviewers like H. H. Scott components for their performance, advanced design features and value for the price. But aren't these the very qualities you look for when you purchase an audio component or system? You'll find these qualities in every Scott tuner, amplifier, receiver and speaker system now on display at your Scott dealer's.

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H.H. Scott, Inc., 111 Powdermill Road, Maynard, Mass. 01754

Check No. 100 on Reader Service Card

TEAC AS-100 and AT-100 expand your system componentially

Just as we make definitive Dolby* equipment at TEAC, we make consummate components. They are designed to be the match of our professional-quality tape decks in every detail. So they must do more *qua* components than merely frequency-demodulate and amplify. And yet they must be sensibly priced so they don't make you ear-rich and pocket-poor. Add either or both to your system and the total improvement is infinitely more than a simple sum.

Take the AT-100 Stereo FM Tuner, for example. It's equipped with a new muting circuit to eliminate inter-station noise, and unique multiplex channel-separation circuitry for distortion-free reception, even in fringe areas.

Similarly, the AS-100 Integrated Stereo Amplifier combines the most desirable features and specs of a preamplifier/amplifier control center. Direct-coupled differential amplifiers inspired by computer and instrumentation systems. Electronic protective circuits on outputs to prevent damage from open or short circuit speaker conditions. Front panel tape deck input jacks, headphone jack and switch selection of two speaker pairs and tape/source monitoring. It's time to take a quantum leap with TEAC tape components.

For name of your local TEAC component specialist, write TEAC Corporation of America, 7733 Telegraph Road, Montebello, Calif. 90640.

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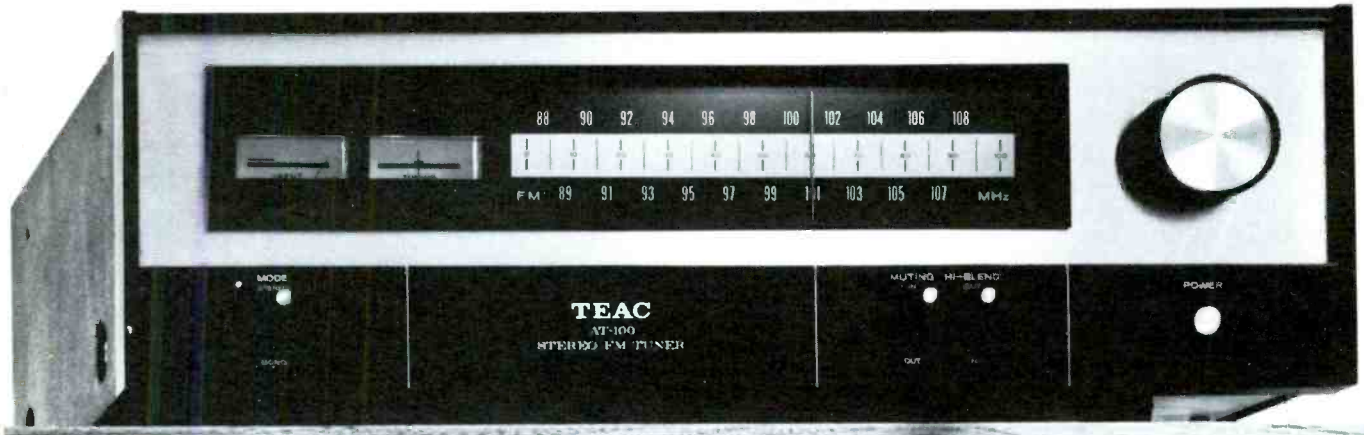

AT-100
FM Stereo Tuner
Sensitivity
2.0 μV (IHF)
Selectivity
Better than 65 dB
(± 400 KHz)
Harmonic Distortion
Below 0.5% (1,000 Hz,
100% modulation)

AS-100
Integrated
Stereo Amplifier
Rated Power
60 W (both channels
operated THD 0.2%,
8 ohms load)
Freq. Response
5-200,000 Hz +0 −2 dB
(power amp)
IM Distortion
Below 0.2% rated power

AUDIO

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FEATURE ARTICLES

BUYERS GUIDE TO OPEN-REEL TAPE RECORDERS

EQUIPMENT PROFILES

RECORD AND TAPE REVIEWS

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UNANIMOUS ACCLAIM!

First test reports on the Zero 100 by the industry's leading reviewers

Brief excerpts reprinted below. Let us send you the full reports.

HIGH FIDELITY *Sept. 1971*

Altogether, this new arm strikes us as an excellent piece of engineering; it probably is the best arm yet offered as an integral part of an automatic player. ☐ Operation is simple, quiet, and reliable. ☐ All told, we feel that Garrard has come up with a real winner in the Zero 100. Even without the tangent-tracking feature of the arm, this would be an excellent machine at a competitive price. With the novel (and effective) arm, the Zero 100 becomes a very desirable "superchanger" with, of course, manual options.

AUDIO *July, 1971*

The Zero-100 performed just about as we expected after reading the specifications. Wow measured .08 per cent — that is in the band from 0.5 to 6 Hz. Flutter, in the band from 6 to 250 Hz, measured .03 per cent, both of which are excellent. ☐ Thus, the Garrard Zero 100 is certainly the finest in a long line of automatic turntables which have been around for over 50 years. ☐ We think you will like it.

Stereo Review *July, 1971*

Indeed, everything worked smoothly, quietly, and just as it was meant to. If there were any "bugs" in the Zero 100, we didn't find them. ☐ Garrard's Zero 100, in basic performance, easily ranks with the finest automatic turntables on the market. Its novel arm — which really works as claimed — and its other unique design features suggest that a great deal of development time, plus sheer imagination, went into its creation. In our view, the results were well worth the effort.

The GRAMOPHONE *August, 1971*

Reproduction quality was excellent with no detectable wow, flutter or rumble under stringent listening conditions. End of side distortion, which is always a possibility with pivoted arms, was virtually absent, due no doubt to the tangential tracking arm.

Popular Electronics *August, 1971*

Our lab measurements essentially confirmed the claims made by Garrard for the Zero 100. We used a special protractor with an angular resolution of about 0.5°, and the observed tracking error was always less than this detectable amount. The tracking force calibration was accurate, within 0.1 gram over its full range. ☐ The Garrard Zero 100 operated smoothly and without any mechanical "bugs."

ROLLING STONE *Sept. 16, 1971*

This unit has every imaginable gadget and gewgaw one might possibly desire, and *it works*. And considering how much it does, and how well it does it, at 190 bucks it doesn't even seem expensive. The changer has so much in it that an analysis of its innards is almost a case study in record player design.

HI-FI STEREO GUIDE *Fall, 1971*

One could go on cataloguing the virtues of the Zero 100 indefinitely.

For 8-page test reports booklet and a 12-page brochure on the Zero 100 and the entire Garrard series mail to British Industries Company, Dept. D-12, Westbury, N.Y. 11590.

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A genuine step upward in automatic turntables

GARRARD ZERO 100

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coming in May

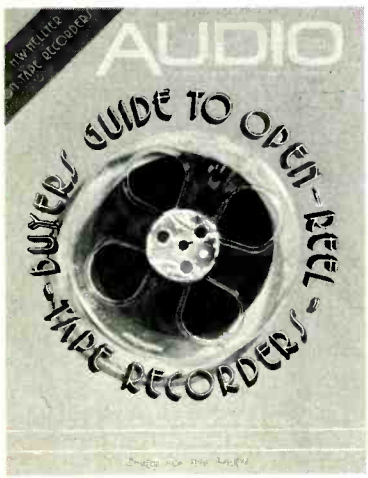
* **The "open aire" principle in headphone design**—F. Warning
* **London Letter**—Don Aldous

Equipment Reviews Include:
***Miracord 50H II Record Changer**
***Heathkit Digital FM Tuner**

* **Men of Hi-Fi**—Gerry Orbach, Tom Lott, and Harry Maynard discuss four-channel systems.

Late Flash!

Due to tremendous interest, the Midwest Acoustic Conference will be held in a larger hall—at the National College of Education, Evanston, Illinois. The date remains unchanged, April 15th.



About The Cover: The demise of open-reel tape recorders has been predicted many times—but they are still very much alive as our Directory shows. This brings to mind Mark Twain's comment on reading his obituary. "The reports of my death are greatly exaggerated. . . ."

Audioclinic

Joseph Giovanelli

Hum in a Turntable

Q. I am having trouble with an excess of hum in my turntable. I am certain that the hum comes from the turntable because it is present only when the turntable motor is on, vanishing when the motor is off. The hum is not present when playing tapes or listening to the tuner.

I checked the ground on my turntable. The hum is about the same whether the ground is connected or not. I tried grounding the amplifier to things in the room, like the radiator, the a.c. outlet box, etc. This did not help either.

The position of the cartridge relative to the record does influence the hum. The further in the cartridge is moved toward the center of the record, the louder the hum becomes.

Any advice you can give me would be appreciated.—Harry Hastings, Pullman, Wash.

A. The fact that the amount of hum varies with the position of the tonearm indicates that the problem is the result of induction from the windings of the motor into the pickup. Either the shielding of the pickup is defective or the shielding in your particular model is insufficient when used with your turntable. If you can obtain some magnetic shielding material, wrap it around the cartridge, leaving room for the stylus and to be sure that the shielding material does not come into contact with the record. I have done this. It did help to some extent. It did not eliminate the problem entirely, however.

I would say that you need to try another cartridge, with the understanding that, if the hum does not cease, you can return the cartridge to your dealer and try a different one. I believe there is no other solution to your problem.

Insufficient Loudspeaker Output

Q. I recently purchased two rather inexpensive outdoor speakers for use in my music system. They are identified as Wald Sound T-3 Tune Toater.

I am using them in conjunction with a Fisher 500TX stereo Receiver. The speakers are located approximately 40 to 50 feet from the amplifier. They are equipped with self-contained volume controls.

My problem is that the volume I get from these speakers is virtually nothing compared to the volume I get from the indoor speakers at the same amplifier volume control setting. Can you shed some light on what my problem might be?—Thomas A. Mantini, Havertown, Pa.

A. As I have no data about your outdoor speakers, I cannot discuss them with certain knowledge. If you have literature which was supplied with them, check it to see if perhaps their impedance is something like 500 ohms or perhaps designated as "70 volts." If this is true, you must remove the matching transformers which are inside the speakers. Further, you must then hope that the basic impedance of the speakers is at least 8 ohms so that they will not load down the amplifier when used in conjunction with the main speakers in your listening room.

Assuming that the speakers are of the correct impedance, I suggest that you use No. 16 gauge zip cord as the interconnecting cable between them and your amplifier. That will keep down losses to an absolute minimum. You indicated that you have a distance of 40 to 50 feet between amplifier and speakers. Sometimes this distance is longer as regards the amount of interconnecting line required. You know what happens. The line must go around moldings and follow baseboards. That can add quite a few feet. Therefore, if it happens that you have 50 to 60 feet of actual interconnecting line, use No. 14 gauge zip cord.

You should check to see whether there are other terminals on the rear of the speaker. Some speakers provide for various arrangements of jumpers which must be connected or disconnected depending on whether you are going to use internal volume controls, etc.

I am not sure just how loud your outdoor speakers do play. More volume will be required when speakers are located outdoors than would be true when they are located indoors. Furthermore, if these speakers are inefficient, and if the indoor speakers are efficient, the indoor speakers will definitely sound louder than the outdoor speakers, even when nothing is wrong with them.

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

Introducing four completely new stereo receivers with more of everything.

Sooner or later other stereo receivers will strive for the total combination of power, performance, features, precision and versatility incorporated into Pioneer's totally new SX-828, SX-727, SX-626 and SX-525. Why wait? Pioneer has more of everything now.

Each of these exceptional receivers delivers the most watts of power for the money. You can prove it by making your own comparisons. SX-828, 270 watts IHF; SX-727, 195 watts IHF; SX-626, 110 watts IHF; SX-525, 72 watts IHF. The use of direct-coupled amplifiers and twin power supplies in the top two models further enhance performance and responses, while minimizing distortion.

The crowded FM local and weak stations offer no challenge to this new and advanced FET and IC circuitry. Every station sounds as though it's just around the corner. Further, your speakers are protected against damage and DC leakage (a cause of distortion) by the ingeniously new and exclusive Pioneer electronic trigger relay system designed for the SX-828 and SX-727.

The highest degree of versatility is achieved with a wide range of features, including FM muting, loudness contour, mode lights, click-stop tone controls, tuning meters, ultra wide FM dial, plus a full complement of connections for turntables, tape decks, headphones, microphones, speakers—and even 4-channel, when you're ready.

Ask your Pioneer dealer to demonstrate each of these new models. Regardless which new Pioneer receiver you finally select, you're assured it represents the finest at its price. SX-828 — $429.95; SX-727 — $349.95; SX-626 — $279.95; SX-525 — $239.95. Prices include walnut cabinets.

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Tape Guide

Herman Burstein

Trouble with S-O-S

Q. I have discovered, at my expense, that the well-advertised features of sound-on-sound and sound-with-sound are impossible to achieve. Because of the physical distance between the record and playback heads, there will always be approximately a one second delay between the two signals being recorded. Therefore the signals cannot be synchronized. Does this difficulty exist in all moderately priced decks? If so, can synchronization of several musical parts be accomplished with a mixer and two tape decks?—Herbert N. Foerstel, Philadelphia, Pa.

A. So far as sound-with-sound is concerned, where signal 1 is recorded on track A, while signal 2 is recorded on track B, you are correct in that there is a distinct problem of synchronization when separate record and playback heads are used. However, in the case of sound-on-sound, signals 1 and 2 are both recorded on the same track, and there should be no problem in achieving synchronization with a tape machine that has separate heads and proper sound-on-sound facilities. Such a machine permits you to listen (through earphones or speakers) to signal 1 at the very instant it is being played on track A and recorded on track B. Simultaneously, through the mixing facility of the machine, you can also record signal 2 on track B. The displacement between the record and playback heads is of no consequence. Yes, if you wish, you can achieve sound-on-sound synchronization by using two tape decks and a mixer. This would enable you to produce stereo sound-on-sound.

$ For Tapes $

Many readers must have tapes which they are particularly proud of. AUDIO will pay $50.00 for the best tape of the month—cassette or reel-to-reel. They will be judged on technical excellence and content. Selected tapes can be processed and marketed—if the owner wishes. Who knows, that old tape may make you a fortune! Please mark your entries TAPE COMP. and send them to AUDIO, 134 No. 13th St., Philadelphia, Pa. 19107.

Four-Channel Conversion

Q. I have a Revox A77 tape deck which I would like to modify so as to be able to play four-channel stereo tapes, such as the Vanguard Surround Stereo series. I plan to replace the present playback head with a four-track one from Nortronics and add two Revox playback amplifier circuit boards. Is this modification feasible? Will the conventional record/playback facilities and/or qualities be affected?—Dennis J. Penner, Pinawa, Manitoba, Can.

A. I think that this modification is feasible, assuming that the Nortronics head is specifically designed for mounting on your transport. You will of course have to align the head carefully with respect to azimuth and vertical height. Keep the cables from the head to the new playback amplifiers as short as possible and of low capacitance per foot in order to minimize treble loss. Assuming that the Nortronics replacement head is of a quality comparable with the original, I don't see why the record/playback facilities in your machine should be adversely affected.

Speed Changing and Fade Outs

Q. Apart from spending $400 on a commercial product, how is one to vary the speed of a tape machine, with about 15% range of adjustment or even more. Some of the tapes I wish to copy are as much as a minor third off.

Is there a practical way of arranging things so that, on a previously recorded tape, a fade erase can be made after recording?—Matthew Notkins, New York, N.Y.

A. To vary the tape speed you might construct a power supply with variable frequency. Such supplies have been described in the audio literature, and a little research on your part should turn up something suitable to your needs.

To accomplish fade erase, you might try installing a variable resistance or variable capacitance between the audio oscillator and the erase head.

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

Nobody ever made a great cassette deck by adding Dolby to an ordinary one.

One way to improve a cassette deck is by adding Dolby. A better way is to make a cassette deck that doesn't need much help to begin with.

Take the Harman-Kardon CAD5.

Like all Dolbyized cassette decks, ours eliminates tape hiss.

But that's only one of the reasons you should buy it.

The CAD5 was designed to give you recordings that are as good as the original program material. Wow and flutter is an extremely low 0.15%. And frequency response is an extremely wide 30 to 12,500 Hz with standard tape. (30 to 15,000 Hz with chromium dioxide tape.) So you not only hear more music, but more overtones, and, therefore, more of the music.

Of course, there are times when you can't use Dolby. (When you play non-Dolbyized, pre-recorded tapes, for example.) But even with the noise suppressor switched off, the CAD5 has very little noise to suppress. The signal-to-noise ratio without Dolby is 45 dB.

With Dolby, the signal-to-noise ratio is 55 dB. Which means noise is suppressed virtually to the point of non-existence.

Finally, the outside of the CAD5 is just as sophisticated as the inside. It comes with two VU meters, an overload indicator, automatic shut-off and two sliding record-level potentiometers.

In all, the only thing the CAD5 doesn't have in common with higher-priced decks is their higher prices.

As Popular Electronics pointed out, the CAD5 is "a lot of recorder for $229.95." Which isn't quite correct. The CAD5 now costs only $199.95.

That's perhaps the one CAD5 feature that isn't very advanced.

For more information, write us: Harman-Kardon, 55 Ames Court, Plainview, N.Y. 11803.

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The Music Company

CAD5 with Dolby

Check No. 7 on Reader Service Card

What's New in Audio

Burwen wideband gain controller

The GC101 is a two-quadrant transconductance multiplier, divider, squarer, square rooter, and gain controller. It is said to control gain over a 60 dB range with 1.0% or 0.1 dB accuracy, with extremely low distortion, low noise, and wide frequency response. Price: $250.00.

Check No. 80 on Reader Service Card

Mura QP-300 headphones

This four-channel headset incorporates eight speakers—two woofers and two tweeters for each ear! The size is small, no larger than a top-line stereo headphone. Featured are a simulated leather adjustable headband and oversize foam-filled ear cushions for comfort. The jacks are labeled for easy identification. A felt-lined, zippered carrying case is supplied. Price: $49.95.

Check No. 81 on Reader Service Card

Nortronics tape accessories

This comprehensive line of professional quality tape recording accessories includes liquid head cleaner, and life extender for cassette and 8-track cartridge, wand head demagnitizer, bulk demagnetizer, cassette demagnetizer, splicer for ¼-in. tapes and cassettes, alignment tapes for cassettes and reel to reel, and other products.

Check No. 82 on Reader Service Card

New Literature

Heathkit offers its 1972 catalog, which contains more than 350 do-it-yourself electronic projects. Included are color TV with built-in service equipment, electronic organs, ham radio gear. Highlight of the catalog is Heath's AR-1500 AM/FM receiver, which was reviewed by AUDIO in January, 1972.

Check No. 83 on Reader Service Card

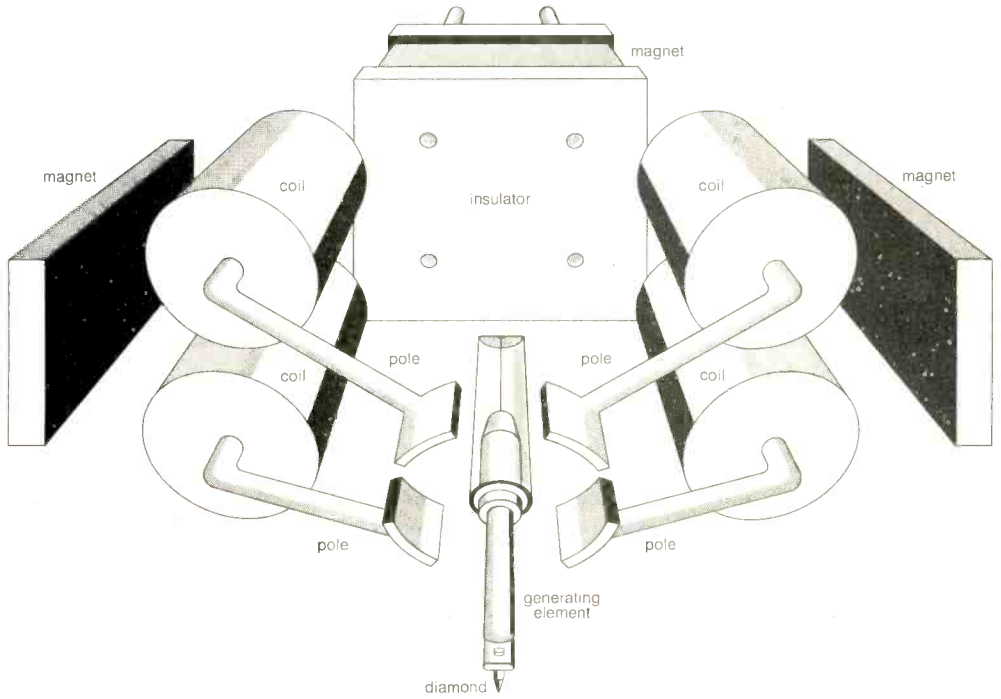
Heath AJ-1510 digital tuner

This FM stereo tuner kit features keyboard tuning, with the user pressing 3 or 4 buttons corresponding to the station frequency desired. Two other tuning methods are also incorporated, sweep/scan and card memory. The sweep/scan mode will tune in all stations, stereo only stations, or stereo stations with minimum signal quality selected through adjustable noise and automatic gain controls. Card memory tuning has inputs for three cards, one of which is chosen by pressing a button. The cards need not be removed to use other tuning modes, and new cards can be made from blanks supplied. Computer-type circuitry includes phase-lock loop

multiplex demodulator, varactor front-end, and pulse-counting, averaging frequency discriminator. The front panel meter is switchable between signal strength and multipath indication. Using the built-in meter and signal lights, the builder aligns the tuner in three no-instrument adjustments, peaking the sweep, sensitivity, and separation. Price: $539.95, optional pecan wood cabinet, $24.95.

Check No. 84 on Reader Service Card

All cartridges are different. Empire cartridges are more different than others! Take a technical look for yourself.



How it works.

If you know how moving magnetic cartridges are made, you can see right away how different an Empire variable reluctance cartridge is. With others, a magnet is attached directly to the stylus, so that all the extra weight rests on your record. With Empire's construction (unique of its type), the stylus floats free of its three magnets. So naturally, it imposes much less weight on the record surface.

Less record wear.

Empire's light-weight tracking ability means less wear on the stylus, and less wear on your records. Laboratory measurements show that an Empire cartridge can give as much as 50 times the number of plays you'd get from an ordinary cartridge without any measurable record wear! HI-FI SOUND MAGAZINE summed it up very well by calling the Empire cartridge "a real hi-fi masterpiece . . . A remarkable cartridge unlikely to wear out discs any more rapidly than a feather held lightly against the spinning groove."

Superb performance.

The light-weight Empire cartridge picks up the sound from the record groove with amazing accuracy. Distortion is minimal. (None at all could be measured at normal sound levels with Empire's 1000ZE/X and 999VE/X.) AUDIO MAGAZINE said of the Empire cartridge "outstanding square waves . . . tops in separation." HIGH FIDELITY noted ". . . the sound is superb. The performance data is among the very best." While STEREO REVIEW, who tested 13 different cartridges, rated the Empire tops of all in light-weight tracking.

X Designates newest improved version.

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empire

HIGH FIDELITY

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Behind The Scenes

Bert Whyte

AS I AM SURE you have noted, in this issue of AUDIO, the emphasis is on open reel magnetic recording. Thus it is an appropriate time to ask how fares this granddaddy of all magnetic tape formats?

In spite of all the doomsayers and carping critics who have been trying to bury open reel for the past few years, this medium is alive and well and is in fact flourishing. Does this run contrary to what you have been told? The key is in recognizing the distinction between the market for open reel tape recorders and that for open reel pre-recorded tapes. Almost without exception, the manufacturers of open reel tape machines have been enjoying excellent sales and growth. This is particularly true with tape decks in the higher priced category—from $300.00 upwards. It would appear that the market for low end open reel decks is virtually dead, with the better quality cassette decks filling this void. Nonetheless, even with the low end decks out of the picture, the *dollar volume* of open reel machines has been rising. The sales of open reel tapes has been slowly declining over the past few years, but not for the reasons usually cited, such as handling problems and high cost. I'll go into that a bit later. There has been a tendency on the part of some people to lump the open reel decks and open reel tapes together as a single market entity, thus giving rise to the stories of the imminent demise of this format.

As even a casual look at the open reel tape deck market will show, there is plenty of activity. Hardly a month goes by without the announcement of a new model tape deck or of related accessories. Nor is this activity confined to the old line established open reel manufacturers. Look who is in this market now . . . Sansui, Kenwood, Pioneer, Panasonic—all big receiver manufacturers and all with one or more models of open reel tape decks. In truth, the entire open reel market is in a state of flux (pun intended). Everywhere you look there is revision, refinement, innovation, evolution. Revox has new models with built-in Dolby B type noise reduction circuitry. Teac has their own accessory Dolby B boxes to go with their new SL tape decks. Akai and Tandberg have updated their crossfield head models. Easy accessibility and adjustment of bias for the burgeoning array of low noise tapes is becoming commonplace. Ferrite and ferrite/glass heads are being used on a number of new decks. And as for four-channel open reel decks, the variety of models is quite astonishing. Sony has come up with a four-channel record/play model for $299.95. Wollensak has a deck with two-channel record/play and four-channel playback. Crown has the same arrangement in one of their models and uses up to 10½ in. reels. In spite of the disastrous fire at the Crown factory last Thanksgiving Day, they will soon be back in production on their big "built like a battleship," 10½ in. four-channel record/play decks. Kenwood has a four-channel record/play deck with a very handy front/rear headphone switch. If you do any live four-channel stereo recording, you will find that monitoring is a sticky problem and this headphone switch is in real help. Astrocom will soon be producing their Model 711, a 10½ in. four-channel stereo record/playback deck with individual synchronous recording facilities on all channels. By the time the Consumer Electronics Show in Chicago rolls around, sometime in June, there will be very few open reel tape deck manufacturers without a four-channel stereo deck in their line.

Those critics who look with jaundiced eye at the discrete four-channel open reel format are vociferous in their objections to the continuing proliferation of four-channel decks when there are so few prerecorded four-channel tapes to play on these decks. You know, these characters have always been around since the beginning of the hi-fi era, and they never change. When stereo arrived about 1954 (via tape of course) they were moaning about the dearth of tapes, that stereo was a "rich man's game," that they were going to "stick to monophonic," etc., ad nauseam. They give me a pain. What the hell did they expect . . . that a comprehensive catalog of stereo tapes was just going to "spring into being"?

Fortunately, a recent development will still the voices of these fulminating critics or at least bring them down to sotto voce. I told you last month about the impending release of four-channel open reel tapes from Project Three and Vanguard Records, and I am happy to confirm this. I recently spent a pleasant afternoon with Enoch Light, discussing the entire four-channel stereo situation. Mr. Light told me he had done very well with four-channel stereo tapes in 1971 and was thus encouraged to issue nine new open reel tapes. Incidentally, the same material will be released on discrete four-channel stereo cartridges and on Sansui and EV matrix discs. Mr. Light intimated that henceforth four-channel open reel tapes would be issued on a regular basis. Mr. Light's Project Three catalog of four-channel open reel tapes now lists 18 productions. Vanguard will release new open reel four-channel tapes including pop material by Joan Baez and others and for the classical enthusiast such items as Handel's "Messiah" and oratorio, "Judas Maccabeaus." Then there is the Tchaikovsky 4th Symphony with Leopold Stokowski conducting his American Symphony Orchestra, the Cherubini "Requiem Mass," and several other works as yet unknown to me. To top it all, these new Vanguard four-channel stereo tapes will be issued with Dolby "B" type noise reduction in front and rear channels! This presents an opportunity for someone like Advent or Teac to come up with an inexpensive playback only Dolby "B" box for the rear channels. The anticipated introduction of the Signetics Dolby "B" IC chip should make such a unit a reality before long.

I should also mention a discrete four-channel open reel tape issued by Dick Shory's Ovation Records. Actually it is a two reel release of mostly pop "surround" music. It is very well done, with intelligent use of the four-channel medium and it has been processed with care for an overall excellent sound quality. Presumably Mr. Shory will be issuing new material, in view of the Project Three/Vanguard releases. Now, with close to 40 four-channel open reel tapes available, the purchase of a four-channel open reel tape deck will be more attractive and practical.

As I mentioned earlier, most people seem to think that the reason for declining sales of open reel tapes is the handling/threading problem and the higher costs of the tapes. While admitting the threading is a problem for some people, let me say, with malice aforethought, that if you gave these people the tape for free, you would be surprised how fast they would learn to thread tape! OK, so obviously no one is going to give tapes away, but in the larger cities where tape is discounted with the same fine fervor as discs, the same piece of music on tape or disc has almost reached price parity. What really has been the trouble with open reel tape sales is sheer availability of the tapes in the record stores and department stores throughout the country. As I pointed out last month, Ampex decided to try and remedy this with a mail order service and the response was

From Rock to Bach in 0.25 Seconds

Sony can't stop those little family arguments. But we can make them more worth winning. And a flip of Sony's unique, knob-and-lever dual selector switch gets the winner into the music of his choice just a little quicker than an ordinary, single-knob selector. Because until your fingertips unleash the STR-6065 receiver's performance, it might as well not be there.

So we didn't just engineer our circuits and our switches. We human-engineered them. For instance, in normal FM-stereo operation, all the 6065's levers make a neat row, and all its knob indexes point straight up; any control that's out of place shows up immediately.

You, who have no doubt adjusted to the crotchets of your current equipment (and perhaps even love them), may not think this much. Julian Hirsch, who must re-adjust to every new component that he tests, commended it: "Most receivers and amplifiers are surprisingly deficient in ease of use. Sony is to be congratulated."

With performance this accessible, the 6065 had better perform. And it does: 2.2 uV IHF sensitivity ("1.9 uV," says Julian Hirsh) gets you the weak FM signals; an FET front end prevents overload from strong ones. And our high selectivity makes tuning easier. If you find those stations easier to listen to, you might also credit our direct-coupled amplifier circuitry. It's supplied with both positive *and* negative voltages (not just positive and ground), so we don't have to put a coupling capacitor between the speakers and the amplifier. And, so that we can maintain full power (255 watts IHF, 160 watts RMS into 4 ohms; 220 watts IHF, 140 watts RMS at 8 ohms) or all the way down to 20 Hz at 50 watts RMS per channel.

Which brings up another way we made the 6065's performance more accessible to you: the price. And if its moderate price isn't accessible enough, we also make a lower-priced model, the 6055. Its power is a little less (145 watts rather than 255 watts) as is its rated sensitivity (2.6 uV instead of 2.2). But its otherwise almost identical.

So perhaps we can solve those family squabbles after all: a 6065 for yourself, and a 6055 for your son.

Sony Corp. of America, 47-47 Van Dam St., Long Island City, N.Y.

SONY® 6065 / 6055

Check No. 11 on Reader Service Card

LIRPA

Professor I. Lirpa, of Bucharest, inventor of the Transpet, has sent us details of his quadraphonic matrix. The article may have suffered somewhat in translation as our Romanian is nothing to boast about—but here it is.

"Four-channel sound is not cheap as more amplifiers are required and then there is the decoder itself which uses expensive ICs. Also, these ICs can cause some phase-distortion. My idea (patents pending, RPO) uses just two loudspeakers mounted back to back (see Fig. 1) in the enclosure with a divider between. This divider, with two sections mounted at right-angles in front of the speaker cones, forms an acoustical matrix. It is made from wickerwork and the twig spacings are most critical. Two small results in poor location and too large causes reduced separation. The formula is:

$$S = \frac{A + N}{A - 10} V$$

Where S is the spacing in cm,
A is the cone area in cm^2,
N is the capacity of the box in liters, and
V is the velocity of sound in meters/sec.

Density of the material should be between 0.5 and 0.6 and the *Cthula* (Young's?) modulus not less than 1.3. The resulting algebraic coefficients at 25 degrees C. are:

$L_f = a + 0.31b + c - 0.54d$
$R_f = 0.561a - 0.131b + 1.81c - 0.671d$
$L_r = 1.31a + 0.1b + 0.54c - d$
$R_r = -1.3a + 0.97b - 0.67c + 0.817d$

The material for lab tests came from a Chinese basket used for another research project. The speaker system should be placed as near to the center of the room as possible and it could be used as a coffee table."

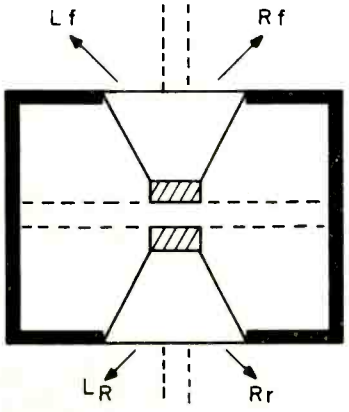


Fig. 1—Diagram of Lirpa quadraphonic speaker.

so astonishing that the project was immediately elevated from an experiment to a permanent service. The other reason that open reel sales were declining was that no one had done anything about the tape hiss that was the only flaw in otherwise fine recordings. I covered this last month too, and I don't want to beat a dead horse, but if repeating can help make it happen, I'll babble on all day . . . process open reel tapes with "B" Dolby and open reel sales will be the success story of the year. 'Nuff said.

* * *

All right, so the open reel tape deck market is in a healthy state. And you want to keep your open reel deck in a healthy state too! In previous issues I have gone over the importance of demagnetization, the inadequacies of most consumer type degaussers, and the special qualities of the R. B. Annis Handimag unit. I duly mentioned the importance of frequent cleaning of the heads and tape path. Well friends, I had an experience recently that calls for another look at the cleaning process. I was making some tape dubs for a friend, playing back a 15 ips two-track Dolby A type master and feeding the output of the Dolby 361 units into a Dolby B box and thence into the dubbing recorder. After setting the correct Dolby B playback levels on the meters of the B box, I was feeding the Dolby tone into the recorder to set the record levels on the blank tape I was going to use to make the dub. Usually, it takes two or three passes, with various adjustments of the recorder's input gain controls to establish the proper record level. But this time I was having problems. If the meter indicated I had to come down slightly to achieve the desired level, once the control was adjusted, the result was not as anticipated. If I had to come up in level, the control adjustment was off here too, in fact more so than when I wanted to attenuate. Suspecting it might be dirt on the heads I applied Q Tip and alcohol and there was slight brown/black coloring on the cotton, but certainly nothing that would have caused the noted fluctuations. Tried to set levels once more . . . Same result. Tried again, and this time the left channel was way down (later measurement showed it to be off by 18 dB). I thought that it must be trouble with the record amplifier. Since the home service base of the manufacturer of the recorder was just a few minutes drive from my home, I took the recorder there. Sure enough their tests showed the 18 dB drop. But imagine my chagrin when the technician said that it was just a dirty head! I protested that not only do I clean the deck's heads about every 3rd or 4th recording, but that I had just cleaned the heads before I came to him. The technician picked up what looked like a miniature tooth brush, except that instead of bristles, there was a square of fairly stiff white felt cemented to it. He moistened it with alcohol and really scrubbed the heads. The design of the "toothbrush" allows you to exert considerable pressure. Needless to say, the once white tip was almost dead black. The deck was then swept from 20 to 20kHz on a Bruel and Kjaer frequency spectrum analyzer with graphic readout. The chart was just as pretty as could be. I was still shook up that head dirt had really been the cause of the trouble. Nevertheless, I armed myself with a supply of the fancy "toothbrush" cleaners, and it was a good thing I did for later I ran into the same trouble.

Now, depending on the brand of recording tape, some shed oxide more than others. But in general the top name brands of tape are rarely problemsome. The tape I was using was a top brand of premier low-noise formulation I had used with complete satisfaction many times before. But things do happen . . . I found out that this particular batch of tape was exhibiting a phenomenon known as "pearling." Evidently under certain circumstances, some of the volatile agents in the binder, plasticizer, and adhesive are not driven off in the curing process, so the oxide surface remains ever so slightly "tacky," but enough that when the tape passes over a head, guide or roller, the friction created rolls off tiny little balls or "pearls" of oxide and adhesive. Naturally tape passing over this obstruction is lifted from the head with resultant drop in signal. The tenacity of this oxide "gunk" is incredible. Obviously the usual Q Tip measures are ineffective and the added pressure and compactness of the felt is needed to dislodge the gunk. Usually when you buy a carton of ten or a dozen rolls of tape, they are all of the same "emulsion" number. If you have trouble with one of the tapes, you will almost certainly have it with the other tapes in the carton. Your only recourse is with the manufacturer, and in the meanwhile try another batch of tape. Thus it was with me . . . using tape of another manufacture I did not encounter any troubles. In the light of my experience, I'm going to clean my heads more thoroughly in the future and keep an eye peeled for any tapes which seem to shed more oxide than usual. As a final note . . . I'm trying to find out the name of the manufacturer of the fancy "toothbrush" cleaner so they can be bought separately and in bulk. At present they come as part of a cleaning kit. Æ

After the monthly breakthroughs and revolutions in speaker design, how come the Rectilinear III still sounds better?

Figure it out for yourself.

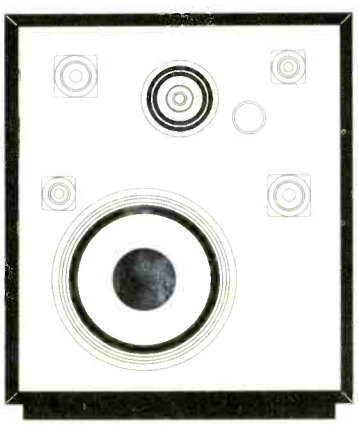
More than five years ago, without much fanfare, we came out with a very carefully engineered but basically quite straightforward floor-standing speaker system. It consisted of six cone speakers and a crossover network in a tuned enclosure; its dimensions were 35" by 18" by 12" deep; its oiled walnut cabinet was handsome but quite simple.

That was the original **Rectilinear III,** which we are still selling, to this day, for $279.

Within a year, virtually every hi-fi editor and equipment reviewer went on record to the effect that the **Rectilinear III** was unsurpassed by any other speaker system, regardless of type, size or price. (Reprints still available.)

Then came about forty-seven different breakthroughs and revolutions in the course of the years, while we kept the **Rectilinear III** unchanged. We thought it sounded a lot more natural than the breakthrough stuff, but of course we were prejudiced.

Finally, last year, we started to make a **lowboy** version of the **Rectilinear III.** It was purely a cosmetic change, since the two versions are electrically and acoustically identical. But the new **lowboy** is wider, lower and more sumptuous, with a very impressive fretwork grille. It measures 28" by 22" by 12¼" deep (same internal volume) and is priced $20 higher at $299.



The new version gave *Stereo Review* the opportunity to test the **Rectilinear III** again after a lapse of almost five years. And, lo and behold, the test report said that "the system did an essentially perfect job of duplicating our "live music" and that both the original and the **lowboy** version "are among the best-sounding and most 'natural' speakers we have heard." (Reprints on request.)

So, what we would like you to figure out is this:

What was the real breakthrough and who made it?

For more information, including detailed literature see your audio dealer or write to Rectilinear Research Corp., 107 Bruckner Blvd., Bronx, N. Y. 10454.

Rectilinear III

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We believe the Heathkit AR-1500 to be the world's finest stereo receiver. The experts seem to agree.

"The AR-1500 is the most powerful and sensitive receiver we have ever measured..."
— JULIAN HIRSCH, *Stereo Review.*

"...a stereo receiver easily worth twice the cost (or perhaps even more)..."
— *Audio Magazine.*

"Great new solid-state stereo receiver kit matches the demands of the most golden of golden ears..."
— *Radio Electronics.*

The Heathkit AR-1500 AM/FM/FM-Stereo Receiver . . . 379.95* (kit, less cabinet)

Mr. Hirsch goes on to say: "The FM tuner section of the AR-1500 was outstandingly sensitive. We measured the IHF sensitivity at 1.4 microvolts, and the limiting curve was the steepest we have ever measured... The FM frequency response was literally perfectly flat from 30 to 15,000 Hz... Image rejection was over 100 dB (our measurement limit)...

"The AM tuner was a pleasant surprise... It sounded very much like the FM tuner, with distinct sibilants and a quiet background, and was easily the best-sounding AM tuner we have had the pleasure of using...

"...all input levels can be matched and set for the most effective use of the loudness compensation. This valuable feature is rarely found on high-fidelity receivers and amplifiers...

"The phono equalization was perfectly accurate (within our measuring tolerances)... The magnetic phono-input sensitivity was adjustable from 0.62 millivolt to about 4.5 millivolts, with a noise level of −66 dB, which is very low... When properly set up, it would be impossible to overload the phono inputs of the AR-1500 with any magnetic cartridge...

"...it significantly bettered Heath's conservative specifications. Into 8-ohm loads, with both channels driven, the continuous power at clipping level was 81.5 watts per channel. Into 4 ohms it was 133 watts per channel, and even with 16-ohm loads the receiver delivered 46.5 watts per channel. Needless to say, the AR-1500 can drive any speaker we know of, and with power to spare...

"At 1,000 Hz, harmonic distortion was well under 0.05 per cent from 1 to 75 watts per channel... The IM distortion was under 0.05 per cent at levels of a couple of watts or less, and gradually increased from 0.09 per cent at 10 watts to 0.16 per cent at 75 watts... The heavy power transformer is evidence that there was no skimping in the power supply of the AR-1500, and its performance at the low-frequency extremes clearly sets it apart from most receiver's...

"Virtually all the circuit boards plug into sockets, which are hinged so that boards can be swung out for testing or servicing without shutting off the receiver. An 'extender' cable permits any part of the receiver to be operated in the clear – even the entire power-transistor and heat-sink assembly! The 245-page manual has extensive tests charts that show all voltage and resistance measurements in key circuits as they should appear on the receivers built-in test meter...

"With their well-known thoroughness, Heath has left little to the builder's imagination, and has assumed no electronic training or knowledge on his part. The separate packaging of all parts for each circuit board subassembly is a major boon...

"In sound quality and ease of operation, and in overall suitability for its intended use, one could not expect more from any high-fidelity component."

From the pages of Audio Magazine:

"...the AR-1500 outperforms the near-perfect AR-15 in almost every important specification...

"The FM front end features six tuned circuits and utilizes three FETs, while the AM RF section has two dual-gate MOSFETs (for RF and mixer stages) and an FET oscillator stage. The AM IF section features a 12-pole LC filter and a broad band detector. The FM IF section is worthy of special comment. Three IC stages are used and there are two 5-pole LC filters...

"...IHF FM sensitivity... turned out to be 1.5 uV as opposed to the 1.8 uV claimed. Furthermore, it was *identical* at 90 MHz and 106 MHz (the IHF spec requires a statement only for IHF sensitivity at 98 MHz but we always measure this important spec at three points on the dial). Notice that at just over 2 microvolts of input signal S/N has already reached 50 dB. Ultimate S/N measured was 66 dB and consisted of small hum components rather than any residual noise. THD in Mono measured 0.25%, exactly twice as good as claimed! Stereo THD was identical, at 0.25%, which is quite a feat...

"...the separation of the multiplex section of the AR-1500 reaches about 45 dB at mid-band and is still 32 dB at 50 Hz and 25 dB at 10 kHz (Can your phono cartridge do as well?)

"The real surprise came when we spent some time listening to AM... This new AM design is *superb*. We still have *one* classical music station that has some simultaneous broadcasting on its AM and FM outlets and that gave us a good opportunity to A-B between the AM and FM performance of the AR-1500. There was some high-frequency roll-off to be sure, but BOTH signals were virtually noise-free and we were hard pressed to detect more THD from the AM than from the FM equivalent. Given AM circuits like this (and a bit of care on the part of broadcasters), AM may not be as dead as FM advocates would have us believe!...

"Rated distortion [0.25%] is reached at a [continuous] power output of 77.5 watts per channel with 8 ohm loads (both channels driven). At rated output (60 watts per channel) THD was a mere 0.1% and at lower power levels there was never a tendency for the THD to 'creep up' again, which indicates the virtually complete absence of any 'crossover distortion' components. No so-called 'transistor sound' from this receiver, you can be sure. We tried to measure IM distortion but kept getting readings of 0.05% no matter what we did. Since that happens to be the 'limit' of our test equipment and since the rated IM stated by Heath is 'less than 0.1% at all power levels up to rated power output' there isn't much more we can say except that, again, the unit is better than the specification – we just don't know *how much* better...

"As for the amplifiers and preamplifier sections, we just couldn't hear them – and that's a commendation. All we heard was program material (plus some speaker coloration, regrettably) unencumbered by audible distortion, noise, hum or any other of the multitude of afflictions which beset some high fidelity stereo installations. The controls are easy to use and quickly become familiar...

"As always, construction instructions are lucid enough for the inexperienced kit-builder and there is enough technical and theoretical information to satisfy even the most knowledgeable audio/RF engineer."

And Radio Electronics had this to say:

"As you know, the original, the AR-15, has been widely acclaimed as one of the very best stereo receivers that has ever been made. Therefore, it's hard to imagine that anyone has gone ahead and built a better one. But spec for spec, the AR-1500 is ahead of the AR-15..."

Kit AR-1500, less cabinet, 53 lbs. **379.95***
ARA-1500-1, walnut cabinet, 8 lbs. **24.95**

See and hear the new AR-1500 at your nearest Heathkit Electronic Center... order direct from the coupon below... or send for your free Heathkit catalog.

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Choosing A Tape Recorder

H. W. Hellyer

OUR GRANDFATHERS did not have this problem. Choosing a tape recorder at the turn of the century was a simple matter—it was Magnetophon or nothing.

Now we have hundreds from which to make our choice, all—if you believe the advertisements—offering something special. The problem is, very often, to distinguish between those that offer what you want and those which are simply embellishing what may be a basically good model, but for which you pay more, get more, but use less.

First—read the reviewers. Read 'em diligently. Contrary to many opinions, these gents (myself among them, though not in these pages or even in this country) do their best to describe good and bad points of the equipment sent to them, adding a personal nuance here and there, which their own coterie of followers will learn to love or hate, and should always back their opinions with the hard bedrock of measured fact.

Second—if there is a point on which you are not clear, then ask! Ask the reviewer, ask the Editor, ask Joe Giovanelli; or for specific advice on tape questions ask Herman Burstein, ask the Editor, or, if you are prepared to wait for the Transatlantic carrier pigeons, ask Donald Aldous or me—but ask. . . . We are here to serve. We do not want you to waste your money, tuck the tape recorder under the bed and go back, disgruntled, to off-the-air programs of someone else's choosing. If there is a question about a switch function, a system matching, interpretation of technical terms, or any other suchlike bother, then we should be able to help you. But if it is a question of whether A is better than B, you may not be so easily served.

With tape, it depends on what you mean by "better."

Less noise? Well, yes, the noise reduction systems do have an effect and it is greatest with necessarily slow-speed cassettes.

For reel-to-reel machines it may seem less important. But tape hiss, the everpresent bugbear, is also relevant at higher speeds and on wider tracks. So the "add-on" noise reduction device is worth consideration.

Some tape recorders will already have the noise reduction facility built-in. Watch for those which add distortion or rob your recording of its dynamic range. There are several methods: One aim of most is to reduce the higher frequencies when the overall signal is lowest. Using the same argument as the more sophisticated Dolby, they sense signal level and apply a frequency-conscious stop filter. Some of these can be viciously potent; my advice is record and replay a familiar piece of music, then listen very carefully for those artificial rises and falls in ambient noise level that give the game away.

Some machines do it both ways, that is, they apply extra pre-emphasis during recording or can be switched to high-energy tape activation, then utilize a noise reduction switch on replay. Although these refinements are more often encountered on cassette machines, where practically *any* improvement has to be beneficial (Ouch! Ed.), makers of reel-to-reel tape recorders are adding all sorts of similar sophistications.

Choice of a reel-to-reel tape recorder, as distinct from a cassette or cartridge machine, argues that one wants the choice of speeds or some greater track-switching flexibility than is currently available because of cassette head size and mounting restrictions.

Accepting that argument, you should look for the tape recorder that does what you particularly want and no more, but one that does it as well as can be.

Tape recorder makers will not love me for saying so, but there's a heck of a lot of apparatus gathering dust because its promise outlived its performance. New models come along: they glitter more, have a lot of inviting facilities, merit a very close look. . . . But when you look, remember that a "track-transfer, multi-sound, echo-flip device" may sound impressive when you show your friends, but may have cost you the dollars you could have spent in getting the simpler, higher-speed, better-performing machine.

Make your choice logically. Say: (1) What do I want to do with this thing? (2) What am I likely to want to do later? and (3) How about after that?

Point 1 is the most important as well as the most immediate. If your main work is vocal—interviews, reports of meetings, out-and-about effects—you need as good a microphone as you can get. Likely you will have bought it or still be drooling over the catalogs. OK, don't waste money on the machine with mic. Not unless *that* machine, for other reasons, seems the best.

General purpose work is a vague term, but we all know what it means. Monday you just had to catch Station Zee-Dee-Kay giving forth on Mahler's love-life; Tuesday was when Junior visited, with his newest-born just gurgling to be historied; Wednesday—well, wasn't that the day the Stag Club just "took off" and haven't you just got to prove that Joe had said what he did before carting your precious tapes and slides to the PTA social on Thursday for your annual lecture on the Lakes of Saskatchewan? General purpose means what it says: your machine has to withstand a bit of hard handling and maybe a can of beer in its innards.

So choose it, expecting the worst. But remember, that Mahler has to come over soft and clear, and you'll do that better at a higher speed, if quality of performance matters more to you than a miserly saving on the cost of tape.

Which brings up another point. Tape length, and, related to it, tape thickness. Calculate your probable program length

We doubt that anyone will be overly surprised to learn that our newest loudspeaker sounds terrific. Most people really expect KLH to make terrific sounding things. But at $62.50† a piece, our new Model Thirty-Eight delivers an amount and quality of sound that we think will astonish even our most avid fans. The bass response is absolutely staggering; the transient response is flawless; and the Thirty-Eight's overall smoothness matches anything we've ever heard. Most important, you can use a pair of Thirty-Eights with virtually any modestly priced receiver. (What good is an inexpensive pair of loudspeakers that need a $400 receiver to effectively drive them?)

The Thirty-Eights are at your KLH dealer now. After hearing them, we think you'd pay $125 for just one. But $125 buys you two. Which has got to make the Thirty-Eights the biggest stereo bargain since ears.

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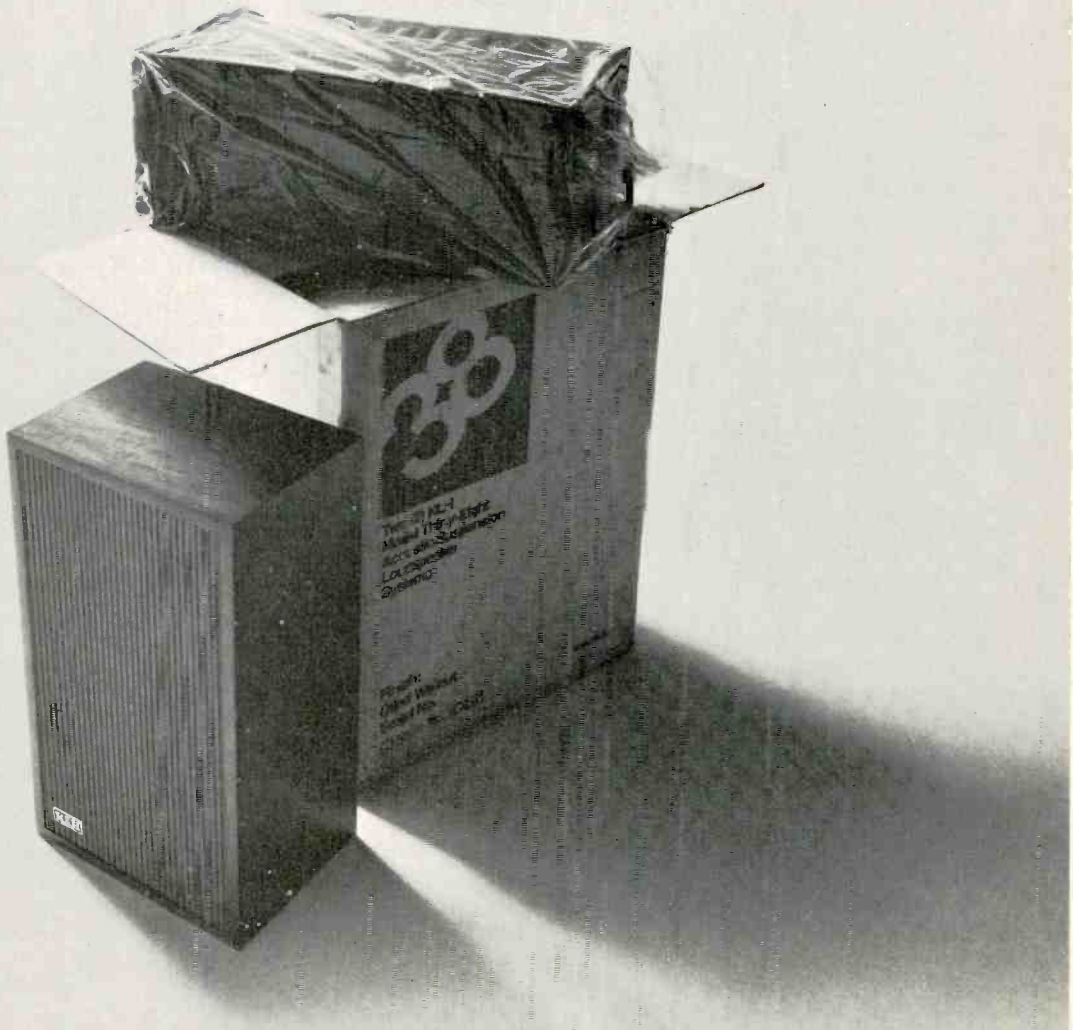

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and add a bit for fluffing. There are plenty of good tape length/time/grade tables around—no need to bore you with another. But let me remind you that, for example, a 1 mil polyester tape on a 7-in. reel (1800 feet length) can give you 45 minutes of recording if you are using half-track stereo at 7½ ips, to get the best signal-to-noise ratio and dynamic range from your machine.

Use a quarter-track machine (I don't like the term 4-track in this context, with so much multi-track studio stuff about) and you'll double the playing time, but have to invert reels midway through that doubled performance. The use of 3¾ ips would have gotten you the same playing time, but for that you would have sacrificed a couple of thousand Hz frequency response at the top end (and don't kid yourself, the hiss is not all up there!) and had to put up with a fractionally worse wow and flutter performance.

The point I am trying to make is that the real perfectionist will go for the highest speed and the widest track and to hell with playing time per spool. Bert Whyte was enthusing about the Nagra—only just breaking out into stereo, forsooth!, when we are all in a quadraphonic fever—and my personal memories of this machine are a blissful month of full-track 15 ips recording while its owner, an explorer friend of mine, laid low by some bug, left it in my loving care. As Bert says, if only we could run two units in sync, we could make such things as outdoor four-channel stereo recordings.

Coming down out of the clouds a while, let me say that, as an engineer, I have the utmost difficulty in choosing tape recorders. I am always more concerned with the design factors and the probable life, the true specification (not just what is quoted, which can be regrettably ambiguous), and the *basic facilities* of the machine.

This is all the more important when reel-to-reel recorders are considered. Mainly because the range of facilities becomes so much wider—and the ultimate quality realizable so much higher. (*That* should offend a few marketeers! Ed.)

I assume you are reading this because the virtues of easy loading, portability, and a library you can carry in your auto map pocket are not so important as those of wider frequency range, better speed stability, improved signal-to-noise ratio (Dolby notwithstanding), and a tremendous eruption of facilities.

Choosing your reel-to-reel recorder is truly a matter of matching your needs to your pocket. In a challenged market, you can be sure that the goods are competitive. If you are a true tape enthusiast, *now* is the time to invest. Quadraphonics, as far as you are concerned, is an impossible or impossibly costly conversion from two-channel stereo. If you want surround sound, get in there now. Makers are jostling for your custom and the technology is not likely to be outdated in the lifetime of your machine—all the headwork is going into broadcasting and discs.

The design commitment in tape recording today is toward getting more flux on the tape, tailoring circuitry to get less noise without losing or distorting signal, and—most significantly—motor control.

Where only one of the "big boys" had a servo-controlled motor a year ago, several are seeing the advantage of this device in 1972 and there are more waiting in the wings. It calls for a hunk of circuit, but that is no great problem in these days of ICs. It gives spot-on speed and makes for less hum radiation, besides cutting down weight.

Automatic recording level control, once the specialty of the portable, is creeping into more and more of the larger models. So is single meter (peak-selective) indication. Both can have advantages in the right situation. Question is, is it yours?

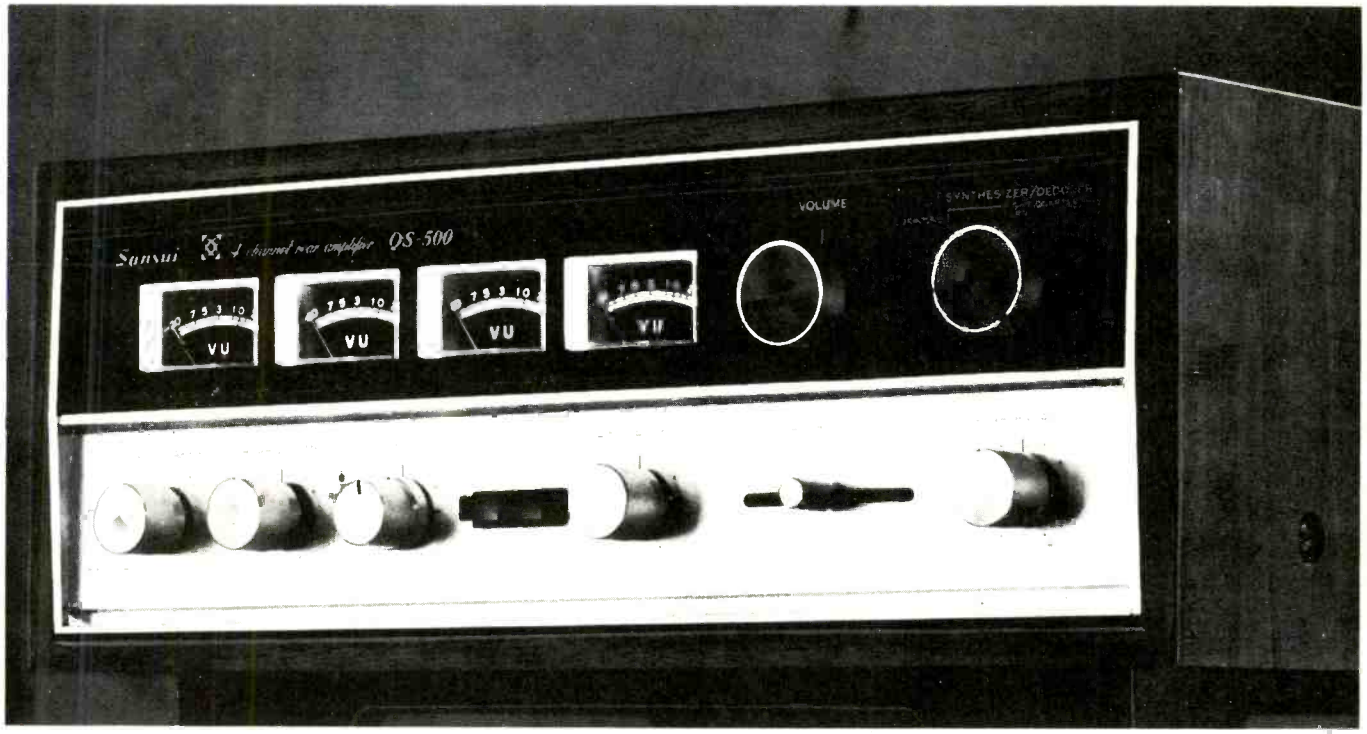
How to choose from the welter of superlatives in the catalogs? The answer, as I said at the outset, is: Read your reviewers. Find whose opinion most matches your own experience or who consistently convinces you. Before making a choice, read as many independent reports on the model as you can. Shop around and try out that all-important factor, operability.

Yes, I *know* the word's not in Webster's. I coined it a coupla years ago when reviewing a portable which was the first I'd met where all the controls seemed to "come to hand." And *that* was a reel-to-reel machine, incidentally.

Make your choice the same way: Check the specs., read the reports, and handle it. If you are buying across the counter, be sure you get the chance to try before you buy. If you are buying mail order, well, you take a chance along with your discount.

Note that I've named no names? Deliberately. *You* have to do the choosing, friend: all I can hope is that my remarks may have sparked off a few ideas to help you. Only one thing is certain—the one you finally select will be the one you just can't quite afford. . . . AE

if you go for four channel...



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Buy yourself a miracle for as little as $214.95 That's all it takes to get your conventional two-channel stereo to do anything any total four-channel receiver and control center can do, now or in the future.

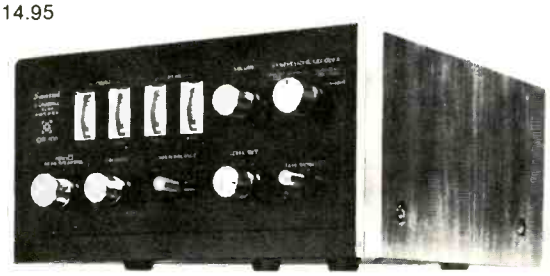
The Sansui QS500 and QS100 converters are complete Four-Channel Synthesizer-Decoder-Rear-Amplifier-and-Control-Center combinations that transform standard two-channel stereo totally. The only other equipment you need is another pair of speakers.

You can decode any compatibly matrixed four-channel broadcasts or recordings and reproduce them in four authentic channels. You can detect the ambient signals present in most two-channel recordings or broadcasts and propagate them through the rear channels. In Sansui matrixing, the exclusive phase-shift technique prevents the cancellation of some signals and the change in location of others that occur in many matrixing systems. And the exclusive phase modulators restore the effect of the live sound field.

You can plug in a four-channel reel-to-reel or cartridge deck or any other discrete source. In the future — if you should have to — you can add any adaptor, decoder or what-have-you for any four-channel system for disc or broadcast that anyone's even hinted at. And a full complement of streamlined controls lets you select any function or make any adjustment quickly and positively.

The QS500 features three balance controls for front-rear and left-right, separate positions for decoding and synthesizing, two-channel and four-channel tape monitors, electrical rotation of speaker output, alternate-pair speaker selection, and four VU meters. Total IHF power for the rear speakers is 120 watts (continuous power per channel is 40 watts at 4 ohms, 33 watts at 8 ohms), with TH or IM distortion below 0.5% over a power bandwidth of 20 to 40,000 Hz. In its own walnut cabinet, the QS500 sells for $289.95

An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $214.95



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Refacing Tape Recorder Heads

William B. Fraser

NOT LONG AGO, a customer brought me a tape recorder for repair. The complaint was poor and erratic sound.

The recorder was an expensive one and almost new. It didn't seem likely that the electronics were at fault. A check of the heads located the problem immediately. The playback head had been mounted incorrectly, so that the height was grossly out of adjustment. In the meantime, the machine had been operated enough so that an obvious tape groove was visible on the face of the head. Under these circumstances, it is usual to consider the head has been ruined. The conventional solution is to install a new head.

But a new head was expensive and not readily available. Further, the customer was anxious for speedy repairs. After some thought, I decided to attempt to salvage the head by refacing it. I have not heard of this being done in a service shop (or elsewhere for that matter) and approached the job with some apprehension. Fortunately, one thing was going for me. The head was ruined anyway, so what was there to lose?

The results of this first attempt were so satisfactory that subsequently I have refaced about a dozen other heads with 100% success. I have often wondered how long these reconditioned heads would last. So far it has been impossible to determine, simply because no customer has ever returned with a complaint. As a guess, perhaps the initial life expectancy of the head has been doubled.

Anything on the face of a tape recorder head which interferes with intimate contact between head and tape will cause unsatisfactory operation. A deep tape groove or a scratch or an erratic or incorrectly located wear pattern all cause the tape to lose contact with the head. It is these types of abnormalities which are considered in this article.

It takes me about one hour of grinding and polishing to reface even the worst head. Add to that the time to remove the head, then reinstall and align, and the entire job runs two to two and a half hours. This is a considerable saving to the customer over the cost of a new head. Occasionally, you will run into a head that is so severely worn that refacing should not be attempted. This is the time when you must depend upon your good judgment. In performance, a refaced head compares favorably with a new head in all important characteristics.

Here's how the job is done. First get the necessary materials. They are all inexpensive and readily available:

1. A wooden board on which to do the grinding and polishing. A small kitchen cutting board about 8 × 10 in. does nicely. It must have a smooth, flat surface.
2. One sheet wet sanding paper, 220 grit.
3. One sheet wet sanding paper, 400 grit.
4. One sheet wet sanding paper, 600 grit.
5. Jar of silver polishing cream, Wright's or equivalent.
6. Piece of soft flannel cloth about a foot square.
7. Magnifying glass, about 10 ×.

Having assembled the equipment, you are ready to start. Remove the head from the machine and disassemble any mounts or shields which interfere with access to the face. Examine the wear pattern to make sure the head can be salvaged and to determine what you have to do. Let us assume the wear consists of a grove about three or four times the thickness of a 1 mil tape. This amount of wear will require a good deal of grinding, and so we start with the coarse (220) paper. The grinding should be done wet, that is with a small flow of water on the grit paper. Wet grinding produces a smoother result than dry grinding. A pressure of no more than six to eight ounces should be used, as heavier pressure will make deep gouges in the face of the head. If you're not sure what a 6 ounce pressure is, get out a pressure gauge and find out. It's important. Hold the head by its sides with the face against the grit paper. As you look downward toward the work, use a rotary motion of the hand, making circles about three or four inches in diameter. Simultaneously with this rotary motion, rock the head back and forth so the entire face is exposed to the grinding action. At all times keep an even pressure on the head. Occasionally, turn the head end for end to insure even grinding. Examine the work frequently under the microscope. When the depth of the groove has been reduced to about half the thickness of a one mil tape, it is time to use the medium (400) paper. Keep up the grinding until the groove is almost eliminated, then finish grinding with the fine (600) paper. Avoid grinding more than necessary, but be certain all traces of the groove have been eliminated.

The next step is to polish the face. Put aside all abrasive papers and wash the cutting board. Fold the flannel cloth double, moisten it, apply a small amount of polishing cream, and polish, using the same techniques as employed during grinding. Fifteen minutes of polishing usually will produce an excellent surface finish—provided your grinding was correctly done.

Let us retrace our steps for a moment to the point when we made the initial examination of the head to determine the depth and extent of the wear pattern. If the wear is light, the grinding should start with the medium or fine grit rather than the coarse grit. In case the coarse grit is employed late in the grinding process, deep scratches will be left in the face of the head. These tend to accumulate debris and interfere with head-to-tape contact.

Well, that completes the job as far as refacing is concerned. Of course, you must reassemble the equipment, align the heads, and test the equipment. As far as the head is concerned, you should achieve specified performance of the recorder. AE

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Artie Altro makes the WOR-FM sound, while Eric Small, Sebastian Stone and Promotion Director, Kim Olian look over a new album.

WOR-FM, the country's leading FM/Stereo rock station, has been using Stanton cartridges since its inception.

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All Stanton cartridges are designed for use with *all* two and four-channel matrix derived compatible systems.

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Mathematics 4 Beginners

Part Four of a Series by Norman Crowhurst

BY THE NEXT TIME George wandered in Henry's office, when neither of them were too busy, George had been thinking quite a little about their earlier discussions on calculations associated with electronics.

"You know," George opened the conversation, "when I took some course in mathematics for electronics, or whatever it was called, there was one thing that always left me in the air. It strikes me now that perhaps you could help me understand it."

"What's that?" questioned Henry.

"Maybe it's really more than one thing, but they all relate to calculations involving reactances," George responded. "I don't know, somehow I've drifted into depending on charts of one kind or another and, if I can't find a handy-dandy chart that just suits my needs, I'm lost. Of course, it is always nice to have a chart do the work, but I'd be a lot happier if I knew what work the chart did for me."

"You mean you're always afraid, when you don't know what you're doing, that you might misuse the chart, because you don't understand what it's supposed to do?" asked Henry.

"That's about it."

"So ask me—perhaps we can figure it out," said Henry.

"I think the first thing that bothered me is that 2-pi bit and 'angular frequency' or something, in the formulas for reactance of inductances and capacitances. Then, when you get past that, there's the whole vector addition bit, where you add quantities together, but they don't follow the rules of addition."

"Let's take one piece at a time," suggested Henry. "The word 'reactance' means something fundamentally different from 'resistance'. A resistance 'solidly' resists current flowing through it. The voltage that 'registers' that resistance is always strictly proportional to the current that causes it. If a resistance is 100 ohms, and the current 20 milliamps, then voltage will be 20 x 100 = 2,000 millivolts, or 2 volts. That's true at every instant, in a resistance, no matter how voltage and current change.

"But in reactances it's different. It is not current or voltage that directly produces a voltage or current effect, as in resistance, but change of current that produces voltage, or vice versa. Let's take inductance first. A Henry—the unit of inductance—is defined as having a value that, when current *changes* at 1 amp per second, the reactive voltage generated is 1 volt."

"Yes," responded George, "I remember that bit, now you repeat it, but from there on, the whole thing lost me, pretty fast. The teacher got into the angular measure of angles or something . . . ."

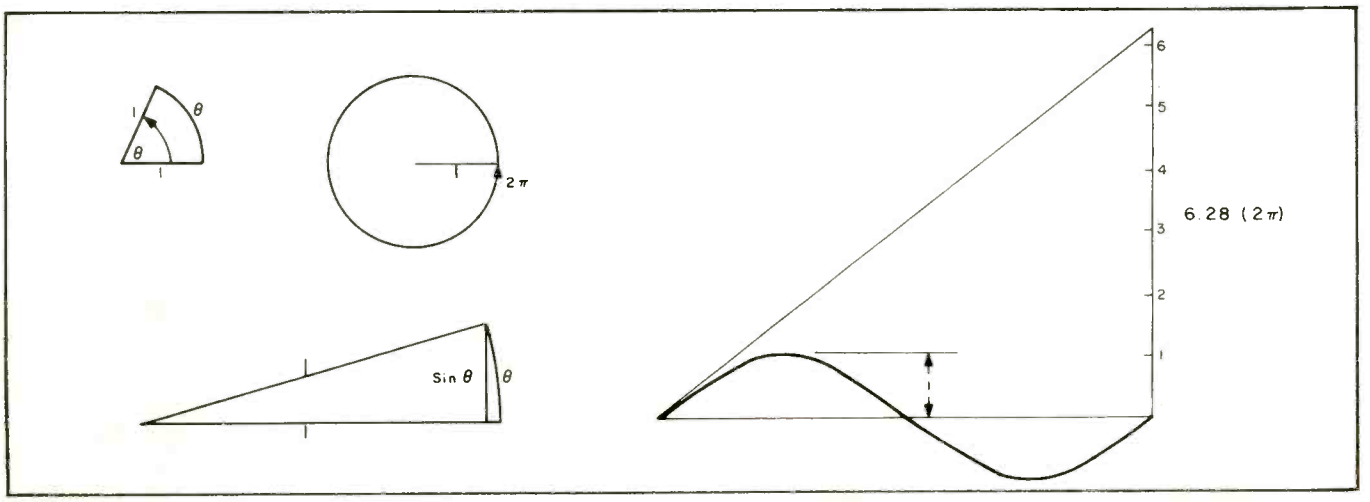
"You mean the circular measure of angles, as opposed to the more conventional 'degree' measure," suggested Henry.

"I guess that's it," George said, "And then a 2-pi got in there, and I never could see how frequency got into the picture. I used the formula for quite a while, without knowing why, and then I found charts took all the trouble out of it, but I've never been happy about it."

"First let us look at the circular measure of angles," suggested Henry, as he started to draw. "Really, it's the degree measure that starts the difficulty. There is no real reason, except that somebody a long while ago did so quite arbitrarily, for dividing a circle into 360 equal parts called 'degrees' or a right angle, which is a quarter—or 'quadrant'—of a circle, into 90 of them.

"The circular measure of angles simply takes a radius, rotates it from its starting point, so one end stays at the center and the other end follows the circumference of a circle, and the movement along the circumference, measured with the radius as unit length, describes the angle made."

Henry was drawing as he did this, and George picked it up. "Oh, I see, so when you've completed a circle, which degree measure calls 360 degrees, the



circumference is 2-pi times the radius that draws it?"

"That's the idea," said Henry. "So far, so good. Now we come to apply that to a sine wave."

"That's another place where I got lost," said George. "Nice neat 30, 60, 90 degree angles, with 45 in there somewhere, made easy figuring, but this 'pi radian' bit lost me."

"Do you remember the ratio that defines the sine of an angle?" asked Henry.

"Yes," replied George, "in fact that is all I can remember of my trig studies, I think. The sine is the 'opposite over the hypotenuse'." He drew it as he said it.

"Now," said Henry, if the angle is small, as it is when it's crossing from negative to positive, near zero, the hypotenuse is the same as the radius, and that little bit of 'opposite' and the little bit of circumference are the same thing, for the time being, aren't they?"

George could see this, so Henry switched his attack and drew out a sine wave. "So the rate at which the sine is changing, where it crosses the zero line, is the same as the rate at which the angle is changing, when you use circular measure, instead of degrees."

George did not say anything, so Henry went on.

"Now, if this rate of change did not change, how big would the sine be, by the time you completed a circle, or period of some frequency?" And he drew a complete sine wave, with a tangent going on up.

"Two-pi?" suggested George.

"Right. Now remember that change of current is what causes voltage, in an inductive reactance. Maximum change is where the sine wave crosses the zero line, as shown by maximum slope at that point. And extending it like this shows that, if this rate of change kept up for the whole period—of whatever the frequency—the change would be 2-pi units."

"Come again," said George, "I'm not quite with you."

"Suppose," said Henry, "the maximum current, at the peak of the sine wave, is 1 amp, and the frequency is 1 Hz, or 1 cycle every second. Then the rate of change where the current crosses the zero line, is 2-pi amps per second."

"Daylight is beginning to dawn," said George. "Go on."

"Now, if the frequency is 60 Hz, then each cycle takes 1/60th of a second, so the rate of change, where the current crosses the zero line, is 2-pi times 60, times the maximum current at the peak of the sine wave."

"Got it," said George. "So 1 Henry will have a reactance of 2-pi times 60—what's that, a little more than 360 ohms?—at line frequency."

Henry showed George how putting the 'pi' mark on the 'C' scale of his sliderule by the '5' on the 'D' scale put 1 on the 'C' scale opposite '6.28' (approximate value of 2-pi) on the 'D' scale, and then that '6' on the 'C' scale came opposite 3.77 on the D scale. "More precisely," he said, "it's 377 ohms."

"It's making sense now," George said. "I could follow the part that showed that maximum voltage appeared at zero current, because that was where current was *changing* fastest. It was how the 2-pi got into the relationships that bothered me. That whistle will be blowing anytime now, to summon me back to work, so I must reserve the getting of capacitive reactance straight for another time. Then there's that 'operator-j' bit. I never did understand that, although guys who did, seemed to do some pretty cute tricks with it and save a lot of time."

Just then the whistle did blow, so they parted for the time being. AE

MICROPHONES -- Quo Vadis?

James H. Kogen*

A Comparison of the Dynamic and Electret Condenser Transducers for Sound Reinforcement Microphone Applications

ONE NEED NOT be very sophisticated in the art of microphone design to discover that there is no panacea for all problems. Of necessity, any practical design is to some degree a compromise. The best microphones are those in which the most important characteristics have been optimized. What constitutes the "most important characteristics" will differ depending upon the application. A microphone that is optimum for one application may not be so for another. To make a fair and honest comparison of microphones, we must consider the application and base our analysis on those characteristics that are significant for the situation being studied.

The selection of a microphone for a given application is ultimately made by the user. The engineer designing a microphone can only anticipate which features will be most important in determining that selection. His choice of features must be based on a thorough analysis of the many design variables and possible compromises. This requires a careful evaluation of all the pertinent characteristics of available transducer types and acoustical designs, consideration of special features, and a thorough study of the many techniques of mechanical construction. Ultimately, his design will be based upon what he conceives to be the best combination of all of these characteristics to satisfy the requirements of the intended application.

A comparison between the electret condenser transducer and the dynamic transducer must take into account many factors. In this article we will discuss these factors, particularly as they apply to microphones for use in sound reinforcement. Emphasis will be placed on identifying the important factors by which a comparison of transducer types can be made. The conclusions as to which microphone is most advantageous for a given situation will be left to the reader.

The electret condenser transducer is an entirely feasible device for use in microphones. This transducer must, however, be judged by the same standards applied to dynamic, ribbon, ceramic, and other types of transducers commonly used in microphones. As stated previously, no transducer offers a panacea. The successful use of the electret condenser transducer will depend upon its particular features and limitations and the way in which these relate to the application of the microphone.

A comparison of the electret condenser transducer and the dynamic transducer, in general purpose sound-reinforcement microphones, covers a very broad range of applications. We will not at this time consider applications such as professional recording and broadcast, mobile communications, and laboratory test microphones. Clearly, the conclusion reached with regard to sound-reinforcement application might not apply for these other applications since the emphasis may be on different characteristics.

Complexity of Microphone Evaluation

When one considers the details, the evaluation of a microphone is a complex matter, and this is particularly true for directional microphones. There is no simple overall criterion of performance that describes the quality of a microphone; there are many criteria for making a judgment and each must be considered separately. Consider the following characteristics by which a microphone can be judged.

1. *Sound Quality.* Several factors affect the sound quality of a microphone. These factors include the frequency response, the polar response (the relative sensitivity of the microphone in all directions), and the distortion at all sound-pressure levels, from the minimum to the maximum to which the microphone will be subjected. Although these parameters can all be measured with great accuracy, our ability to relate these parameters in detail to the subjective sound quality is still quite limited. As a result, in addition to making the laboratory measurements, we must also make an evaluation based on listening—which of course is entirely subjective.

2. *Extraneous Noises.* Since microphones are designed to respond to minute changes in sound pressure measured in microbars (a microbar is one-millionth of barometric pressure or 14.7×10^{-6} psi), they are often sensitive to other kinds of mechanical energy input as well. Structure-borne noise can be very disturbing in many applications. When a microphone is held in the hand, for example, a variety of characteristics become important, such as cable noise, frictional noise caused by rubbing the hand or clothing against the microphone, and "thump" noise when the microphone is placed on a floor stand. Such noise can be a very significant factor in judging the quality of a microphone.

Another type of extraneous noise is the "pop" that often occurs when a user expresses the letter "p" or "t." In close-talking applications, excessive "pop" sensitivity can make a microphone practically unusable.

A third type of extraneous noise is that produced by wind. In outdoor applications, the relative sensitivity of a microphone to wind noise may well determine whether or not the microphone can be used.

3. *Reliability.* A microphone with a multitude of superb features, but with poor reliability, is essentially worthless. Sound-reinforcement applications require reliability often under conditions of severe abuse. We have seen microphones swung by their cables and dropped on floors on many occasions. To qualify as a reliable sound-reinforcement product, a microphone should be capable of being dropped on a hardwood stage without deterioration of performance.

Other factors related to reliability are humidity and temperature. Sound-reinforcement microphones are employed outdoors in sub-zero weather and in the heat of a tropical sun. They are used in arid desert regions as well as in highly humid atmospheres.

4. *Output Level and Signal-to-Noise Ratio.* Output level is a significant factor because the signal-to-noise ratio of the system depends upon the output of the microphone in relation to the noise of the system (usually as determined by the input

*Vice President, Development and Design Engineering, Shure Bros., Inc.

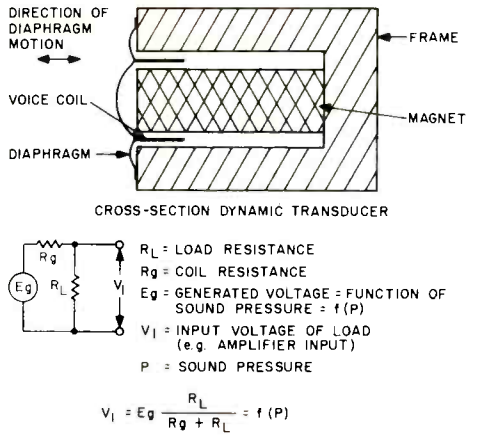


Fig. 1—Equivalent electrical circuit of a dynamic transducer.

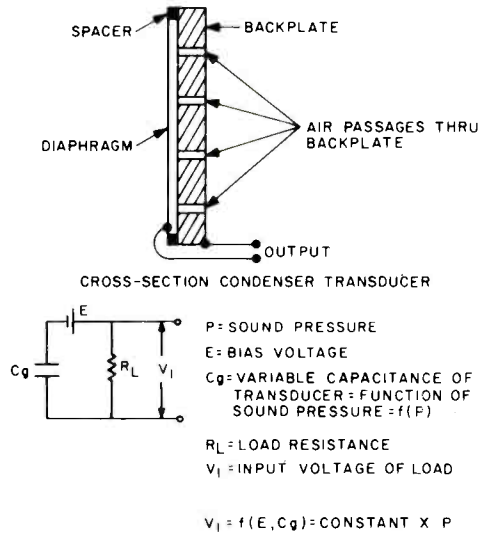


Fig. 2—Equivalent electrical circuit of a condenser transducer.

stages of the mixer or preamplifier). A higher output level from the microphone can be advantageous in improving the signal-to-noise ratio. However, an excessively high output level may overload the input stages of the mixer or preamplifier. This means that the output level must be designed to consider peripheral equipment as well as the internal design of the microphone itself.

These are just a few of the factors that must be considered in evaluating a microphone. Each factor must be considered in detail, and specifications, where possible, must be assigned to assure proper performance. The selection of a transducer must then be made in terms of how that transducer performs for each and every one of these specifications. As we stated initially, no transducer offers a panacea. Each transducer has its own particular features and we must select the device that best suits our application requirements.

In the remainder of the article, we will first describe the operating principles of the dynamic and the electret condenser transducers, and then we will compare the two on the basis of a number of important specifications. These specifications include power supply requirements, frequency response, polar response, handling noise, "pop" and wind noise, reliability, output level, distortion, and transient response.

Operating Principles and Major Characteristics

The following is a very brief review of the principles of operation and major characteristics of the dynamic and electret condenser transducers.

The dynamic transducer operates as an electrical generator. A coil of wire (the voice coil) is attached to a metal or plastic diaphragm that moves in response to an input of sound energy. The coil is placed in a magnetic field and a voltage is produced when there is relative motion between the coil and the magnetic field. The dynamic transducer is a self-generating device that requires no external source of power. The equivalent circuit and the equation that relates output to input, shown in Fig. 1, is highly simplified and presented to indicate the steady-state relationship between sound input and electrical output.

The three significant characteristics of the dynamic transducer pertinent to much of the discussion later in this article are:

1. It is self-generating and requires no external power supply.
2. It has a low internal impedance in the range of 25-1000 ohms at all frequencies in the audio spectrum.
3. As compared to the condenser transducer, it has relatively high diaphragm-coil mass.

Both the standard and electret-type condenser transducers convert acoustical energy into a variation in electrical capacitance. This variation occurs when the diaphragm is moved by a sound pressure, thus changing the distance between the diaphragm and the backplate. This capacitance change is reflected as an electrical output in a circuit, such as that shown in Fig. 2. The microphone acts as a varying series element in this circuit. (As in Fig. 1 for the dynamic transducer, this circuit is simplified in order to show the relationship between the acoustical input and the electrical output.) The equation relating output voltage to acoustical input is also shown in Fig. 2. In an electret condenser transducer, the bias voltage results from a permanently stored electrical charge in the transducer; conventional condenser transducers require an external voltage supply.

Characteristics of the electret condenser transducer pertinent to later discussion are:

1. It is a self-generating device requiring no external power supply.
2. It has a very high impedance since it is a capacitor of a few hundred picofarads minimum and requires a preamplifier located physically close to the transducer.
3. It has minimum mass for a diaphragm-type transducer in that nothing is suspended from the diaphragm.

Comparison of Transducers

1. *Power Supply Requirements.* While both the electret condenser and the dynamic transducer are self-generating devices, there is a considerable difference in application in that the former is a high-impedance device and the latter has a relatively low impedance. It is standard practice to employ low-impedance dynamic microphones with cables of hundreds of feet in length without significant problems with hum pickup and deterioration in frequency response. This is accomplished without preamplification at the microphone location.

On the other hand, the high impedance of the condenser microphone necessitates the use of a preamplifier in close proximity to the transducer element. In practical application, the best solution is to build the preamplifier into the microphone and provide either a battery or an external power supply to energize this amplifier.

An external power supply provides a suitable solution but does mean that this extra element must be included in the system or, alternatively, d.c. voltage must be made available at the input terminals of the microphone amplifier. The latter arrangement provides the neatest solution, but at the present time, sound-reinforcement equipment is not normally provided with such a voltage source. As a consequence, if the extra element (the external power supply) is to be avoided, an internal power source must be provided, which means a battery in the microphone.

When a microphone incorporates a battery, one must immediately be concerned with battery life. It is possible to design a preamplifier with current drain so low that the battery

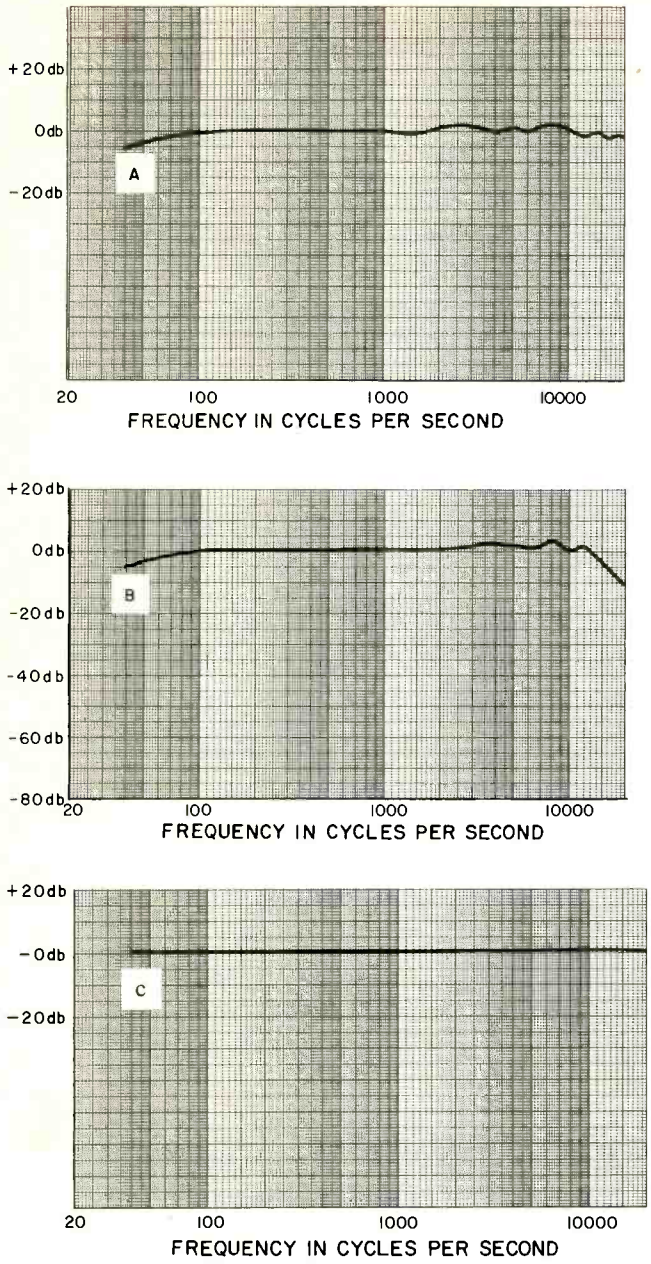


Fig. 3A—Free field axial response of a professional quality omnidirectional dynamic microphone. **B**, Free field axial response of a professional quality omnidirectional condenser microphone. **C**, Free field axial response of a ½-in. laboratory condenser microphone.

life will be quite long. The life of a battery may vary over a considerable range, depending upon the normal quality variations of batteries and upon the temperatures to which they are subjected. The life of a battery might be as high as 10,000 hours or a little over one year. However, the variation in life is very large and might extend from as little as a few months to many years.

The major point of consideration here is that although battery life can be reasonably long, the battery is still a replacement item that must be maintained. A dead battery means a dead microphone. A weak battery may mean a marginally operating microphone. A leaky battery could mean a damaged microphone. The dynamic microphone does not have this problem. The electret condenser transducer must offer features to overcome this disadvantage when compared to the dynamic transducer.

2. *Frequency Response.* As we have stated, the frequency response of a microphone presents only a rough indication of the sound quality. It is nevertheless a standard by which microphones are compared and must be considered as a very important basis of comparison. In the following, we will consider low frequency response extension, high frequency response extension, and mid-frequency smoothness.

In terms of low frequency response extension, the condenser transducer potentially has an advantage. Through the use of very high impedance preamplifiers, this transducer can be made to operate at frequencies well below the low end of the audio range (20 Hz). Dynamic transducers can be made to operate at very low frequencies also, but in order to achieve such response, a compromise must be made that tends to make the microphone more sensitive to handling noise. The advantage of response below 50-100 Hz is of questionable value in sound reinforcement, although this potential advantage of the condenser element might be useful in other applications.

In terms of high frequency response extension, we cannot state with certainty at this time that either transducer has an advantage insofar as audio frequencies are concerned. Figures 3A and 3B are response curves of two popular omnidirectional dynamic and condenser microphones. Both of these types exhibit response to 20 kHz within a few decibels. Figure 3C is the response of a laboratory-type condenser microphone with frequency response extending well beyond 20 kHz. For sound-reinforcement applications, both types of transducers have the capability of satisfactory high-frequency response.

Smoothness of response in the mid-region can be accomplished by both transducers, as shown in Figure 3. The condenser element might have an advantage in having fewer small variations in its response curve, but the variations in a good dynamic microphone response would be in the order of 2 dB or less, and it is doubtful whether this would affect the sound quality sufficiently to be detected when the two types of transducers are compared subjectively.

In our judgment the frequency response possibilities of the two types of transducers, for use in sound reinforcement, are similar. We must, however, remind the reader of the point made previously with regard to frequency response and subjective sound quality. Frequency response does not tell the whole story with regard to sound quality. The frequency response of a dynamic and electret condenser microphone may be similar, but the sound quality could differ because of other factors.

3. *Polar Response.* Theoretical analysis indicates that neither the dynamic nor the electret condenser transducer has an advantage with regard to polar response. This characteristic is primarily a function of the acoustical design of the microphone in conjunction with the transducer. Measurements on existing microphones have corroborated this theoretical analysis.

The unidirectional dynamic microphone requires a mass-controlled transducer having a relatively low fundamental resonant frequency. The condenser microphone requires a resistance-controlled transducer having a resonant frequency in the mid-range. The acoustical networks required to achieve unidirectional characteristics can be similar for the two transducers, and there are a variety of networks available for either type. Ultimately, we may discover that a particular network in conjunction with one or the other of the transducers offers some practical advantage. At the present time, however, this is not the case, and the two types of transducers are comparable with regard to polar response of the microphone in which they are employed.

4. *Handling Noise.* This is a characteristic that is often overlooked but one that can be very important. A microphone is

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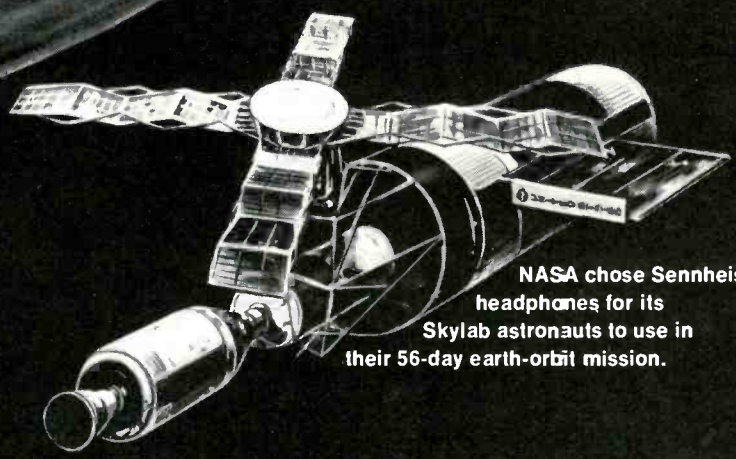

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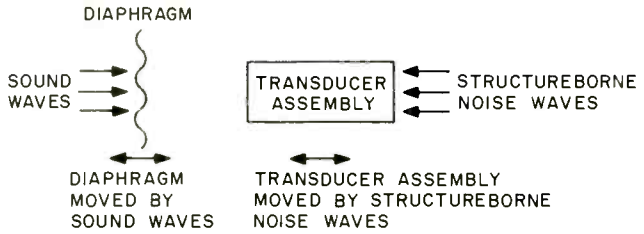

Fig. 4—Voltage generation caused by structure-borne noise. Relative motion between diaphragm and assembly produces electrical output and can result from either diaphragm or assembly motion.

a unique instrument in that it must be highly sensitive to the input of sound energy but should also be insensitive to the input of structure-borne energy. These are decidedly conflicting requirements. As a general rule, the sensitivity to structure-borne sounds will increase with the mass of the diaphragm in the transducer. The electret condenser transducer unquestionably has an advantage over the dynamic transducer in this regard. Figure 4 shows a simplified representation of how the microphone transducer reacts to structure-borne noise. In order to reduce the effects of this type of noise, it is standard practice in dynamic microphone designs to introduce a shock absorber between the outer case of the microphone and the dynamic transducer. Because of its inherent low sensitivity to structure-borne noise, the requirement for shock isolation of the condenser microphone is significantly less than that of a dynamic microphone. This results in two important considerations.

A. For a given structure-borne noise sensitivity, the cost of the shock isolation in a dynamic microphone will be higher than that of a comparable electret condenser microphone.

B. The requirement for shock isolation will add to the size of the dynamic microphone. Stated conversely, the electret condenser microphone could be made smaller because of the simplicity of the shock isolation required. This feature has merit, for example, in a lavalier microphone or a microphone mounted on a headset boom. The advantage is less in situations where microphone size is determined by other factors such as windscreens, pop filters, and cable connectors.

We feel that insensitivity to structure-borne noise can be the major advantage of electret condenser microphones in sound-reinforcement applications.

5. *Pop and Wind Noise.* Measurements on a large variety of dynamic and condenser microphones indicate that both transducers are equally susceptible to pop and wind. A reduction of pop and wind noise must be achieved through the use of external windscreens and pop filters in either case.

6. *Reliability.* As stated previously, reliability is an extremely important factor in comparing products for sound-reinforcement applications. We will consider three factors relating to reliability: mechanical ruggedness, the effect of humidity, and the effect of temperature.

With regard to ruggedness, the dynamic microphone has proved itself over a period of more than 30 years. A properly constructed dynamic microphone is sufficiently rugged to withstand the rigors of severe sound-reinforcement applications. The electret condenser microphone has yet to prove itself. The answer to the question of relative ruggedness will only be gained through experience over an extended period of time.

In humid conditions, the dynamic transducer presents no problem. Care must be taken, of course, to adequately protect metallic parts, but this is standard practice in all quality microphones. The electret transducer, on the other hand, has potentially severe problems in humid atmospheric conditions. High humidity can cause the loss of the electret charge. This

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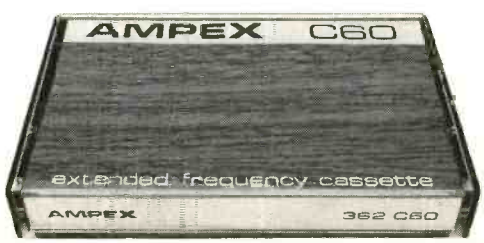

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was a problem in electret devices made several decades ago, using Carnauba wax, and presents a potential hazard to modern-day electrets employing plastic materials. Clearly, for the microphone to be satisfactorily reliable, the electret charge must be maintained under the extreme conditions often found in sound-reinforcement applications.

In laboratory tests, our company considers life of 1,000 hours at 100% relative humidity to be a minimum requirement for any microphone. We have tested several electret microphones that would not withstand this test at room temperature. Our conclusion is that suitable electrets can be made, but that humidity still presents a potentially serious problem for the electret.

In comparing the two transducer types under conditions of high temperature, we find the onus again is on the condenser to match the known performance capability of the dynamic. Dynamic microphones made by Shure are required to withstand storage temperatures from –20 degrees F to +165 degrees F and must operate within standard performance specification at temperatures from –20 degrees F to +140 degrees F. We have found these to be suitable temperatures to guarantee reliability in performance of the microphone under field conditions. The electret condenser microphone must, of course, also be capable of withstanding these extremes of temperature. The high end of the temperature range will offer the most difficult problem for the electret, particularly when combined with high humidity.

An additional factor that must be considered in evaluating the electret condenser microphone at high temperature is the effect of temperature on the dry cell incorporated in many of these microphones. Most alkaline and carbon zinc batteries will not withstand a temperature of +165 degrees F for an extended period of time. We would include the dry cell in temperature tests to determine whether any leakage of the cell might damage the microphone. Since the dry cell is normally easy to replace, we feel that it is reasonable to change to a new dry cell for subsequent testing after the high temperature exposure is completed.

7. *Output Level.* Since the electret condenser microphone must be supplied with a built-in preamplifier, there is a possibility of providing a very high output level—much higher than with the unamplified dynamic microphone. Care must be taken in providing a low-noise preamplifier in order to achieve suitable signal-to-noise performance. The design must also consider the problem of amplifier saturation in order to minimize distortion at high sound-pressure levels. The advantage of a high-output level is somewhat mitigated by the fact that an excessively high-output level can result in overloading the input stages of the mixer or amplifier to which the microphone is connected. Typical output of a dynamic microphone is in the order of –57 dB with reference to one volt per microbar. We would question the value of an output level of greater than roughly –52 dB because of the probability of overload in subsequent stages of amplification.

8. *Distortion.* Dynamic microphones usually exhibit very low distortion. We have measured a large variety of both omnidirectional and unidirectional dynamic microphones at levels up to 150 dB sound-pressure level. Total harmonic distortion is typically below 1% up to the highest pressure measured. (As a point of reference, 130 dB sound-pressure level can cause physical damage to the ears.) Similar measurements on condenser microphones indicate total harmonic distortion below 2% for the majority of microphones, and below 1% for the higher quality condenser microphones up to sound pressure levels of 130 dB SPL. Condenser microphones exhibit a relatively sharp overload point in the range of 130 to 150 dB SPL, at which level the distortion rises very rapidly. This type of distortion can be caused by bottoming of

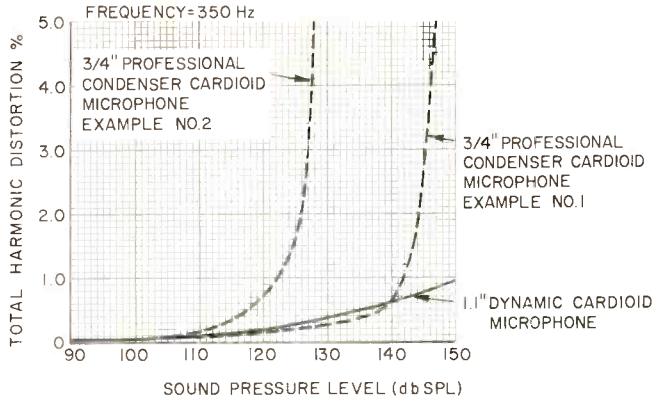

Fig. 5—Overload characteristic examples of condenser and dynamic microphones.

the diaphragm but is normally the result of clipping in the preamplifier. Figure 5 shows total harmonic distortion versus sound-pressure level for typical dynamic and condenser microphones.

The two transducers can be comparable in terms of distortion at normal sound-pressure levels and can be suitable for maximum sound-pressure levels normally found in sound-reinforcement applications. The dynamic transducer is inherently less difficult to control with regard to distortion and has an advantage in being able to handle extremely high peaks of sound pressure, which may sometimes occur in "close talk" applications.

9. *Transient Response.* At this time, there is no standard test for transient response of a microphone. While this type of test is commonly used in evaluating amplifiers, loudspeakers, servomechanisms, and so on, there are several problems in applying the test to microphones. One problem is that of creating a standard transient; and at this date, no such standard has been devised or specified. A second problem is correlating the results of such a test with other types of measurements (such as frequency response) and with subjective reaction.

Since no standard test procedure exists, and since there is little documentation with regard to the significance of transient response tests, we do not feel that it is proper to make a comparison of microphones on this basis at this time. While one might easily design a test that will display differences between two microphones, to be fair one would have to document the significance of the differences noted. One major aspect of this documentation would certainly be the subjective differences. We strongly emphasize that this type of testing must be very carefully controlled with many variables to be considered. One cannot make a judgment based on a simple demonstration.

Conclusion

In summary, then, we would like to make the following points. Any comparison of microphone types must consider the application for which the microphone was intended. Comparison of microphone types is complex and must include all of the many pertinent characteristics. In comparing transducer types, one must consider the way in which the total microphone is designed and built. Either the dynamic or the electret condenser transducer can be employed in a good or bad microphone design.

This article has attempted to describe some of the more important characteristics pertinent to electret condenser and dynamic microphones in sound-reinforcement applications. The selection of a microphone will be made by the user and will be based on those characteristics that are most significant to the application. Æ

Activating Your Loudspeaker Crossover

Michael W. King

ONE OF THE PROBLEMS in hi-fidelity system design is that of a crossover network to divide the output spectrum into portions suitable for high and low frequency loudspeaker drivers. In the past, this has been achieved with the use of passive filters, as shown in Figure 1A. The disadvantage of this system is the non-constant input impedance of a direct-radiator loudspeaker.[1] A solution to this problem has been proposed by Ashley and Kaminsky,[2] employing a system like that shown in Figure 1B. In this system filtering is accomplished at low levels and the speakers are driven by low output impedance buffer amplifiers. Clearly, this isolates the driving point impedance of the loudspeakers from the output of the filter; and, in addition, the input impedance of the buffer amplifier can be made virtually any value of pure and constant resistance making this system also suitable for use with passive filters. In addition, it should also be noted that the typical passive network of Figure 1A requires capacitances on the order of tens of microfarads, which are expensive and difficult to obtain, while the active network of Figure 1B requires capacitors on the order of nanofarads, reducing the cost differential between the two systems.

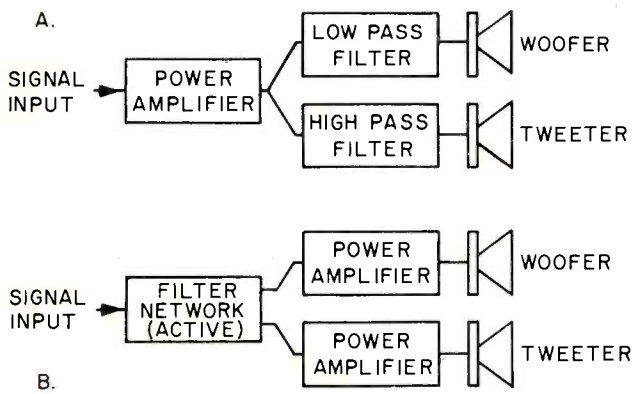

Fig. 1—Possible crossover-amplifier arrangements.

Following Ashley and Kaminsky,[2] a filter as shown in Figure 2 was constructed. This is an asymmetrical third-order network where the high-pass has a third-order Butterworth characteristic. Here the high-pass is achieved by an active filter and the low-pass portion is derived by subtraction of the high-pass signal from the total input signal. This design is of the constant voltage type described by Ashley[3] and Small,[4] meaning that the phasor sum of the outputs of the filter is equal to some constant in the frequency domain. Because of this, given perfect drivers and amplifiers, the total acoustic output signal will be a perfect reproduction of the source material. This can be demonstrated, as shown below by adding the transfer functions of the high and low pass filters to give the transfer function for the sum of the outputs.

$$\frac{e_{total}}{e_{IN}} = \frac{e_{HI}}{e_{IN}} + \frac{e_{LO}}{e_{IN}} = \frac{-0.5\,S^3}{S^3 + 2S^2 + 2S + 1} + \frac{-0.5\,(2S^2 + 2S + 1)}{S^3 + 2S^2 + 2S + 1}$$

$$= -0.5\,\frac{S^3 + 2S^2 + 2S + 1}{S^3 + 2S^2 + 2S + 1}$$

$$= -\frac{1}{2}$$

Thus, this network has a gain of one-half which is constant with respect to frequency. The filter was designed for a gain of one-half in order to simplify component values and to avoid problems caused by excessive levels.

A μA741 operational amplifier was chosen because of its high gain and wide range of operating voltages. This was chosen over the popular μA709 operational amplifier because the 741 requires no external frequency compensation. Supply voltage of $\pm$15v was chosen because this was most compatible

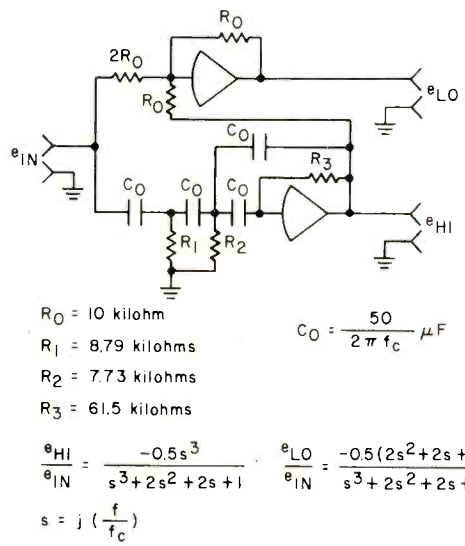

Fig. 2—Active filter network.

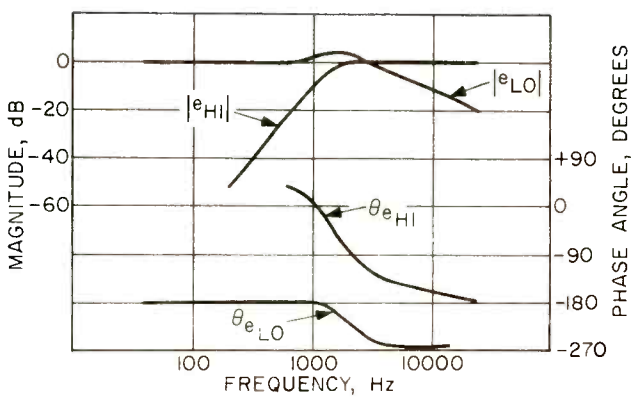

Fig. 3—Measured response of I.C. filter network.

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Table 1—Capacitor values for active filter network.

with the commercially available integrated-circuit power amplifiers and it was intended that both filter and buffer amplifiers could be powered from a common supply.

For this network, the slope of the high-pass characteristic in the stop-band is 18 dB per octave and the phase goes from –180 degrees in the pass-band to 90 degrees in the stop-band, with –45 degrees at the crossover frequency. For the low pass, the stop-band slope is 6 dB per octave and the phase response goes from –180 degrees in the pass-band to –270 degrees in the stop-band with approximately –180 degrees of phase shift at the crossover frequency. Ideally, perhaps, the phase shift in the pass-bands would be zero degrees; however, the operational amplifiers require an additional –180 degrees for stability because of the feedback employed. Note also that a filter could have been synthesized by deriving the low-pass and subtracting to obtain the high-pass. This would also be a constant voltage network and for a third-order low-pass would have an 18 dB per octave slope for the high-pass. The disadvantage to this arrangement is that, because of the greater energy in the low-frequency portion of the spectrum, the tweeter would be forced to handle considerably more power because of the lesser stop-band slope, and this might adversely affect reliability. Furthermore, because of their built-in inductance and reasonably civil behavior above the usual cutoff frequencies, today's low-frequency drivers are more suitable for use with a 6 dB per octave stop-band slope.

Component values were selected from Table IV of Ashley and Kaminsky's paper,[2] which is reproduced here as Table I, for a crossover frequency of 1584.89, which is suitable for an 8-in. woofer. The values specified by Ashley and Kaminsky are:

R_0 = 10 Kilohm
R_1 = 8.79 Kilohm
R_2 = 7.73 Kilohm
R_3 = 61.5 Kilohm
C_0 = 5.02 Nanofarad

Since these values are not readily available, some change was necessary as shown below.

R_0 = 10 Kilohm
R_1 = 8.79 Kilohm
R_2 = 7.8 Kilohm
R_3 = 60.7 Kilohm
C_0 = 5.0 Nanofarad

This was found to have a negligible effect on the actual response, as demonstrated by the fact that the measured –3 dB point of the high-pass signal (crossover frequency) was 1.55 kHz which is in error by less than 5 percent.

The measured frequency response is as shown in Table 2 and Fig. 3. We note that this is a very flat curve without unexplained bumps and glitches that sometimes plague passive

Freq., -Hz	e_{hi} Mag., dB	e_{hi} Phase, degrees	e_{lo} Mag., dB	e_{lo} Phase degrees	Freq., -Hz	e_{hi} Mag., dB	e_{hi} Phase, degrees	e_{lo} Mag., dB	e_{lo} Phase degrees
40	-50		0	-180.0	1200	-7.2	-12.7	2.9	-184.0
50	-50		0	-180.0	1400	-4.3	-33.4	3.5	-192.7
60	-50		0	-180.0	1700	-2.3	-62.9	3.6	-206.7
80	-50		0	-180.0	2000	-1.0	-81.9	2.8	-217.6
100	-50		0	-180.0	2500	-.4	-104.1	1.4	-229.5
120	-50		0	-180.0	3000	-.2	-118.4	-.1	-238.2
140	-50		0	-180.0	4000	-.1	-135.6	-2.6	-245.5
170	-50		0	-180.0	5000	-.1	-145.2	-4.5	-250.0
200	-52		0	-180.0	6000	0	-150.1	-6.0	-251.8
250	-47		0	-180.0	8000	0	-158.3	-8.0	-253.7
300	-42.2		0	-180.0	10000	0	-163.1	-10.6	-255.9
400	-34.8		0.1	-180.0	12000	0	-166.7	-12.3	-258.5
500	-28.9		0.2	-178.8	14000	0	-169.0	-13.8	-261.9
600	-24.3	42.1	0.4	-177.7	17000	0	-171.4	-15.8	
800	-17.0	27.4	1.1	-177.1	20000	0	-173.1	-17.5	
1000	-11.3	6.9	2.0	-178.8	25000	0	-179.4	-20.0	

Table 2—Measured response of f. C. active filter.

networks of this kind. Also note that the stop-band slopes and phase response are as predicted by myself, and Ashley and Kaminsky.[2]

In short, it is felt that the active filter network is a good performing, easy to realize alternative to the passive networks used in the past. In addition, given the relatively more common component values used as compared with a passive network for a similar function and the low cost of integrated-circuit operational amplifiers (the μA741 is available for less than $1.00), the cost differential should not be excessive. Æ

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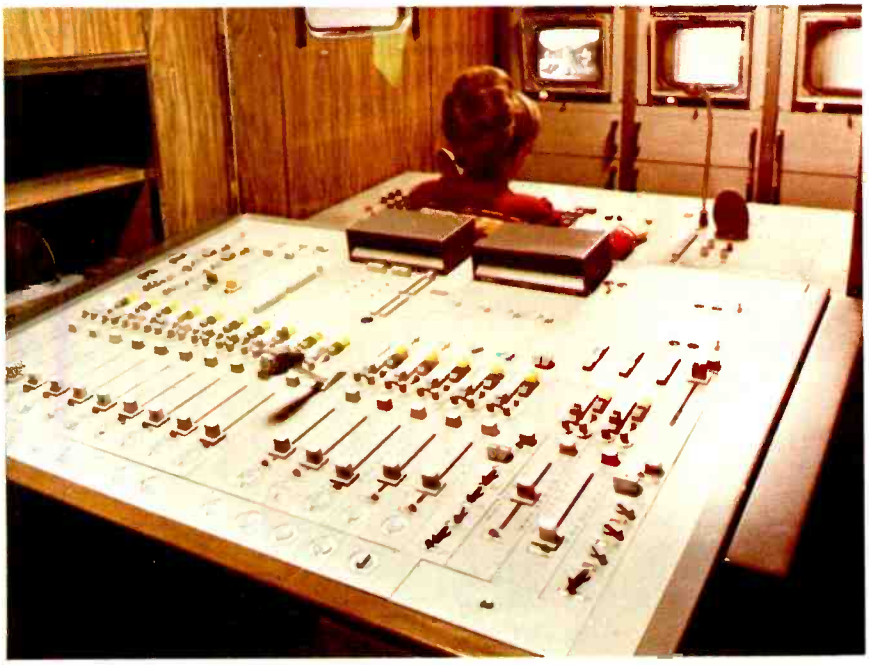
George W. Tillett

Editor's Review

I had been intrigued by a series of advertisements for Hungarian loudspeakers appearing under the above heading in some trade . . .

I HAD BEEN INTRIGUED by a series of advertisements for Hungarian loudspeakers appearing under the above heading in some trade journals and so, when I was invited to join a party visiting Hungary, I jumped at the chance to find out what "the people who brought us Franz Liszt" could have in store for us. (In passing, I notice that Deutsche Grammophon's European advertisements read "From the people who brought you Valhalla." It's up to the Italians now. . . .) Anyway, before I bring you Hungary, I want to "make one thing perfectly clear." I have experienced both Fascist and Communist states at first hand and I dislike any form of totalitarian government. Our free enterprise system is far from perfect but it gives more freedom and a higher standard of living than obtains anywhere in the world. That said, I must say that I was pleasantly surprised to find more freedom in Hungary than I expected and, although there is no *political* freedom, the regime is probably more liberal (in the best sense) than any in Eastern Europe. The standard of living is low by our standards, but even so it is better than that in surrounding countries. Conditions have improved enormously since the abortive (counter*) revolution of 1956 and Hungarians are now free to travel—a privilege granted to citizen groups in the Soviet Union. We stayed in Budapest which is a very beautiful city with many historical buildings. Much damage was caused during the war, but considerable rebuilding is in progress. Unfortunately, all the shops—with the exception of tourist centers—close promptly at 6:00 p.m., after which the good people of Budapest are swallowed up by the subway and the yellow caterpillar-lines of streetcars, leaving the town as deserted as Philadelphia on a Sunday morning. Well, not quite because there are 14 theaters and a multitude of restaurants—and some night clubs! It is a city of contrasts—incredibly ancient public telephone boxes outside a streamlined modern bus

*Take your choice.



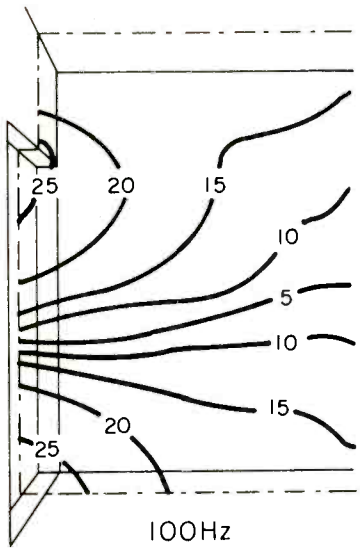
Typical EAG control desk.

station, an ultra-modern international-style hotel near gems of baroque architecture, and posters about America and Vietnam next to advertisements for Coca-Cola and the latest Streisand movie. In spite of anti-American propaganda (mainly confined to the Vietnam issue), I met nothing but friendliness and goodwill from people at all levels.

Every morning our party of 18 plus two interpreters were picked up at the crack of dawn by "Icarus 108-40"—a comfortable bus which in due course decanted us at a factory. Here we would be greeted by the staff and, after sampling the wine, we would look at the production lines, laboratories, and so on. Most of the organizations made loudspeakers but one in particular, ElectroaKusztikai or EAG, made a great variety of electronic equipment as well. The range included tape recorders, language laboratories, interpreter systems, communication systems, airport tape monitors, studio control desks, microphones, headphones, high power amplifiers, outdoor speakers, and acoustic panels. There is even a range of equipment called "Beat Set" designed for rock groups!

One of the cassette recorders demonstrated, used a noise reduction circuit called EX-CO, which appeared to be similar to the Dolby system. I could get no circuit details or figures beyond the claim that the S/N was improved by 10 dB—but it certainly sounded impressive. Another model handled both reel-to-reel and cassette tapes—not unknown here—but this model allowed for completely independent operation. It is mono only and the frequency response at 7½ ips is given as 40 to 16k Hz +3, -5 dB with a signal /noise ratio of 45 dB. Motorola and RCA transistors are used extensively but some are Hungarian made, as were the tape heads, plastic mouldings, and cassettes themselves. The studio desks appeared to be of a high standard with galvanometer type VU meters and up-to-the-minute low-noise circuitry. Typical figures were -125 dbm for microphone input and -74 dB for line. It was stated that 300 had been made during the past year and most of these went to the Soviet Union.

Videophone has several factories, employing a total of 10,000 people, and we visited two locations—both over 50 miles from Budapest near Lake Balaton. One produces all the woodwork and the other is devoted to electronics and loudspeakers. The acoustic labs were well-equipped and I was impressed with the amount of research devoted to cone materials, room acoustics, and absorption properties of materials. One of the novel devices developed here was an ingenious method of plotting a sound field by using colored lights. Five lamps of different colors are fixed close to a microphone which is mounted on a rod. Output from the microphone is fed to a level recorder fitted with contacts arranged to switch on one of the lamps when the output of the microphone is within one of the relatively narrow level ranges plotted. A camera with open shutter is used to photograph the sound field variations which appear as isobars. The system was the subject of a paper presented to the 7th International Congress of Acoustics, Budapest, 1971.



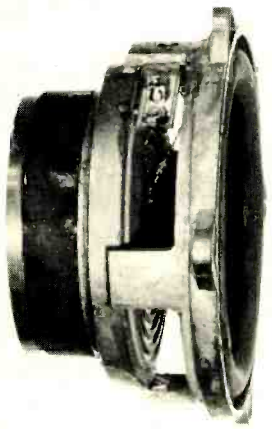
Showing sound field penetrating through a door at 100 Hz.

Most of the lab instruments were made in Hungary but I also noticed equipment by Marconi, B & K, Hewlett-Packard, Solartron, and Radiolab. Loudspeakers by Wharfedale, Tannoy, and Electro-Voice were also seen in one of the labs. Loudspeaker magnets used were either Alnico 5 ring magnets or ferro-ceramics made in other Hungarian plants, but speaker baskets and cones were made in this particular factory. I should mention here that Videotone and EAG are part of the same group and like the rest of Hungarian industry, controlled by the State.

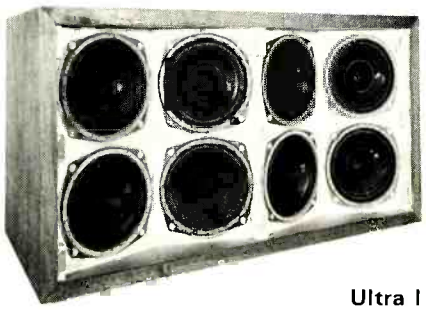
The assembly lines at Videotone were like others we saw—reasonably efficient but (to our eyes) they did things the hard way. For instance, where we use electric or air-operated tools to insert screws, they use hand drivers. We use automatic sweep generators and all kinds of production aids to reduce costs but they get the same results in the end because of the rela-

tively low overall production costs. For instance, girls on the assembly line get 8 to 9 forints an hour for a 48-hour (5½ day) week. At the present rate of 30 forints to the dollar, this is still pretty low but the cost of living, subsidies, and fringe benefits must be taken into account. For those interested, some comparative figures are given at the end.

Several speaker systems, ranging from single units in small enclosures to studio monitors, were demonstrated. Amplifiers included a McIntosh and a Videotone with an AR turntable and a Pickering V-15 cartridge. At least, I believe it was but I cannot be certain. Sound quality varied and I hesitate to pass judgment as the program material was not that good. I liked a small system, the 132, which used a 5-in. bass unit with a 4-in. treble speaker. The bass unit had an unusually large magnet—about 22 ounces, I would guess—and the cone surround was of soft rubber. Flux would be around 12,000 lines and the voice coil looked just over an inch in diameter. At the other extreme, I liked the HEC-11 studio monitor which used a 12-in. bass unit with four 5-in. speakers. Each speaker system had its own built-in 50 W amplifier which incorporated narrow-band adjustable filters. The enclosure itself is vented and the system could handle a great deal of power with low coloration. But the speaker that attracted most interest from our group was the Ultra-1, already available here and in Canada. It uses nine 4½-in. double-cone speakers in an enclosure measuring 13 in. high, 23 in. wide, and 11 in. deep. Eight speakers are mounted at the back and one at the front. However, unlike similar systems, placement is optional and the enclosure can be turned around so the eight units face the front. In other words, the stereo image can be diffuse or sharp according to the room acoustics or listener's preference. Price here is $399.00 a pair and we hope to review this model in the not-too-distant future. Incidently, Videotone makes a very big range of radio receivers as well as TVs—both monochrome and color.



Bass speaker used in the D-132 system.



Ultra I

The woodwork factory was set in rural surroundings some miles away and we were all impressed by the high standard of craftsmanship. The majority of cabinets were spray-finished in a high gloss polyethylene which is not too popular here but many other finishes are available.

The Budapest broadcasting network comprises two AM stations in the medium frequency bands, a short wave, and a FM stereo transmitter. We visited the studios near the center of the town and were somewhat surprised to learn that cameras could not be taken inside. The 1956 revolution started here and it would seem that the authorities are still a little nervous. Be that as it may, we were received with typical Hungarian courtesy and shown the studios and control rooms. The director told us that they recorded in four-channel but had made no broadcasts in this medium so far. Microphones were AKG and Neumann and combinations of spaced and MS were used for quadraphonics. Studio equipment was EAG with Hungarian EMG tape recorders which looked very similar to the Studer. Monitor speakers were larger versions of the HEC-11 with a 15-in. bass unit crossing over at 650 Hz to eight 5-in. speakers arranged in two semi-circles.

Qualiton and Hungaroton records have a worldwide reputation and a visit to their studios was one of the highlights of our busy week. Present production is over three million discs a year, of which over 50 per cent is classical. Although accent is on Brahms, Hayden, Bartok, Beethoven, and Mozart, special attention is also given to young contemporary composers. Up to the present, no quadraphonic discs have been made and I got the impression that the studio manager regarded the whole idea with some suspicion. . . . Recorders were Studio Telefunken but these will be replaced with EAG models later this year. Monitor speakers were Goodmans Tri-Axials mounted in corner enclosures. It was noted that the customary 8 and 16 channel recorder/mixing units were absent, but we were told these would be installed soon. Which may be a pity. . . .

One of the most interesting experiences was watching a musician-engineer (their description) editing pops, crackles, and other noise from a tape. There he was, sitting at an editing recorder, snipping off tiny pieces of tape and joining up. The tape was an old one—Mengleberg conducting the Amsterdam Concertgebouw playing Bartok's Second Violin Concerto with Zoltan Szekeley. It was made way back in 1939 and the performance was a brilliant one. Although the engineer-musician had a big collection of tape ends, he estimated that the total musical loss would only be a second or two. (Tape speed was 15 ips.) A very tedious job, though, but rewarding in the artistic sense.

After a brief look at the new sound system at the National Theatre, we went to the Erkel Opera House to hear a Hungarian Operetta by Ferenc Erkel. I thought the staging was excellent and the orchestra gave a really polished performance. Acoustics were very good

and most of the audience got about 90 per cent *direct* sound (sorry about that!). Seats were somewhat cheaper than Broadway standards at 25 cents!

So, apart from speeches at the Chamber of Commerce and a visit to a state wine farm, which I refuse to discuss, thus ended a most exhausting but enjoyable week. And now for some conclusions.

*The EAG group already export some 85 per cent of their products but there is no doubt that they could sell studio and communications equipment in the U.S.

*The speaker systems are competitively priced and I am certain that in this area the Hungarians will pose a serious challenge to Japanese and U.S. made products—and possibly to Western European manufacturers too.

*I see no reason why we cannot trade with Hungary. Ultimately this would raise their standard of living with far reaching results. I have the impression that the Hungarians want to look west as well as east. Of course, trade has to be two way, but they are already importing American transistors, instruments, and many other items. The more dollars they earn, the more they can buy from us.

Finally, I would like to thank Mrs. Edith Vezér of Elektromodul, the Hungarian trading company, and Mr. G. Simonyi from Ultra-Tone of Canada, who organized the trip.

Here are some comparative prices (30 forints to the dollar):

Salaries: Top managers, executives, chief engineers . . . 5000 forints/mo.
Middle echelon managers, engineers, supervisors . . . . . 3000 forints/mo.
Semi-qualified engineers, manual workers . . . . . 2000 forints/mo.
Assembly workers, girls . . . . . .8 to 9 forints per hour (48 hour week).

Prices (selected at random):
Cars, VW, ... 110,00 forints
East German (DDR) mini . 60,000 forints
TV, B&W, 18 in. . . . . 8,500 forints
Men's suits . . . . . 750 forints
Leather shoes . . . . . 500 forints up
Suede shoes . . . . . 250 forints up
Cassette recorder . . . . . 300 forints
12-in records . . . . . 35 to 60 forints
Bread (subsidized) . . . 3 forints/kilo
Coffee . . . . . 32 forints/6 oz. app.
Tea . . . . . 30 forints/6 oz. app.
Beef . . . . . 50 forints/kilo
Dinner in a restaurant . . . . 25, up to 100 forints for a gourmet meal

One engineer told me that the Hungarian bank has a "car winning" deposit scheme. Participants stand a chance of winning a car by a lottery—but the snag is—no interest is paid! Normal interest rates are 3 per cent for three months minimum, and 5 percent yearly—capitalist thinking which would make Karl Marx turn over in his London grave!

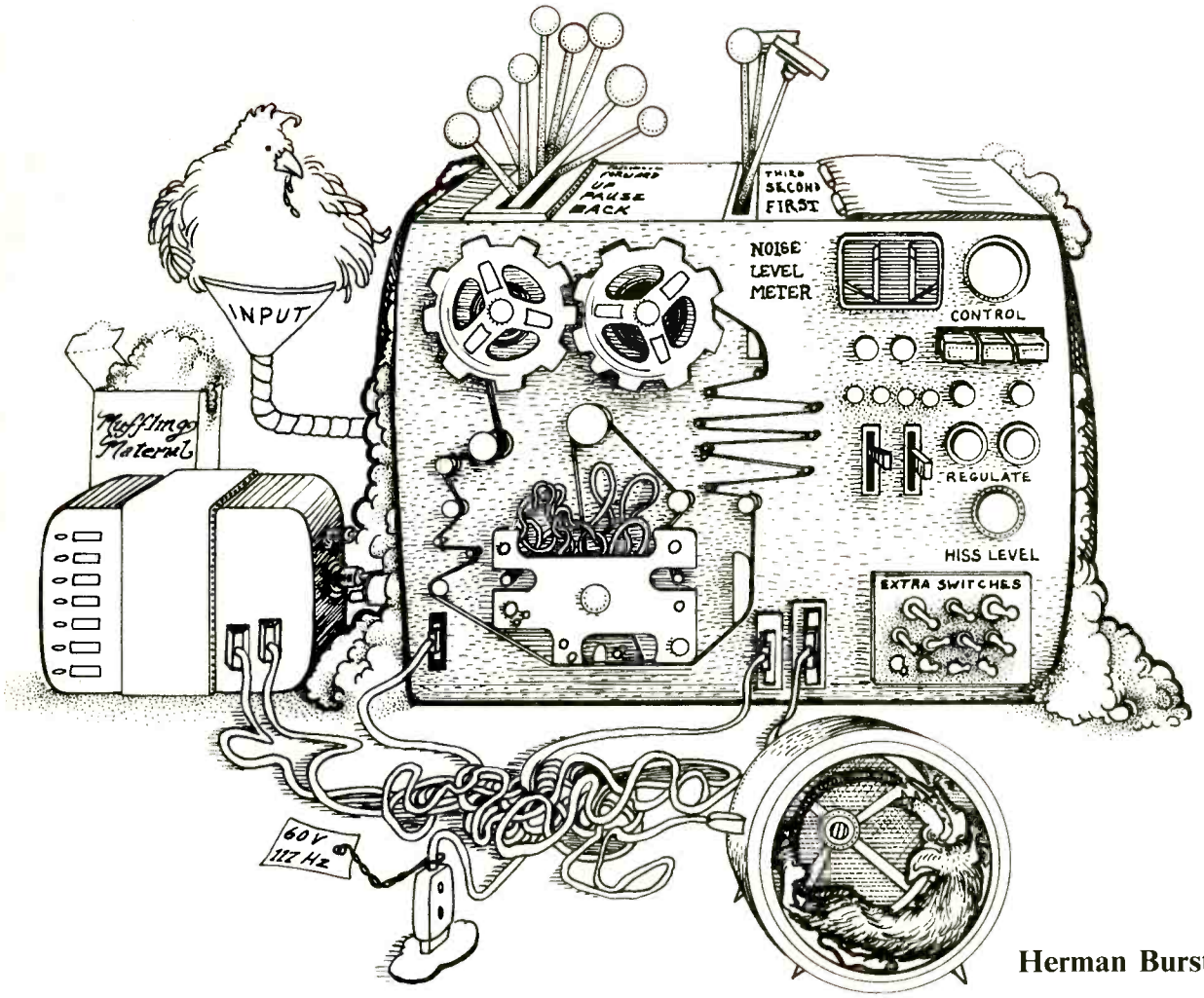
Rents are cheap and vacations in group centers are heavily subsidized. Books are relatively inexpensive, so are theater prices as noted previously. Finally, some advice for those who will be visiting Hungary.

*The food is magnificent, so don't go if you are on a diet and have no will power.

*The wine is very potent, so be careful.

*Bring Alka-Seltzer tablets. Æ

TAPE RECORDERS--
A View From The Crystal Ball



Herman Burstein

LOOKING BACK at the nearly 25 years that the tape recorder has belonged to the family of home entertainment devices, one can count numerous and wondrous advances. The tape machine one buys today in the range of about $300 to $1,000 is a remarkable instrument. But is it all one could ask for? Has the technology fully matured? Have all the features and conveniences been thought of? From here on can one essentially expect only more of the same? I doubt this very much, judging from letters to the TAPE GUIDE, from what the experts say, from my own experience, and from the momentum of technology.

I have not attempted to survey manufacturers as to the innovations they plan for the next several years. For one thing, I suspect they are unwilling to reveal the aces up their sleeves, that is, to tip off the competition. Mainly, though, I feel what the future holds is geared to the *felt needs* of the present. Therefore my thoughts about the future do not try to conjure up undreamed of marvels, but relate largely to problems of the present.

Even so, some of these thoughts may seem far out to some persons. Here I am reminded of a conversation I had about 10 years ago with the chief engineer for a tape manufacturer. He stated that audio tape then was just about as good as it ever was going to become in terms of extended treble response, low noise, and low distortion. Yet there have been substantial improvements in tape since that conversation. Hence I hope the reader, whether amateur or expert, will be charitable toward my expectations, far out as they may seem.

For the most part my thoughts concern open-reel tape decks, which are still the principal medium for high fidelity. But the reader can freely translate these thoughts into terms of cassette machines. So, following are ten possible developments to increase the happiness of the tape recordist.

Speed Control

A number of the better phonographs enable the user to rapidly check and adjust turntable speed. Strobe markings and a neon lamp permit a check for accurate speed. And speed may be adjusted over a useful range by such devices as a magnetic brake or a variable-diameter shaft. Why not something similar for tape machines? Some audiophiles with treasured tapes made on an

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Choice of Color
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Please ship my order to: ☐ Home ☐ Office

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Company _____

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Signature _____
(Order must be signed)

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P.S. I like the "Big As Life" Animal Skin Rugs. Please ship me the following products and charge my account only $98.50 ea. plus a slight additional shipping and handling charge.

Bear Rug (5' x 7') ☐ white ☐ brown ☐ black
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☐ Please bill my credit card $98.50 plus $3.50 freight and handling. (Fill in credit card info on the left)

AU-4

old off-speed machine would like to play them on a new machine if the latter's speed could be adjusted. Individuals playing prerecorded tapes or exchanging tapes would like to have correct speed, or at least speed satisfactory to their ears. The meticulous user would like to be able to check whether speed stays correct throughout the reel. And so on.

Reversibility

I have in mind an improvement and extension of what is already with us. Although a number of tape machines feature reversibility, few do so in a way that provides maximum usefulness. Many of the reversible machines operate this way only in playback, not in recording. Yet to me the reversible feature has the most importance in recording, because the tape may run out in the midst of a prized and unrecapturable moment of the recording session. (I become all thumbs in trying hastily to reverse the reels, rethread the takeup reel, and put the tape in its proper path. Under this kind of stress, more than once have I put the base side of the tape against the heads.) In playback I am less unhappy about the reel running out, because I haven't lost any of the material I wish to hear.

Therefore I look forward to an increased number of tape decks that are reversible in recording as well as playback. The user should always have the option between automatic and manual reversal, so that the machine will not accidentally erase the tape as the result of inadvertent reversal in recording. Automatic reversal in recording should be on a fail-safe basis, requiring the user to push a button or lever *each time* he wants automatic reversal. To guard against accidental erasure, perhaps a bell might ring and/or a light might flash on as the machine approaches automatic reversal.

Noise Annihilation

So quiet now are all other components of a quality audio system that the tape deck looms prominently as the chief offender with respect to noise. For a long time designers of tape decks have struggled hard to inch up the signal-to-noise ratio by a decibel or two. Tape companies have considered it a prideful accomplishment to produce a tape that—all other things remaining the same—has 2 or 3 dB less noise. The difference between excellent and good S/N has generally been a mere four or five dB or so. A high quality machine can achieve something like 55 to 60 dB S/N, compared with S/N or 65 dB and higher in their components.

Fortunately, today's technology points not merely to further reduction of tape system noise by a few dB, but to virtual annihilation of noise. Compression systems, such as those of Dolby and Burwen, portend noise reduction by at least 10 dB and possibly by as much as 50 dB.

To give an idea of what this is about, consider the tape system noise to be at 0 dB level. Assume the dynamic range—difference between the loudest and softest sounds—of the program material to be 50 dB. And assume the S/N ratio of the tape system to be 55 dB (quite typical for high quality home machines); that is, peak recording level (corresponding to maximum tolerable distortion) is 55 dB above the noise level. If the loudest material is recorded at peak recording level, then the softest material is recorded 50 dB lower, which is only 5 dB above the noise level. Hence noise is evident on soft passages, and even on medium ones if volume is moderately high. However, if S/N could be extended to, say, 70 dB, then the softest passages would be a handsome 20 dB above the noise.

In view of the importance of noise reduction, let us briefly inquire into the basics of compression systems such as those of Dolby or Burwen. The Dolby, on low-level signals, supplies boost in recording and corresponding cut in playback. With the cut comes a reduction of noise due to the tape and tape deck electronics. Since this process takes place only for low-level signals—when noise reduction is most needed—there is no tendency to overload the tape in recording as the result of the boosted signal. For home machines, the Dolby system operates only in the treble region, where most noise lies. For professional equipment, the Dolby system operates in several audio bands.

The Burwen system compresses all signals, so that the dynamic range becomes, say, 10 dB instead of 50 dB. Therefore the signal can be recorded at a level 40 dB higher than before; and the softest passages are an *additional* 40 dB above the noise of the tape system. In playback, the signal is expanded, so that the dynamic range of 10 dB again becomes one of 50 dB, with the softest passages retaining their *additional* margin above the noise. (This 40 dB extra margin is only illustrative; the actual margin could be less or more.)

Presently the tape recordist walks a tightrope in choosing the proper recording level: too high a level, and distortion is excessive; too low a level, and noise is excessive. Achievement of S/N of 70 dB or higher would greatly ease his task and would permit him to record material with greater dynamic range. For example, the task of recording electric guitar, with its tremendous peaks, would be simplified.

Instant Location of Program Material

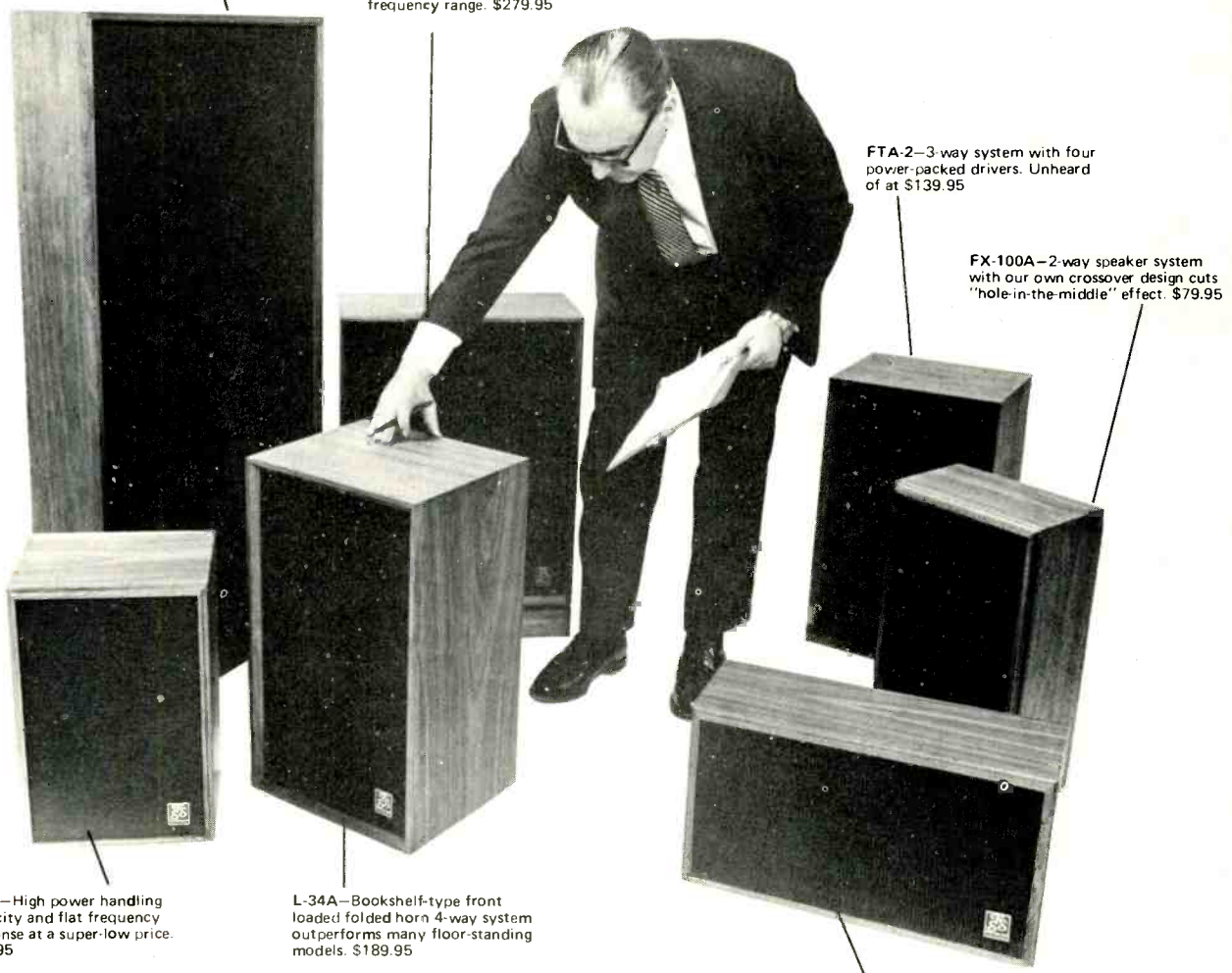
The index counter is a useful but only approximate device for finding the start of a desired selection within a reel of tape. By comparison, it is much easier to locate the exact start of a section of program material (visible band) on a phono disc, for example the beginning of a song. Perhaps a bit of ingenuity will eventuate in a more precise locating device for tape.

Front-Panel Alignment Controls

The high quality tape deck incorporates a variety of alignment controls to adjust some or all of the following: bias level, recording level, playback level, record-level indication, recording equalization (treble boost), playback equalization (bass boost), erase current, bias frequency, etc. Generally the manufacturer's philosophy has been to bury these controls well inside the chassis of the home tape machine to prevent the unversed user from fiddling with them. But not all users are unversed. In fact, many of those who purchase high quality machines are quite knowledgeable or on the way to being so. Many also possess equipment such as signal generators, a.c. VTVMs, and alignment tapes, permitting them to make the necessary alignments, particularly when shifting from one kind of tape to another. Such alignments, or realignments, become necessary as tape formulations change, as components in the tape deck change value with age and heat, etc. Also, many users like to experimentally learn the effects of changes in bias, equalization, etc. Perhaps we should keep in mind that the name of the game is not only "audio" but also "experiment." However, it is an awful pain to have to remove 10 knobs, 24 screws, 8 grommets, an awkward electrical interlock, and a chassis 1/16th inch wider than its cabinet in order to get at the alignment controls!

Some manufacturers of home tape machines have been kinder to the user by putting the alignment controls, or at least the principal ones, at the rear of the chassis. But even this can be a pain if the tape deck must be moved in order to get at the back. My hope is that in the future all alignment controls will be readily accessible to the user at the front of the tape deck—perhaps concealed under a hinged panel for

before you select a speaker look into all the Fax.



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Find out how experts test and rate our speakers in comparison to other leading speaker systems. Send for your free copy of a highly informative Test Report. A must before purchase.

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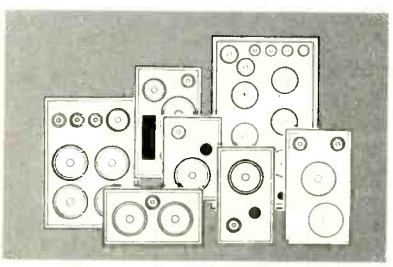

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esthetic reasons and as notice they are not operating controls.

It would be quite simple to prevent the user from radically fouling up the alignments if the manufacturer would put knobs on all the alignment controls and mark with paint the original factory setting for each knob. Thus the user would have benchmarks enabling him to return to the original setting of each control.

Built-In Test Facilities

A quality machine already has a signal reading device: the VU meter, which provides readings in dB. If the machine is further equipped with several test tones—say 400, 5,000, 10,000 and 15,000 Hz—it then incorporates very useful built-in test equipment, which can be used to check or adjust bias current, equalization, recording level, etc. In today's state of the art, a several-tone signal generator can probably be constructed in the form of an integrated circuit occupying minimal space.

How might the user put such equipment to work? For one thing, based on the tape manufacturer's recommendation for each of his tapes at each speed, he could adjust treble boost so that, relative to the reference frequency of 400 Hz, it is at the appropriate level at, say, 10,000 and 15,000 Hz. For example, a tape manufacturer might specify that his tape works optimally at 7½ ips when recording boost is 11 dB at 10,000 Hz and 16 dB at 15,000 Hz. Assuming the tape machine contains suitable switching facilities so that the internal signal generator and the VU meter are connected to the proper test points, the user could adjust recording boost to meet these specifications as closely as possible.

Next he could adjust bias current so that treble response in playback is as flat as possible, as measured by the VU meter. (We are assuming that the meter is truly a VU meter, with essentially flat response throughout the audio range.) He might then make fine touch-ups involving both treble boost and bias to achieve the flattest possible response. Or, to minimize distortion, he might increase bias at the cost of a slight sacrifice in treble, say 3 dB down at 15 kHz instead of perfectly flat out to that frequency.

With alignment test tape, the user can adjust azimuth of his tape heads; azimuth is correct when the VU meter gives a maximum reading in playback. With a frequency test tape, he can use the meter to check playback response, and he can touch up the playback equalization (if the machine contains such provision) for flattest playback response. By means of the internal signal generator he can check overall record-playback response at the available frequencies; then perhaps it might be nice to have a few additional frequencies, such as 50, 100, and 1,000 Hz. Using the standard reference tone on a test tape, at which the VU meter should read 0 VU in recording—he can adjust the record-level indication as follows: play the test tape; note the VU meter reading; record the 400 Hz internal frequency on the tape to be used for recording; adjust recording level until the same playback reading is obtained as for the test tape; at this recording level, adjust the VU meter calibration to read 0 VU.

Peak-Reading Record-Level Indicator

So long as the recordist is caught between the horns of excessive recording level and excessive noise, owing to a limited S/N ratio, it is highly desirable to know when signal peaks are exceeding maximum permissible recording level (corresponding to maximum tolerable distortion). That is why I have long favored the electronic eye, which is a peak-reading device, over the VU meter, which is an average-reading device. And that is why it is the practice in a number of foreign countries to use peak-reading meters.

On the other hand, a meter that reads average signal level also has its advantages, for example in equating the levels of different sound sources or in making level adjustments of known magnitude. The best answer therefore seems to be to provide the recordist with both average-reading and peak-reading devices. For example, an electronic eye could be built within the case of a VU meter or it could be mounted atop or below the meter. Possibly a meter can be designed with two pointers and two scales for average-reading and peak-reading.

Radio-Pickup Elimination

Quite a few readers complain about their tape machines, particularly in playback, picking up nearby radio broadcasts—AM, FM, military, aviation, etc. It would be no great problem for home tape machines to include better filtering at the inputs of the recording and playback amplifiers to prevent such pickup.

Modular Components For Easy Servicing

Audiophiles often find it quite burdensome to go through the process

of having their tape decks serviced. Often this involves locating a reputable service agency, lugging or shipping the machine to the agency, waiting several weeks or months for the machine to be serviced, and hoping the machine is cured of what ailed it—a hope too often unfulfilled. Use of modular components, perhaps some 8 or 10 modules for the electronics, could go a long way toward helping the user be his own serviceman. If separate modules are employed for each stereo channel, most of the modules would be duplicates, permitting interchange of modules between channels in order to identify a defective module. For example, if Channel A isn't recording but Channel B is, then substituting Channel B modules into Channel A, one at a time, is apt to turn up the defective module. If modules can be kept to a low cost, say under $10 each, it might pay for the user to stock spare modules in the way he used to stock spare tubes.

I wonder how far the modular approach can be carried out in the case of the electro-mechanical portion of the tape deck, that is, the transport mechanism. Given hard thought to the matter, design improvements might be achieved which permit the user to at least make some repairs with ease, such as changing belts, brakes, idlers; adjusting tape tension; replacing heads; etc. In this age when good service is hard and costly to come by, it is to be expected that the machine of the future will be serviceable by the user to a higher degree than now.

Improved Logic

Modern tape recorders pay much attention to the logic of their controls; that is, to be proof against the user making the wrong move which might break tape or accidentally erase a recording, and to minimize the number of controls and connections required to achieve a desired effect. It is to be expected that the trend will continue. To illustrate, not all tape machines give adequate warning that the unit is in record mode; a panel lamp that glows when the machine is in record mode, and starts glowing before the transport starts up, is desirable. Not all machines make it easy to get into the sound-on-sound mode; some require special reconnection of cables. Some machines facilitate feeding a mono signal into both outputs of the unit, while others don't. With some decks it is easy to record on one channel while playing the other, and with other decks it is difficult or impossible. Æ

Open Reel Tape Recorders

Crown SX824

Akai GX-280D

Concord Mark VIII

Astrocom/Marlux 711

MANUFACTURER	MODEL	Speeds (see letter code)	Power amp(s) built in?	Max. reel size, in.	No. of heads	No. of tracks	No. of motors	Drive motor type	Drive to capstan	Frequency response, Hz to kHz, ± 3 dB	Wow and flutter, %	Signal-to-noise ratio, dB*	Fast wind, 1200 ft., sec.	Mic. input Z, ohms	Rec'ng level indicator type	Dimensions W × D × H, in.	Weight, lbs.	Price	Special Features
AKAI	X330	A	Yes	10½	4	4	3	Hys.	Belt	30-25k ±3	0.04	50	60	10k	2 Mtrs.	17⅛ × 14¾ × 9⅜	48½		
	GX-365-D	G	No	7	3	4	3	Hys.	Belt	30-28k +3	0.04	55	60	10k	2 Mtrs.	16¼ × 18½ × 11⅛	56		
	1730-55	B	No	7	4	4	1	Hys.		30-22k ±3	0.12	50	75	30k	4 Mtrs.	16½ × 18 × 9½	33		
	GX-280D	B	No	7	3	4	3	Ind.	Direct	30-24k +3	0.08	50	60	10k	2 Mtrs.	17 × 10 × 18	44		
	GX-220D	A	No	7	3	4	3	Ind.	Direct	30-24k ±3	0.08	50	60	10k	2 Mtrs.	17¼ × 9¼ × 17	41¾		
ALLIED RADIO SHACK	909B	A	Yes	7	2	4	1	Ind.	Belt	50-18k	0.2	40			2 Mtrs.	24¼ × 14 × 7½	25	199.95	
	999B	A	No	7	3	4				40-20k	0.2	40			2 Mtrs.	16 × 7¾ × 13¼		179.95	
AMPEX	AX 300	A	No	7	6	4	3	Hys.	Idler	20-20k ±3	0.09	57	55	Hi	2 Mtrs.	16½ × 14½ × 6	45	599.95	Speed logic cir.; outside bias & VU mtr. calib.; heads—2 rec., 2 PB, 2 erase.
ASTROCOM/MARLUX	711 4-Chan.	B F	No	10½	4	4*	3			25-24k	0.06	60		Lo	4 Mtrs.			Under 2,000.00	*4-chan., synch. recording, mixing.
	407	B	No	7	4	4	3	Hys.	Belt	30-20k	0.07	50	60	10k	Dual Mtr.	21 × 14½ × 10½	27	459.95	Auto rev., PB; s-w-s; s-o-s-; solenoid conts.
BANG AND OLUFSEN	Beocord 1800	A	No	7	3	4	1	Hys.	Idler	30-18k ±2	0.07	65	120	200	2 Mtrs.	17¾ × 15 × 8⅞	36	400.00	S-o-s; echo; sync. PB; PA facility; mixing.
	Beocord 2400	A	Yes	7	3	4	1	Hys.	Idler	30-18k ±2	0.07	65	120	200	2 Mtrs.	17¾ × 15 × 8⅞	37	450.00	As above w. 2 10-W. rms amps.
CONCORD	MK 8	A	Yes	7	2	4 or 8	2	Ind.	Belt	50-12k	0.2	45		2k	2 Mtrs.	18 × 16¼ × 8¼	49	319.95	
	Mk 4	A	No	7	4	4	1	Hys.	Idler	20-23k ±4	0.08	52		50k	2 Mtrs.	17 × 17 × 8½	25¾	279.95	Auto Rev. PB; silent sensing; dual capstan.
CROWN	SX724	B	Opt.	10½	3	4	3	Hys.	Belt	20-25k ±2	0.09	60	45	350k	2 Mtrs.	19 × 9 × 15¾	45	995.00	Dual mike-line mixing; 5-in. VU mtrs.; also ½ track.
	SX824	B, F	Opt.	10½	3	4	3	Hys.	Belt	20-20k ±2	0.09	60	45	350k	2 Mtrs.	19 × 9 × 15¾	48	1,495.00	Wal. Cab.; tape contr. opt.; also ½ track.
	CX822	E	Opt.	10½	3	2	3	Hys.	Belt	30-30k ±2	0.06	60	45	250 (bal)	2 Mtrs.	19 × 9 × 17½	53	2,120.00	As above; also 4-chan. ¼ track.
	SC744	B	Opt.	10½	3	4	3	Hys.	Belt	20-25k ±2	0.09	60	45	350k	4 Mtrs.	19 × 19 × 21	60	1,895.00	8 mike inputs.

Pioneer QT-6600

JVC 1694

Speeds indicated by letter code:

	A	B	C	D	E	F	G	H
15					X	X	X	
7½	X	X	X		X	X	X	
3¾	X	X	X		X		X	X
1⅞	X		X	X			X	X
15/16			X					

*at the highest speed of the machine

Revox A77-Dolby

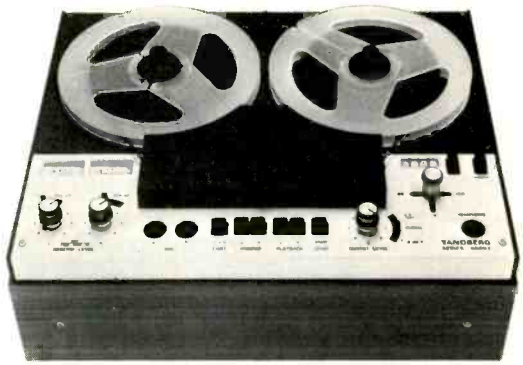
Kenwood KW-8077

MANUFACTURER	MODEL	Speeds (see letter code)	Power amp(s) built in?	Max. reel size, in.	No. of heads	No. of tracks	No. of motors	Drive motor type	Drive to capstan	Frequency response* Hz. to kHz. ± dB	Wow and flutter, %*	Signal-to-noise ratio, dB*	Fast wind, 1200 ft., sec.	Mic. input Z, ohms	Rec'rng. level indicator type	Dimensions W × D × H, in.	Weight, lbs.	Price	Special Features
GRUNDIG	TK-600	B	No	7		4	1			30-18k ±2	0.15	50		100k	2 Mtrs.	16½ × 14¼ × 7¼		430.00	S-o-s; auto stop; auto & manual rec. level.
JVC	1694	A	No	7	3	4	1			30-20k	0.15	52				15¼ × 8⅛ × 12⅜	20	149.95	S-o-s, s.w-s, side vol. controls.
	1400 4-chan	B	No	7	3	4	1		Idler	20-25k ±1.5	0.07	53		10k	4 Mtrs.	15¼ × 8⅛ × 12⅜	20	399.95	4-chan. PB & rec.
KENWOOD	KW4066A	A	No	7	3	4	1	Hys.	Idler	25-20k ±3	0.15	50	150	10k	2 Mtrs.	16 × 12¼ × 7	22	199.95	Auto stop; slide vol. conts.; bias swit., tape mont. & mode swit.
	KW-4077	A	No	7	3	4	1	Hys	Idler	20-20k ±3	0.12	50	260	2k	2 Mtrs.	16 × 17⅞ × 7⅞	26½	309.95	Auto rev. & repeat; slide vol. conts.
	KW-6044 4-chan.	A	No	7	3	4	1	Hys.	Idler	20-20k ±3	0.12	50	150	50	4 Mtrs.	16 × 15½ × 7	22	359.95	4-chan. PB; auto stop.
	KW5066	A	No	7	4	4				25-20k	0.15	50			2 Mtrs.	16 × 15½ × 7	22	279.95	Rec. bias adjust; s-o-s
	KW-8077	B	No	7	6	4	3	Ind. /		20-20k	0.04	52			2 Mtrs.	17 × 9 × 19¾	46	559.95	Auto Rev. PB & Rec.; search sys.; 5-step equalizer control.
PANASONIC	RS-736US	E	No	7	3	4	1	Hys.		30-25k ±3	0.09	53	150	600 20k	2 Mtrs.	17 × 8½ × 18½	33	329.95	Bias adjust.; mixer; s-o-s; s-w-s.
PIONEER	T-8800	B	No	7	6 (4)	4	2	Hys.	Belt	40-15k ±2	.08	55	110	50k	2 Mtrs.	21-29/32 × 16½ × 9½	50	549.95	PB/Rec auto rev.; G head; bias selec.; s-o-s; easy load.
	T-6600	B	No	7	4	4	1	Hys.	Belt	50-15k ±2	.12	55	110	50k	2 Mtrs.	17-3/16 × 7-5/32 × 17	28	299.95	PB/Rec. auto rev.; pause cont.; easy load.
	T-6100	B	No	7	4	4	1	Hys.	Belt	50-15k ±2	.12	55	110	50k	2 Mtrs.	15-15/16 × 6-27/32 × 14⅜	26	249.95	PB auto rev.; pause cont.; easy load.
	QT-6600 4-chan.	B	No	7	5	4	1	Hys.	Belt	30-20k	.12	55	110	50k	4 Mtrs.	–	–	599.95	4-chan. rec./PB; 2 chan. rec /PB; auto rev.
PREMIER	70A-TRSH	E	No	10½	3	2	3	Hys.	Direct	35-26k ±2	0.08	56	60	50k	2 Mtrs.	19 × 8½ × 21	69	675.00	Solid state, modular plug-in boards. Portable case, $37.00. 70A-TRSQ has 4 tracks.
REVOX	A77	B	Opt.	10½	3	2 or 4	3	Hys.	Direct	30-20k ±2-3	0.08	61	60	Hi, Lo	2 Mtrs.	16 × 8 × 14	34	649.00	For Dolby, add $210.00. Auto rewind; varia. pitch.
	A77 HS	F	Opt.	10½	3	2 or 4	3	Hys.	Direct	30-20k ±1.5	0.04	64	60	Hi, Lo	2 Mtrs.	16 × 8 × 14	34	749.00	As above.

Open Reel Tape Recorders

Sony/Superscope TC-277-4

Sansui SD7000



Tandberg Series 6000X

MANUFACTURER	MODEL	Speeds (see letter code)	Power amp(s) built in?	Max. reel size, in.	No. of heads	No. of tracks	No. of motors	Drive motor type	Drive to capstan	Frequency response, Hz to kHz, ± 3 dB	Wow and flutter, %	Signal-to-noise ratio, dB	Fast wind, 1200 ft., sec.	Mic. input Z, ohms	Rec'ng level indicator type	Dimensions W × D × H, in.	Weight, lbs.	Price	Special Features
SANSUI	SD7000	B	No	7	4	4	3	Hys.	Belt	15-25k ±2	0.06	60	100		2 Mtrs.	21 × 17 × 10	60	679.95	Auto rev. w. 20-Hz sig. rec. built-in; auto rewind; opt. rem cont; auto sleep sw.
SONY/SUPERSCOPE	252-D	A	No	7	2	4	1	Ind.	Idler	30-18k ±3	0.12	52	150	600	2 Mtrs.	16-1/16 × 15 × 10¼	18	159.95	252, with amps, $229.95.
	353-D	A	No	7	3	4	1	Ind.	Idler	30-25k ±3	0.12	55	150	Lo	2 Mtrs.	15¾ × 7½ × 13-7/16	18	219.95	353, with amps, $329.95.
	330	A*	Yes	7*										Lo				349.95	*Reel-to-reel plus cassette.
	440	A	No	7	4*	4	1			30-25k ±3	0.06	56	100	Lo	2 Mtrs.	16-9/16 × 8½ × 16-3/16	27	369.95	*Auto reverse, 6-head function.
	580	A	Yes	7	4*	4	3			30-25k ±3	0.06	56	60	Lo	2 Mtrs.	17-9/16 × 8⅝ × 18¼	43	499.95	*Auto reverse, 6 head function.
	640	B	No	7	3	4	3	Hys.	Idler	30-20k ±3	0.07	55	90	Lo	2 Mtrs.	14½ × 9½ × 15½	33	349.95	Timer activated rec, PB, & stop.
	650-2	B	No	7	3	4	3	Hys.		30-22k ±2	0.04	59	90	Lo	2 Mtrs.	16¾ × 9½ × 17-5/16	46	499.75	650-4 $475.00.
	770-4	A	No	7	4	2/4	1			20-22k	0.09	56	180	Lo	2 Mtrs.	16¼ × 5-13/16 × 15-5/16	25	795.00	With 2 ECM-22 mikes, ni-cad battery.
	770-2	A	No	7	3	2	1			20-22k	0.09	58		250	2 Mtrs.	16¼ × 15-15/16	25	795.00	
	850-2	E	No	10½	4	2	3			30-25k	0.03	57	65	Lo	2 Mtrs.	17½ × 10 × 19¾	57	895.00	850-4, quarter track, $895.00
	366-4 4-chan.	B	No	7	4	4	1	Ind.	Belt	20-25k	0.09	55	120	Lo	4 Mtrs.	17 × 9¾ × 18¾	21	499.95	4-chan. rec. & PB.
	654-4 4-chan.	B	No	7	4	4	3	Hys.	Direct	30-22k ±2	0.04	57	60	Lo	4 Mtrs.	16¾ × 9¾ × 20	48½	875.00	4-chan. rec. & PB.
	854-4S	E	No	10½	4	4	3	Hys.	Belt	30-25k ±2	0.03	56		Lo*	4 Mtrs.	17⅞ × 10 × 22	61½	1,795.00	*Bal. Cannon XLR mic inputs, 4-chan. rec & PB, sync s-w-s.
	277-4 4-chan.	A	No	7	4	4	3	Hys.		50-18k ±3	0.12		90	Lo	4 Mtrs.			339.95	4 & 2 chan. rec. & PB; bias swit.; pause cont.; auto off.
TANDBERG	3041X	A	No	7	4	4	1	Asyn.		40-20k ±2	0.07	60	105	200	2 Mtrs.	15½ × 12⅜ × 6½	20	349.00	3041X, ½ track, $369.00.
	4041X	A	Yes	7	4	4	1	Asyn.		40-20k	0.07	60	105	200 600	2 Mtrs.	15½ × 12⅜ × 6½	23	459.00	4021X, ½ track, $478.50; 4041XQ, 4-chan. PB, $559.50.
	6041X	A	No	7	4	4	1	Asyn.		40-20k	0.07	61	105	200 600	2 Mtrs.	15½ × 12⅜ × 6½	21	499.80	6021X, ½ track, $528.00.

Telex 2001

TEAC 7030SL

Speeds indicated by letter code:

	A	B	C	D	E	F	G	H
15					X	X	X	
7½	X	X	X		X	X	X	
3¾	X	X	X		X		X	X
1⅞	X		X	X			X	X
15/16			X					

*at the highest speed of the machine

3M/Wollensak 6364

MANUFACTURER	MODEL	Speeds (see letter code)	Power amp(s) built in?	Max. reel size, in.	No. of heads	No. of tracks	No. of motors	Drive motor type	Drive to capstan	Frequency response, Hz to kHz, ± dB	Wow and flutter, %	Signal-to-noise ratio, dB	Fast wind, 1200 ft, sec	Mic. input Z, ohms	Rec'ing level indicator type	Dimensions W × D × H, in.	Weight, lbs.	Price	Special Features
TEAC	7030SL	F	No	10½	4	2	3	Hys.	Belt	30-22k ±3	0.04	60	90	600	2 Mtrs.	17½ × 8¼ × 20⅞	62	949.50	Bias swit., meter sensitivity switch.
	4070	B	No	7	4	4	3	Hys.	Belt	30-20k ±3	0.06	58	90	600	2 Mtrs.	18 × 9¼ × 17⅞	40½	699.50	Bias swit.; 2 direc. rec. & PB; auto rev. cont. PB; pause & fade.
	3300	F	No	7	3	2	3	Hys.	Belt	30-22k ±3	0.04	60	90	600	2 Mtrs.	15⅜ × 9¼ × 15⅜	40½	549.50	Bias swit.; pause; also available in several track/speed configurations.
	1230	B	No	7	3	4	3	Hys.	Belt	40-18k ±3	0.08	55	90	600	2 Mtrs.	17¼ × 8 × 15	37½	399.50	Pause; bias swit.; adj. turntable height.
	TCA-43	B	No	7	4	4	3	Hys. 2 spd.	Belt	50-15k ±3	0.12	50	100	10k	4 Mtrs.	17½ × 7 × 12	37	729.00	Sync. overdub; 4 & 2 (¼) chan. Rec. & PB; ½ track PB.
	TCA-40 4-chan.	B	No	7	3	4	3	Hys. 2 spd.	Belt	50-15k ±3	0.12	50	100	10k		12 × 17½ × 7	37	365.00	Compatible 4- and 2-chan stereo p.b. deck; 4 p.b. ampls; auto reverse for 2-chan. operation.
	TCA-41 4-chan.	B	No	7	3	4	3	Hys. 2 spd.	Belt	50-15K ±3	0.12	50	100	10k	2 Mtrs.	12 × 17½ × 7 deck	37	535.00	4-chan p.b. and 2-chan rec. and p.b. incls. connectors to adapt to 4-chan. recording. Amp 4¾ × 17¼ × 7¼ in.
	TCA-42 4-chan.	B	No	7	4	4	3	Hys. 2 spd	Belt	50-15k ±3	0.12	50	100	10k	4 Mtrs.	12 × 17½ × 7 deck	37	695.00	4-chan rec. and p.b. deck; compatible with 2-chan, ¼ track stereo rec. and p.b. Amp. as above.
	A1200U	B	No	7	3	4	3	Hys. 2 spd.	Belt	50-15k ±3	0.12	50	100	10k	Dual Mtr.	17½ × 9¾ × 17	41	329.50	S-o-s; echo; opt. rem. pause cont.
	A1250	B	No	7	3	4	3	Hys.	Belt	40-18k ±3	0.08	50	90	10k	Dual Mtr.	17¼ × 8 × 14⅛	37½	499.50	Pause cont.; bias switch
	4010SL	B	No	7	4	4	3	Hys. 2 spd.	Belt	40-18k ±3	0.08	55	90	600	2 Mtrs.	17½ × 9¾ × 17¾	48	549.50	S-o-s; echo; opt. remote cont.; auto off; tape tension switch; bias switch.
	6010SL	B	No	7	4	4	3	Ind.	Belt	30-20k ±3	0.06	58	90	600	2 Mtrs.	17½ × 6⅞ × 20⅜	52	799.50	Auto rev., rewind, stop; mixing.
	7010SL	B	No	10½	4	4	3	Ind.	Belt	30-20k ±3	0.06	58	90	600	2 Mtrs.	17½ × 8¼ × 20⅜	62	999.50	As above.
TELEX	433	A	No	7	3	4	3	Ind.	Belt	40-18k ±3	0.2	54	70	50k	2 Mtrs.	15¾ × 8¾ × 14⅜	34	394.95	Walnut base.
	Quad/Sonic 2 + 2	A	No	7	1	4	3	Ind.	Belt	40-18k ±3	0.2	50				16½ × 6¾ × 11	30	249.95	2 & 4 chan. PB only.
	2001	B	No	8¼	3	4	3	Hys.	Belt	45-18k ±2	0.18	52		Hi	2 Mtrs.	19½ × 8 × 14½		799.95	Monitor, solenoid operations; walnut base.
3M/WOLLENSAK	6150	A	No	7	3	4	2	Hys.	Idler	35-20k ±2	0.12	54	90	2.2	2 Mtrs.	16½ × 13½ × 6½	18	199.95	Bias selector; tape-source monitoring.
	6154 4-chan.	A	Yes	7	3	4	2	Hys.	Idler	35-20k ±2	0.12	54	90	2.2	2 Mtrs.	16½ × 13½ × 6½	18	319.95	4-chan. pre-amp playback; 2-chan. record-play deck.
	6364 4-chan.	A	Yes	7	3	4	2	Hys.	Idler	35-20k ±2	0.12	54	90	2.2	2 Mtrs.	20½ × 11½ × 7½	30	399.95	Amplified 4-chan. play; 2-chan. record and play.

Equipment Profiles

TEAC Stereo Cassette Deck Model A-24

MANUFACTURER'S SPECIFICATIONS

Track System: 4-track, 2-channel, stereophonic system. **Compatible Tape:** C-60, C-90 Philips-type cassette tapes. **Tape Speed:** 1⅞ ips. **Wow-Flutter:** 0.2%. **Fast-Forward Time:** Approx. 70 seconds with C-60 tape. **Signal-To-Noise Ratio:** More than 45 dB. **Frequency Response:** 40 to 12,000 Hz. **Inputs:** Microphone, 0.3 mV (−70 dB) at 600 ohms; Line and Tuner, 0.1 V at 50,000 ohms. **Outputs:** Line, 0.3 V at 10,000 ohms load; **Headphone,** 8 ohms. **Power Requirements:** 117 V a.c., 60 Hz. **Power Consumption:** 20 W maximum. **Dimensions:** 13⅝ in. W, 9⅝ in. D, 4¼ in. H. **Weight:** 11 lbs. net. **Price:** $179.50.

The increasing popularity of cassette tape practically demands that some model of cassette recorder be included in any modern hi-fi installation. And there is an enormous selection of them available today—45 of them in the high-fidelity category were listed in the September Buyers' Guide issue, and there are many more than that on the market, although not all by any means could be called hi-fi, even though they are so labeled.

Improvements in tape formulations, increased bias current, Dolby systems, and reduction of wow and flutter as a result of more-precise manufacturing, and the use of hysteresis motors have all contributed to the better performance obtainable from cassette recorders and players on the market today. The A-24 employs most of these features.

In addition to having the usual compartment for the cassette, there are six "piano-key" controls which effectuate all tape-motion functions. At the left is the red RECORD key. To record, this key is depressed simultaneously with the PLAY key; both remain down and the recording function is indicated by an illuminated jewel just above the RECORD key. The next key is labeled STOP AND CASSETTE. If the machine is winding tape, either in the play or record modes or in either of the fast directions, the tape motion simply stops. If the tape is stopped, the door of the cassette compartment snaps open and the cassette is pushed forward enough to be easily picked up with the fingers. When the door is opened, a cassette may be inserted in the plastic track on the underside of the door and pressed until it clicks. Closing the door engages the hubs of the cassette with the reel spindles. The next key is the REWIND control. When this button is depressed the tape is rewound to the left spool; when completely wound, the drive shuts off automatically. The next key is for FAST-FORWARD motion, but it does not stay down—it must be held with the finger as long as the tape is being moved forward. The two fast-wind keys are indicated by arrows pointing in the direction of tape motion.

The next key is the PLAY control. When it is depressed, the tape proceeds at its leisurely 1⅞-ips speed under control of the capstan and pinch roller. The last key, marked PAUSE, lifts the pinch roller slightly so the tape does not move. This is convenient when starting to record, since with the machine in the record mode levels can be set without actually recording the tests which almost always precede a recording session. Furthermore, it permits the user to make those occasional pauses in a performance—station breaks, and so on—that if recorded would mar an otherwise unblemished recording.

One of the protective features of the A-24—although no harm would likely result—is that the PLAY key cannot be depressed unless the cassette holder is closed. How to record on a cassette which has the protective tab broken off will be described later—though perhaps you shouldn't know it if you have a lot of recorded cassettes.

Further to the right is the dual record-level meter, which indicates the signal during recording to aid in getting the right level on the tape, and it also indicates the output level while playing back—always a useful feature.

On the flat top surface of the recorder is a panel with three sets of controls. At the rear is a four-position switch which selects inputs from the LINE input jacks or from the TUNER input jacks, or from two of the five terminals on a DIN socket on the rear apron, or, in the same position, from microphones which plug into miniature phone jacks on the lower front of the cabinet, just under the record-level meters. When microphones are plugged in, the DIN-plug input is disconnected. The fourth position of the switch is for playback.

Forward of the switch is next a dual-concentric record-level control, and forward of it another dual control for playback level, or actually for the level at the LINE output jacks and the

stereo headphone jack adjacent to the microphone jacks, because a signal is present at these points during recording—the source, naturally.

Circuit Description

The amplifier circuitry in each channel consists of a single transistor input stage operating at increased gain for playback, and at somewhat reduced gain for recording. It is followed by the record level control which is simply the variable shunt resistor of a "T" attenuator network. This stage, with its switched record-level control, next drives a feedback pair, with different equalizations being selected by the switch to suit the requirements of recording and playback. The playback level control follows, and its output feeds the output jacks as well as a transistor stage which drives the level-indicating meter. One additional stage driven in parallel with the playback level control serves as the record head driver, which has additional equalization in its emitter circuit and a bias trap in the output. The output line also feeds a single-transistor amplifier stage which is transformer coupled to the 8-ohm headphone jacks.

A single transistor serves as the bias oscillator, with erase signal fed from the secondary of the oscillator transformer, and the bias signals fed through adjustable capacitors to the two record heads. The split-primary power transformer (for operation on either 117 or 240 volts) has two secondaries—one to drive the single hysteresis motor (at about 50 volts) and to feed a full-wave rectifier system to provide the 28 volts d.c. for the amplifier section, and a 5-volt winding for the meter-illuminating lamps (which indicate POWER ON) and the record indicator lamp.

The automatic-stop circuit is intriguing. Whenever the unit is in any of the tape-moving modes, a relay is energized and its contacts, which are in series with the shutoff solenoid, are open. The relay is energized by the collector current through two transistors in series to ground. The bases of the transistors are connected together through a time-constant network by a reed switch which is alternately opened and closed by a magnet in a rubber idler wheel which is rotated by the take-up spindle. When the spindle stops (or when power is shut off) the reed switch becomes stationary—either open or closed. When the time constant between the bases expires, one of the transistors shuts off, releasing the relay, and its non-operate contacts close, causing the solenoid to operate to shut off the unit, which it does by releasing any of the keys which were depressed. All of this takes place fast enough so the d.c. stored in the filter capacitors is still sufficient to actuate the solenoid. Some similar circuitry is commonly used in the better cassette machines, but this is the first one using this particular type of releasing mechanism—most we have observed simply cut off the a.c. power to the motor. In all, there are 15 transistors and five diodes in the electronic portion of the A-24.

Performance

Frequency response—one of the most looked-for parameters in any tape recording equipment—is shown in Fig. 3. Still more important, perhaps, is the percentage of wow and flutter, which measured at 0.09 per cent in the range from 0.5 to 6 Hz, 0.11 from 6 to 250 Hz, and 0.16 per cent over the whole band. Distortion at "0" recording level measured 1.2 per cent, while the 3 per cent point was reached at an indicated recording level of +4 dB. The input signal required for "0" level was 84 mV from the line and tuner inputs, as well as from the DIN socket. From the microphone jacks, an input of 0.35 mV was sufficient to provide the same recording level, all with the record-level controls at maximum. The same recorded signal from the tape provided a line output of 0.7 volts with the playback level control at maximum, and an output of 0.21 volts at the 8-ohm headphone outputs. Signal-to-noise ratio was a comfortable 47 dB, and due to the good track spacing, stereo separation was 32 dB—about normal for cassette tapes. Crosstalk between tracks recorded in the forward direction and playback from tapes played in the reverse direction was 43 dB. Both rewind and fast-forward times for a C-60 cassette were measured at 65 seconds. Bias oscillator frequency was 85 kHz, which is comparatively high for cassette decks.

A removable cover plate on the right end of the chassis gives access to the main printed-circuit board for adjustment

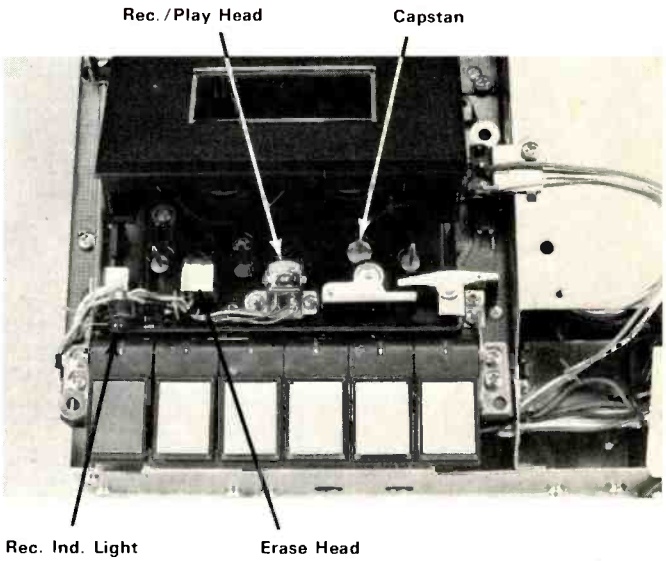


Fig. 1—View of the cassette compartment showing the positions of the two heads, the capstan, and the record indicator light.

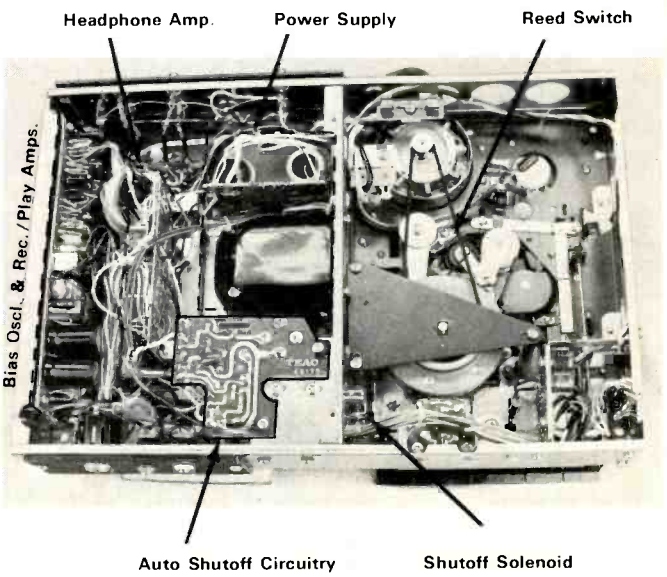


Fig. 2—The underside of the chassis showing locations of the main circuit boards and the reed switch, which actuates the shutoff mechanism.

of bias level. A 0.5-amp. fuse protects the unit against failure of any power supply components. Both the motor rotor and the flywheel are dynamically balanced. Not mentioned in the instruction booklet is the fact that both motor and flywheel—which is on the capstan shaft—have two grooves on their pulleys so the machine could be converted to 50-Hz operation in minutes.

The construction of the A-24 is apparently meticulous throughout. In many recorders and decks, we have noticed that the meters were held against the front panel by foam pads without any other fastening to keep them in place, so they depended solely on the pressure of the cover panel to locate them accurately. In this machine, however, while a foam pad was used to mount the meter, the two were cemented together and to the chassis so the meter remained in the correct position even when the housing was removed.

The TEAC A-24 cassette deck is easy to handle, effective in its performance, and an overall delight. It should do a lot toward carving a niche in the home music system for cassette machines. The instruction book accompanying the unit is complete and should serve as a good introduction to tape recording for the complete novice. For instance, the instructions tell how you can defeat the anti-erase feature common to all cassette machines—the protection offered to a cassette when the safety tab in the back of the cassette is broken out—you simply depress the RECORD key *before* inserting the cassette. One other provision in the instruction book is the inclusion of a schematic. While it is not expected that the owner will ever service his machine, it is possible that some technician might have occasion to do so and the presence of the schematic could be a great help. *C.G.McProud*

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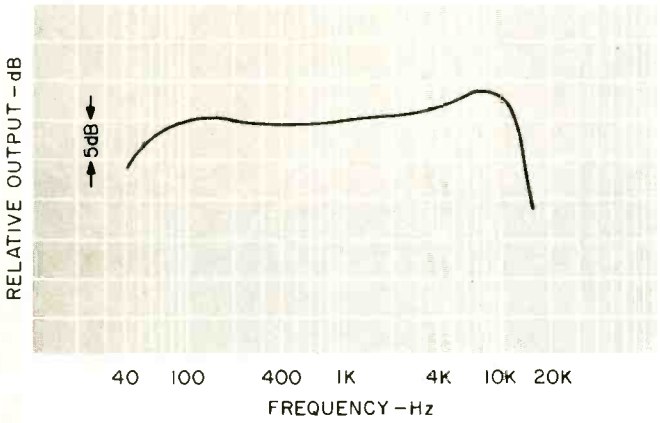
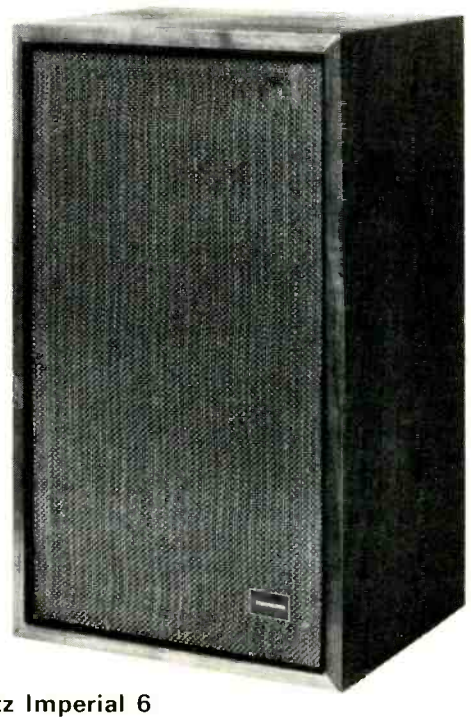


Fig. 3—Frequency response for a signal recorded and played back. Recording input level was 15 dB below indicated "0" level. Tape used was a TDK C-60SD cassette.



Marantz Imperial 6

MANUFACTURER'S SPECIFICATIONS

System Type: Two way. **Components**: 10 in. bass speaker, 2 in. treble. **Frequency Response**: 40 to 18,000 ±5 dB. **Nominal Impedance**: 8 ohms. **Dimensions**: 14½ H by 25½ W by 11½ D. **Price**: $129.00.

The Marantz Imperial 6 is a new two-way system using a 10 in. bass unit with a 2 in. cone tweeter. This latter is fitted with a hard dome at the center to smooth the response and obtain a wide dispersion. A heavy paper cone is used in the bass speaker, and the surround is a plasticized cloth. The voice coil is unusually large at 2 in., and the magnet structure weighs 2 lbs. Crossover is about 3000 Hz (an octave above the tweeter resonance point), and a three-position

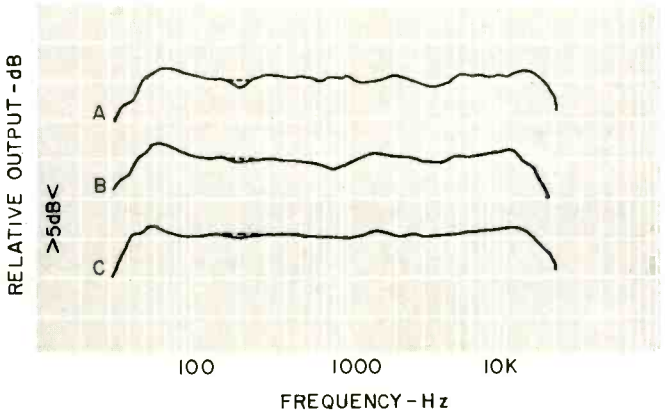


Fig. 1—Response curves with one-third octave pink noise; **A** is taken on-axis, **B** at 45 degrees off-axis, and **C** is an average of five angles.

switch gives a choice of lift or cut. Instead of the usual acoustic suspension or infinite baffle arrangement, the 6 uses a tuned port and the enclosure itself is filled with fiberglass. The cabinet is finished in walnut with a black trim and appears to be solidly constructed. The grille cloth is brown and the front is held on by plastic foam pads.

Figure 1 shows the response curves using one-third octave pink noise: A is taken on-axis, B at 45 degrees, and C is an average of the response at five angles. All were measured with the treble control in the center or normal position. Response below 200 Hz will be affected by room conditions, and a corner position will, of course, increase the low frequency output. The small dip at 200 Hz is due to phase-cancellation and should be disregarded. Figure 2 shows the frequency response with the treble switch in its three positions and it will be seen that each step has a one dB change. At 7 watts input, frequency doubling commenced at 42 Hz but a useful output was obtained down to 35 Hz. Figure 3 shows the harmonic distortion at 5 and 10 watt levels. Transient response was particularly good at low frequencies,

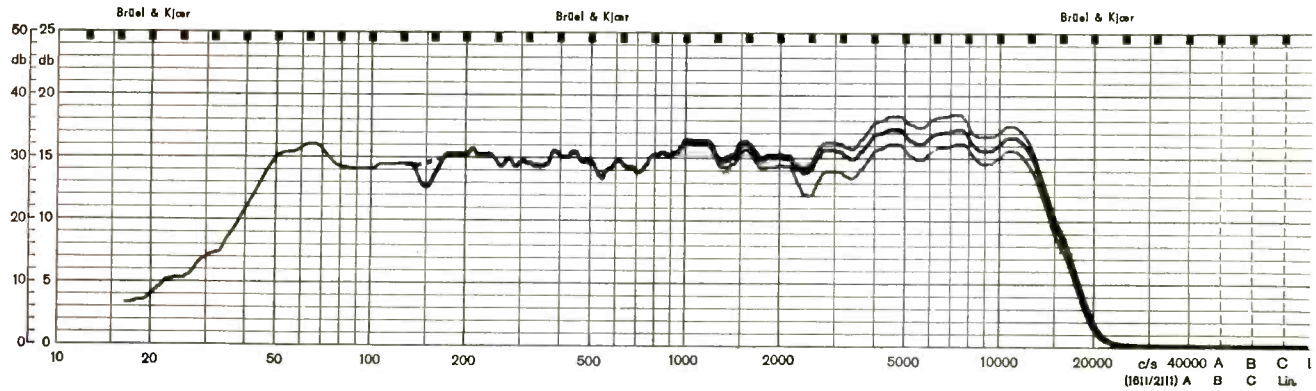


Fig. 2—Frequency response with the tweeter level control in three positions.

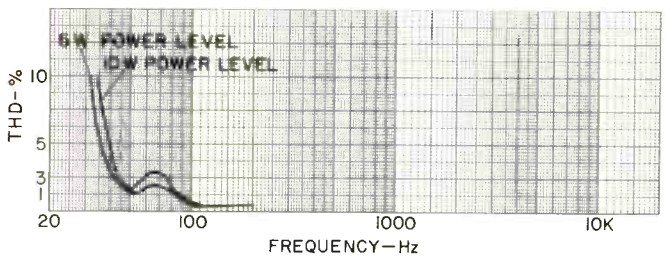


Fig. 3—Harmonic distortion at low frequencies.

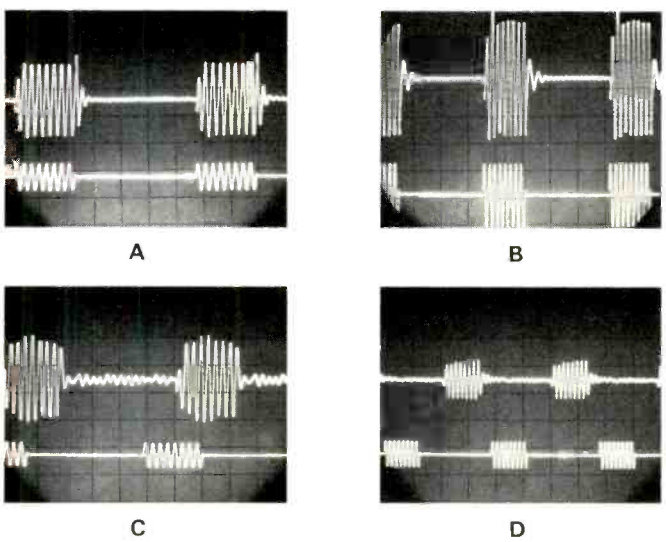


Fig. 4—Tone-burst response at **A**, 50; **B**, 100, **C**, 3000, and **D**, 10,000 Hz.

as can be seen from the tone-burst photographs in Fig. 4. The impedance curve showed a low point of 4.5 ohms, rising to a maximum of 22.5—typical of two-way systems. System resonance was approximately 60 Hz. White noise tests confirmed the smooth overall response and coloration was quite small. Sensitivity was somewhat above average; quoted efficiency is 95 dB SPL from one watt input at 400 Hz. An amplifier with 15 to 25 watt rms per channel capacity would be sufficient for most people when used with Imperial 6 speakers in a medium-sized room.

Listening Tests

The first impression was of a better-than-average transient response and a clean bass with a commendable freedom from coloration—especially in the 80 to 200 Hz region, which can give that voice-in-a-barrel effect. Extended listening tests over a period of three weeks confirmed these opinions. The center or normal position of the treble control was found to be the best for my room unless the speakers were angled inwards when the highest position was preferred.

Summing up: The Marantz 6 can be recommended to those who require a bookshelf system with above average performance. *T.A.*

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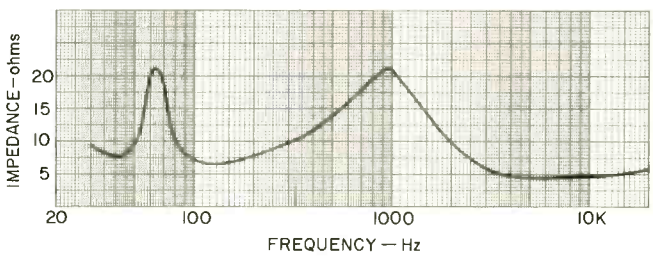


Fig. 5—Impedance characteristics.

Telex 48H Automatic 8-track Tape Player

MANUFACTURER'S SPECIFICATIONS

Magazine Capacity: 12 Cartridges. **Power Output:** 15 watts peak. **Distortion:** Less than 2%. **Speaker Impedance:** 3 to 8 ohms. **Frequency Response:** 50 to 15,000 Hz. **Preamp Output:** 1 volt p-p. **Signal/Noise:** 40 dB unweighted. **Wow and Flutter:** Less than 0.30% rms. **Dimensions:** 9 in. H. by 18 in. W. by 26 in. D. **Price:** $299.95. Loudspeakers, Model P2/H: $69.95 pair.

The Telex 48H, formerly distributed by Quatron, uses a novel rotary magazine for 8-track tapes, allowing up to 13 hours playing time. Any standard 8-track tape of any length can be used and there is a choice of four operating modes. The first permits the selection of any program on any tape, the second—called INTERMIX—plays the first program on Tape 1, then the first on Tape 2, and so on, right up to number 12. then follows the second program on each tape, then the third, and the fourth. The third mode is the AUTOMATIC 4-PROGRAM and all bands on all tapes are played in order. The last choice is called REPEAT and it enables all four programs of a particular cartridge to be played again. These four press-buttons can be seen in Fig. 1. On the right is an illuminated push-bar switch which functions as a reject control as well as giving visual indication so that one can see what band is being played at a particular time. The top button operates the AUX selector switch for inputs from a tuner, record player, etc. At the bottom is the cartridge selector switch labelled 1 to 12 and below that is the ON/OFF switch. At the top of the panel are the volume, balance, and tone controls with the cartridge load switch in the middle. At the rear, shown in Fig. 2, are the AUX input sockets, preamp output, and speaker sockets. Thus, the unit can be connected directly to a hi-fi system if so desired.

Much thought has obviously been given to the mechanical details; for instance, depression of the AUX switch when a tape is playing not only connects an external input, but the tape cartridge is automatically returned to its stored position. The motor and its fan are left running to give ventilation. A single shaded-pole motor is belt-coupled to the capstan and flywheel assembly for tape drive and operation of the changer mechanism. See Fig. 3. Under the motor, to the left, is the track-shifting solenoid which is energized by a power transistor in

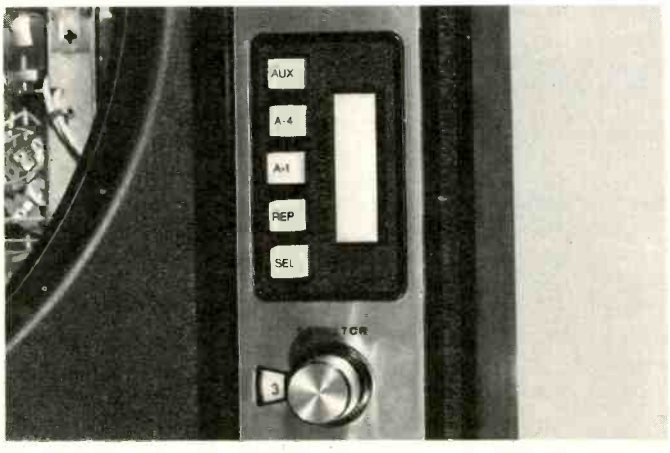


Fig. 1—Control panel.

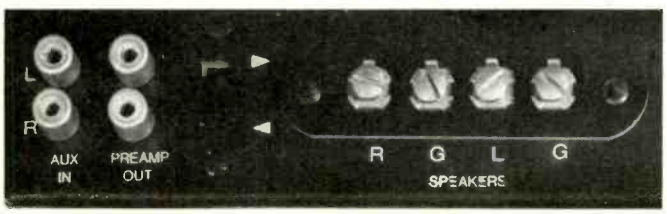


Fig. 2—Rear panel.

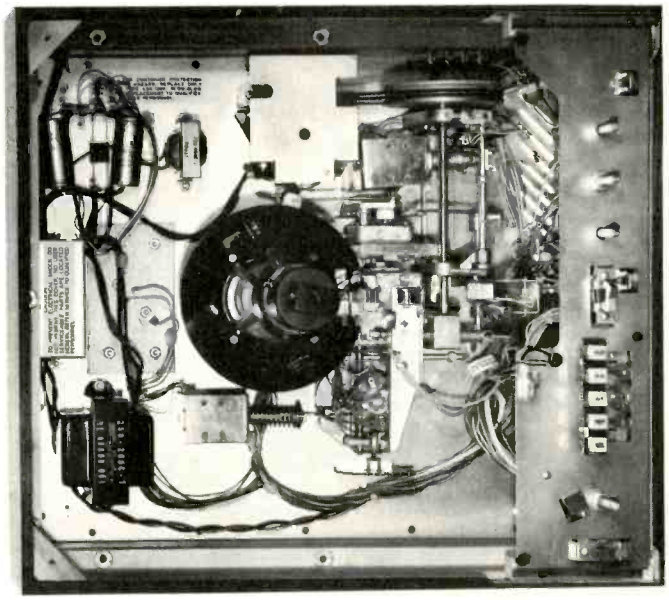


Fig. 3—Inside view.

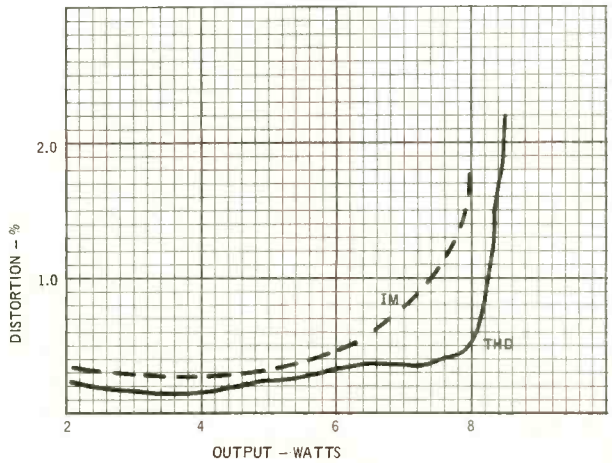


Fig. 4—Power Output, both channels driven (4 ohms).

a trigger circuit operated by sensing foil on the tape. Above the motor, to the right, is the capstan shift solenoid which either engages with the capstan drive to change a cartridge or with a cartridge pinch roller for playback. This solenoid is operated by a complex transistor circuit employing a multivibrator arrangement. A starwheel (not shown) projects below the cabinet and rotation gives a small amount of vertical head adjustment to take care of alignment errors on certain commercial tapes. If crosstalk is experienced, the wheel is turned accordingly.

Circuit Details

The preamplifier uses three transistors in each channel—two amplifiers and an emitter-follower output. The AUX input is taken to this point which is followed by a passive tone control and the volume control. The preamp output is connected here and then comes the main amplifier which uses a NPN-PNP pair driving a complementary pair output stage. A single d.c. supply is employed so the speakers are capacity coupled.

Performance

Figure 4 shows the power output with THD and IM distortion. It will be seen that total power measured just over 8 watts per channel. Overall frequency response of the amplifier from the AUX input extended up to 100 kHz (see Fig. 5), falling slightly from 30 Hz at the low end. The tone control is a single unit and this had the effect of reducing the overall level, giving a rise at low frequencies centered on 150 Hz. The volume control is connected as a tapped loudness control and the frequency compensation roughly follows the tone control curve. Figure 6 shows the response using an Audiotex test tape taken with the volume and tone controls in the maximum positions. Output from the preamp was about 350 millivolts. Wow and flutter varied from 0.25 to 0.35 per cent which must be considered good for an 8-track machine.

On test, the 48H did everything claimed for it. The mechanism worked smoothly with no problems whatsoever. The amplifier side cannot be considered top hi-fi quality and eight watts per channel is not a great deal of power—but for all that, the 48H sounded surprisingly good when coupled up to a pair of Dyna A-25 speaker systems. Using the preamp only, results will probably be as good as the cartridge itself and a model is available without the power amplifier at $249.95 (Model 48D).

Summing up: The Telex 48H can be recommended to those who require quick selection of a number of tapes or continuous programs lasting several hours for background music or whatever. **Check No. 55 on Reader Service Card** *T.A.*

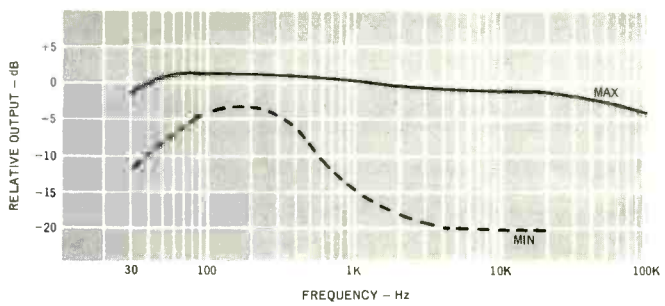


Fig. 5—Tone control and frequency response.

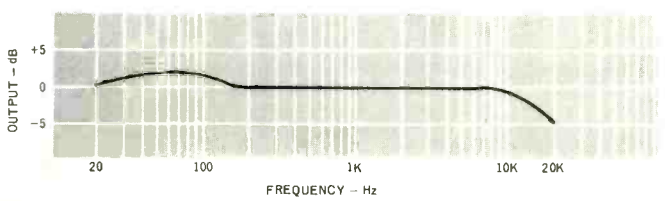


Fig. 6—Response from standard tape.

Solti's Magic Flute

Richard Freed

FOR A WORK so well-beloved, Mozart's fairy-tale opera *The Magic Flute (Die Zauberflöte)* has had relatively few recordings since the first one, conducted by Sir Thomas Beecham, appeared on 78s in the late 30's. The newest one, conducted by Georg Solti on London (OSA-1397, $17.94), brings to a total of four the complete versions currently available in stereo, the others being Böhm's on Deutsche Grammophon, his earlier one on Richmond, and Klemperer's on Angel. The old Beecham may be had now (in mono, of course) in an inexpensive Turnabout set, and, unless I'm mistaken, there have been only two other complete *Magic Flutes* on records, one under Karajan on Columbia some 20 years ago and one under the late Ferenc Fricsay, a DGG recording issued in mono on the Decca label, in stereo on Heliodor, and not available in either form at present. There are threads of continuity running through these seven recordings, more striking than anything similar encountered under any other title, and I think they are worth noting before we proceed to a consideration of the latest addition to the list.

Böhm, as already noted, conducts two of the current recordings, and the orchestras involved in them are also heard in others: the Berlin Philharmonic, in his DGG set, also plays for Beecham, and the Vienna Philharmonic, on Richmond, also figures in the Solti version, as it did earlier in the Karajan. More significantly, one finds several of the singers turning up repeatedly from one recording to the next, and not in every case repeating their respective roles. Fisher-Dieskau, the Papageno under both Fricsay and Böhm on DGG, is the Speaker in the new Solti version; Martti Talvela, one of the Armed men in Böhm/DGG, is Solti's Sarastro; Franz Crass, the Böhm/DGG Sarastro, is the Speaker and an Armed Man under Klemperer; Martin Vantin, Fricsay's Monostatos, is the Priest in Böhm/DGG; Walter Berry and Christa Ludwig sing the same roles—Papageno and the Second Lady, respectively—on Angel and Richmond; Emmy Loose and Wilma Lipp, the Papagena and Queen of the Night on Richmond, also sang those roles under Karajan on Columbia. There may even be more such phenomena to be catalogued. The point of it all is that the performers involved in these recordings really *are* "involved"; many of them have lived with this material for some time, so that there is a cohesiveness and commitment evident in every one of these sets, such as one simply cannot expect when a recording is undertaken by musicians who have had little or no experience in their respective parts.

And, happily enough, all of these sets are so fine that one may find oneself quibbling over degrees of excellence. But there *are* varying degrees, to be sure, and there *are* some disappointments here and there. Because the new Solti set offers the fewest disappointments and the greatest number of outstanding successes, I have little hesitation in placing it at the top of the current list.

The Beecham mono version's appeal must be on historical and/or sentimental grounds, so we can discount it as a serious contender against the four stereo versions. Of those, I would eliminate the Klemperer/Angel because, compared with the others, it lacks warmth and the air of fantasy I consider so indispensable to this music. Dignity it has in abundance, and, of course, gorgeous singing and playing, but it's really a little stuffy if measured against the *Gemütlichkeit* of the two Böhm versions and the sparkle of the new Solti.

And Solti's does sparkle, for sure. He is one of the really supreme opera conductors of our time; since Böhm is one of the few others, lovers of *The Magic Flute* have a rather dizzying assortment of riches in the three sets under their direction. If Solti's pacing is a bit brisker than Böhm's, that is not to say that Böhm is at all sluggish, or that Solti is headlong; in fact, their approaches are not significantly dissimilar. Since both have first-rate orchestras and, in the two newest sets, on DGG and London, superb recorded sound, the choice may be based almost entirely on the vocal contributions. If economics should be a factor, though, the earlier Böhm version, on Richmond, is very much worth considering, for the interpretation is the same as in his DGG remake, and some of the individual roles are even stronger: Walter Berry, for example, is a much more satisfying Papageno than Fischer-Dieskau, and Emmy Loose is the ideal Papagena. The main weakness of the Richmond set is its Sarastro. True enough, Sarastro has only two big arias, but so, for that matter, does the Queen of the Night, and much of the work's overall impact rests on their effectiveness. Kurt Boehm, though he made a valiant effort, simply was not in the same league as Talvela, Crass, Gottlob Frick (with Klemperer) or Ludwig Weber (Karajan).

Taking the principal characters role by role, they are pretty evenly matched in the Böhm/DGG and Solti/London recordings, but the latter has a more impressive Queen of the Night in Cristina Deutekom and a much more appealing Papageno in Hermann Prey. Fischer-Dieskau's Papageno was just too cutesy and heavy-handed for my taste, enough to mitigate my enjoyment of the otherwise excellent Böhm set. Prey is surely today's outstanding Papageno (the real successor to Erich Kunz), and it was high time he recorded the role. Deutekom, whose only previous recording seems to be her recent recital disc for Philips, is both a secure and a daring singer, turning challenges into opportunities for really dazzling display. Roberta Peters, on DGG, is no slouch, either, but Deutekom is simply a knockout.

If Prey's Papageno is "definitive" now, the same might have been said of the late Fritz Wunderlich's performance as Tamino, which is one of the strong points of the DGG set. Stuart Burrows, however, proves to have been an

inspired choice with Solti: he does honor to the great line of recorded Taminos which includes Anton Dermota in the old Karajan set, the great Mozart stylist Léopold Simoneau on Richmond, Ernst Haefliger with Fricsay, and Wunderlich himself.

Solti's Pamina is Pilar Lorengar, who has shown unsteadiness at times but here, as in her recent *Traviata* under Maazel and in the *Egmont* music with Szell, gives one of her finest, most persuasive performances. Martti Talvela, as one might have predicted, brings to his role all the majesty, all the dignity, and at the same time all the warmth and compassion one wants in a really convincing Sarastro, and Renate Holm makes a most attractive Papagena.

Aside from the factor of exceptionally fine singing, there is the utterly convincing characterization on everyone's part. The recording, by the way, does include the spoken dialogue (as do all the others now except the Klemperer), and this, too, is handled most effectively, with a bit more charm than on DGG. One other especially charming touch, which had not been attempted on records before, is having the Three Boys actually sung by boys instead of women. Solti's Boys are three members of the Vienna Boys' Choir, and they are most effective, without in any way compromising the extraordinary musical standards of the set.

Sometimes when one is carried away with enthusiasm it becomes difficult to tabulate the reasons for it dispassionately, and perhaps I have not done as much of that as I might have done in this case, but I hope I have made it clear that I think the Solti *Magic Flute* is the outstanding recording of this work so far, in every respect. As in many of London's other operatic recordings, there are some sound effects to help make the drama "visible through the ear." We hear the padlock click when the Ladies affix it to Papageno's mouth, and when the Queen of the Night appears there is thunder beyond what is produced by the timpani. I don't find these things at all disturbing. Indeed, the only disappointment I can report, after hearing the set through three times over, is Solti's use of the celesta instead of a glockenspiel when Papageno plays his bells. Böhm does use a glockenspiel on DGG, and the effect is enchanting.

By way of documentation, the booklet with the new London set includes an interesting essay on the opera's Masonic significance, on Freemasonry in Vienna, and on Mozart's involvement with it, by Arthur Hutchings. Æ

Classical Record Reviews

Edward Tatnall Canby

The Three Tchaikovsky Piano Concertos. Gary Graffman; Philadelphia Orch., Ormandy; Cleveland Orch., Szell. **Columbia MG 30838 (two discs),** stereo, $6.98.

As you peruse this brand-new Columbia album, you will note that the Cleveland Orchestra now belongs to Angel and the Philadelphia to RCA and Mr. Szell has been dead quite a time. So it goes. But the idea of putting the "2½" concertos together in a special album is a good one, basically. (The "half" concerto is the one completed movement of No.3, not widely known mainly because it leaves the soloist high and dry in midstream.)

Gary Graffman is a powerhouse pianist, the sort who can make a huge piano sound even larger than life, and a big piece sound even bigger. He has the necessary dramatic flair. But he is a pounder if ever there was one. He has good musical instincts but at the drop of a conductor's baton they turn to muscularity. A good conductor, who wants to, can work wonders with such a pianist. An easy-going conductor just lets him pound.

That, it seems, is what the ever-amiable Mr. Ormandy did. Ormandy is a marvelous accompanist—that is, he can bend his orchestra to follow a solo musician the way a *lied* accompanist must follow his singer. That isn't what Gary G. needs! He needs a Szell. A conductor who is a perfectionist with his own vehicle and who *demands*, directly or more likely by sheer example, the same finesse from his featured artist. In the famed Concerto No. 1, Gary pounds out those first big chords triumphantly, but by the time the orchestra has got down to its beautifully controlled low volume follow-up, you are aware that there is to be more than pounding in this version, warhorse or no. It is a pleasure to sense Mr. Szell's workmanship as the music goes onward. Very good for Gary Graffman.

In the Second, and the truncated Third, Mr. Ormandy goes heartily along with Graffman, pound for pound, the tactful accompanist at his most ingratiating! It is a royal pound-fest throughout, a rather glorious noise, it must be admitted, but in a different league from the carefully disciplined music under Mr. Szell. Maybe it's worth acquiring this whole set just so you can savor the differences. Nice.

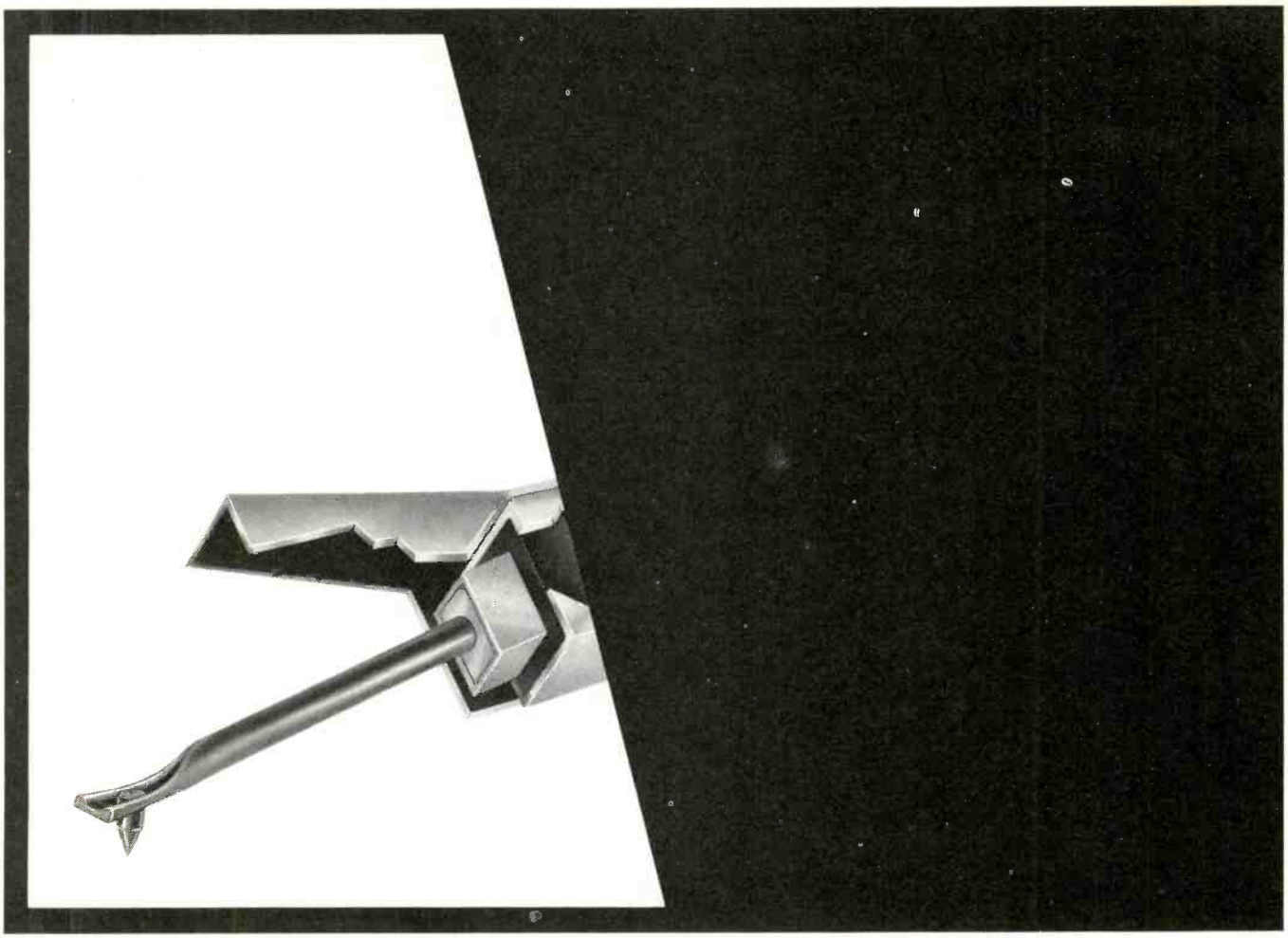
Performances: B, B— Sound: B, B+

Mass

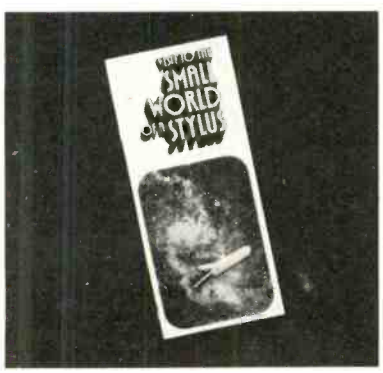
Bernstein: Mass. A Theatre Piece for Singers, Players and Dancers. Norman Scribner Choir, Berkshire Boy Choir, Soloists, Instruments conducted by the composer. **Columbia M2 31008,** two discs, stereo, $11.98.

Rave reviews from the music critics, the dance critics, the architects, the sociologists, the *haute monde* and everybody else who got a chance to slide into Kennedy Center on Opening Night. A multi-media spectacle, with top dancers, lighting, singing, chanting, what have you, including music from tape (a must these days) as well as live. So what's in it for *you*, blind in your living room in front of the stereo? (Well, not quite blind—there's a superb big book with texts and big blue-purple blurry photos.)

It's a Mass, out of the Catholic tradition all right, including familiar Latin terminologies and those not-so-familiar, too, like *trope*, a sort of insert interlude of side-commentary between sections. But, of course, it's Bernstein, and it includes some Hebrew, here and there, plus—what else?—musical comedy à la West Side Story. But definitely! A li'l bit of everything and no wonder



Straight talk about a stylus



Listen carefully and you can still hear some audiophiles refer to the record stylus as . . . "the needle." Although we are not about to quibble over semantics, we would like to go on record, so to speak, as observing that the stylus of today bears no more resemblance to a needle than it does to a ten-penny nail. In fact, it is probably the most skillfully assembled, critically important component in any high fidelity system. It must maintain flawless contact with the undulating walls of the record groove — at the whisper-weight tracking forces required to preserve the fidelity of your records through repeated playings. We put everything we know into our Shure Stereo Dynetic Stylus Assemblies — and we tell all about it in an informative booklet. *"Visit To The Small World Of A Stylus."* For your copy, write:

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the people like it, most of them being somewhat less than musical connoisseurs.

Good or bad? Well, in works like this you can't really say. No standards exist, unless you think they do. (I don't.) If some people are shocked by assorted blues and stage stuff in a Mass—well, there's plenty of *that* around today, and not invented by Bernstein. If others, with higher brows, decry the slightly lowbrow approach, then they, too, should shop elsewhere. You can write good music in lowbrow style, remember, if *you* are good. Bernstein had every right, etc. As for dancing, and light shows, and taped elements, all that is merely par for the course in any up-to-date big production these days. So you can't gripe on any of these counts, nor on most others of an *a priori* sort according to earlier standards.

Ah—but you can listen to the music, though it is only part of the show, and there the description isn't difficult, though judgment is. I enjoyed Mass a lot (following the action and text throughout in the big book) and so will you. But don't expect anything very modern. It's old fashioned as all get-out! Straight from the Bernstein heyday —when else?—the 1940's.

You can't help hearing On the Town, West Side Story, Fancy Free, augmented and upgraded, at times ennobled, the 40's pop nicely interlarded with 1940's middle-Stravinsky in the familiar Bernstein manner, and Aaron Copland (middle period) peeping around the corner every 30 seconds. Hard to believe. And all this in spite of the superficial modernities of tape music, multi-media staging, and eye-stoppers such as the ultra-modern Alvin Ailey American Dance Theatre (they work with the likes of John Cage).

After all, Bernstein is getting on and settling down, long since comfortably established in his dynamic role as godfather to the arts, united. Still interested and excited by what's new, of course. But in his own work, both composing and conducting, he tends now to be conservative. He harks back to the heady days when pop joined hands with the Philharmonic in his very person. Nostalgic, and even a bit quaint.

Yet the man is a fine musician and I found most of Mass, mixing pop and classical performers in the old Bernstein tradition, to be economical and in consistent taste—consistent with itself. But sometimes I grew embarassed, and not for the reason's you'd think. I cringed at Mr. Bernstein's rock—awful. Not remotely rocklike, was my reaction, and I suspect the younger rockers will agree. Off the beam, and the indignity is not to the classics but to the pop music he is supposedly honoring. In fact this is the chief criticism of Mass—it demeans its pop music more than its classical, a sort of unintended Uncle Tomism. Curious.

For all the credits—Producers, Choreography, Musical Director, Production Coordinator, Additional Texts, Celebrant, Settings, Costumes, Lighting, there are confusingly few references to the musicians involved. The Norman Scribner Choir and the Berkshire Boy Choir get credit but the multitudes of others seem to be intentionally anonymous, neither on the album cover, the discs nor the cover and flyleaf of the booklet. Contracts? Or just a new trend?

Performance:
The one-and-only original.
Sound: B+

Canby's Capsules

Edward Tatnall Canby

QUADRAPHONIC DISCS

Stan Kenton and His Orch. Live at Brigham Young Univ. Creative World ST 1039, 2 discs, (SQ), $13.98. P.O. Box 35216, Los Angeles, Calif. 90035.

Quadr. sound is going to be big in "live" recordings—it takes you there, with the audience. Curious perspective in this one but OK: audience is mostly in front, but band is all 'round. (Where are *you?* Who cares!) Real participation, if you like Kenton's fat, portentously brassy and dissonant mod. jazz. My ear says it's outa the steely 1940s.

Barbra Streisand—Stony End. Columbia CQ 30378, (SQ), $6.98.

Yes—Barbra plays OK in stereo (for an extra buck). In this big-time slickpop, 4-way sound merely rounds things out a bit. Barbra is vaguely front, slick strings etc. vaguely elsewhere.

Morton Sobotnik: Touch. Columbia MQ 31019 (SQ) $6.98.

"Touch" is all-electronic (Buchla), 2 sides long; this type music has no "front" or "rear," ideally needs equal power all way 'round. SQ does good job adding spatial interest.

Dynaco 4-Dim. Stereo Demonstration Disc (#2). Pop and Classical. **Dynaco SPV-7,** (DY), $2.95.

Fun/games. Play this via SQ, E-V or what-not and it'll sound OK. Via Dyna-type matrix, an emphasized separate rear space; via SQ, more rounded, with more stereo in front. One side is classical: "Hallelujah" (Handel) in mono, stereo, Dyna (why bother?); superb Mozart strings in tank-like big space; the usual Berlioz (Requiem) 4 brass choirs (no—can't tell which is which, but that is the "live" effect too); a mvt. from Tchaikovsky 4th. All from Vanguard. A useful demo on any four-way system.

Mercury 4-2-4 Matrix Demo Disc MQ-1 (not for sale).

Snitch this if you can—it's terrific. Superbly played music (Mercury) and fine four-way sound via E-V matrix. But note—all is Mercury's derived 4-channel, from 3-ch. originals! Nicely proves that 4 discrete channels aren't *necessarily* required, tho obviously they offer maximum recording versatility. Handel, Brahms, Stravinsky (2). Tchaikovsky, Leroy Anderson . . . . top-rank playing.

Dick Rogers and his TV recording orch. play polka varieties. KL Recording KLP-6, (DY), **(Box 55, Hubertus, Wis. 53033.)**

A very pro job from Way Out There, done up in Dynaquad. (It plays SQ with the same arena-type big sound.) Fat, tubby, dynamic band, with tuba, playing polkas and waltzes, sort of German-Polish-U.S. Goes nicely with beer.

Bach: St. John Passion. Raskin, Forrester, Lewis, Shirley, et al., Singing City Chorale, Phila. Orch. Ormandy. **Columbia M3 30517,** stereo, $17.98.

Cf: (Same). Soloists, Concentus Musicus, Wiener Sängerknaben; Chorus Vienensis, Gillesperger. **Telefunken SKH-19,** (3 discs), $17.85.

Ormandy's ears are always open—this monster performance, outwardly in old big-oratorio tradition, is cleverly updated—modern, faster tempi, correct continuo accpt. (with a loud, wiry harpischord), chorales sung fast and minus old long pauses. But the chorus is huge and vibrato ridden, the soloists do their best to sing in pompous Sunday style. Not bad (and the solos are top artists)—if you like the big-time U.S. approach. For comparison, note the (1966) "authentic" Telefunken job, with old instruments, etc. Much thinner and cleaner, the recitatives "spoken" lightly, the chorus lean and accurate. But the sound is distant and flat, lacking perspective.

Musik der Dürerzeit (Music in Dürer's Time). Cappella Antiqua Munchen; Studio der Frühen Musik; Monteverdi Choir. Hamburg. **Telefunken TK 11515/1-2,** stereo, 2 discs, $11.90.

Josquin Desprez: Chansons, Frottole & Instrumental Pieces. Nonesuch Consort, Rifkin. **Nonesuch H-71261,** stereo, $2.98.

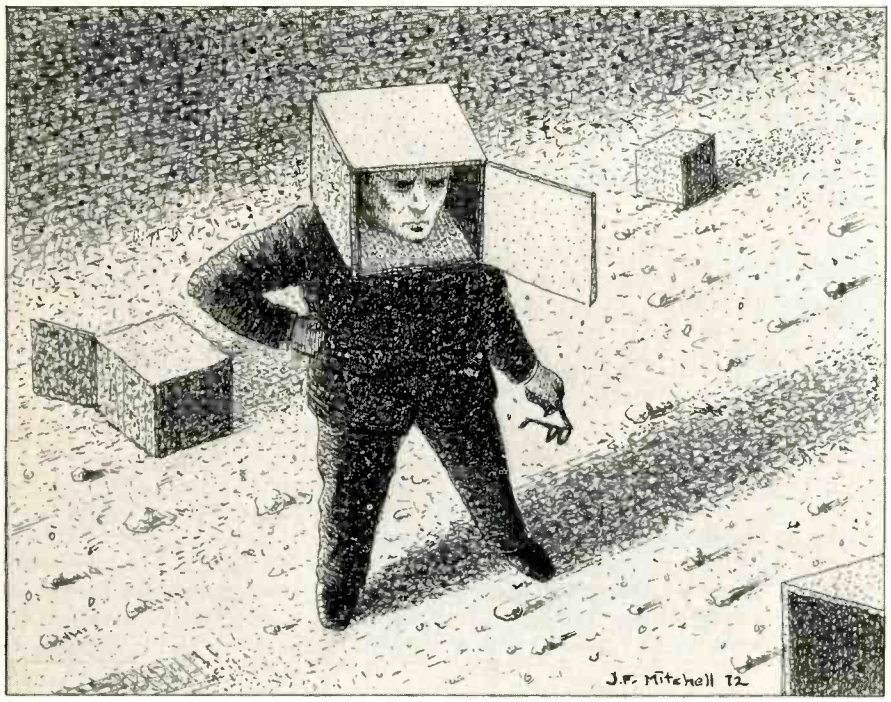
Eur. and American performances of similar music c.1500, done with now-standard musicological authenticity from old ms. or contemp. editions. The Telefunken "Dürer" album (see cover) is a "best of" combination survey—wonderfully musical, voices and instruments beautifully balanced, an over-all gentle quality, relaxed. The Nonesuch music is louder, at higher tension, less well balanced and phrased, more driving. Good instr. playing, some fine voices, but ensemble is often so-so.

Prokofiev: Symphony No. 1 ("Classical"); Symphony No. 3 (1928). London Symphony Orch., Claudio Abbado. **London CS 6679,** stereo, $5.98.

Really excellent Prokofieff! Both the familiar "Classical" and the tough, dissonant 3rd, out of a non-performed earlier opera (1927, the Fiery Angel). Abbado is a very solid young conductor, letting the music have its say, at reasonable tempi and without histrionics—yet his phrasing, balance, detail work, are impeccably musical. Best "Classical" I know, bar none.

Audio ETC

Edward Tatnall Canby



the corporate block UNBLOCKED

"HOW LONG will it last?" My final words, a month ago. Well, it's lasting, the Corporate Block, and in some ways getting worse. But, at least in our area, there are breaks to be seen. And a new factor has entered into *my* calculations. I just made it up. I will call it the 2½ factor, and it is very likely to measure success or failure to come.

Mainly, what has happened in the early months of 1972 is a kind of forced motion, still non-productive, among the dismally blocked giant corporations. Internal explosions. Bustups. Realignments. Still—no product. Just mounting pressure, unrelieved by sales. This isn't the happy outward movement of active trade, a functioning market with product, distribution, sales, cash, the completed economic circuit with all currents flowing! It's still deadlock. And corporate earthquakes, like that in EVR. Or big legal challenges, like that from the recent E-V matrix patent.

I cited 2½ areas of interest in respect to this blocking phenomenon last month, and wrote only about the extra "half" as a refreshing contrast—international trade. It may be full of danger and uncertainty but at least it *moves*. Products in abundance, distribution all over, sales galore, cash flowing, if sometimes into the red. Any business that moves in this fashion, I say, is healthy, even if people do lose their shirts in it (that's competition).

But competition *without any business* is something else again. Many products announced, none available. Competition before the fact, without consumers, carried on inside industrial empires like Medieval warfare out of impregnable castles! Far too many new systems, all aiming where a few will fit. And all of them mutually—deliberately—incompatible and irreconcilable. That's the shape of the corporate block, and to the consumer it's for the birds.

The two particular areas I have in mind are, of course, our immediate and close interest, the four-channel field, quadraphonics/sonics, and the larger, more revolutionary area of the so-called TV cassette and the TV disc. (Will *somebody* please invent a name to cover both?) We in audio are so involved in quadraphonics that we tend to ignore the larger, more fundamental warfare going on 'way up there over our heads in respect to the big, picture-filled cassettes. We aren't much bothered, from day to day, by the all-embracing, productless stall that has developed there among the corporate giants; it's not our money nor our headache.

But, stall or no stall, the TV cassette (and disc . . .) still has an enormous potential. It is still going to revolutionize our electronic lives, though it will take a little longer than planned. It has huge, unsuspected depths of meaning for mass communication in the future, all too little understood, even among those who do the dry-run promoting today. (That's part of the trouble.) We will be involved, all of us, merely as people. And, mind you, every TV cassette (and disc) that ever plays into a TV tube or light-screen equivalent, by whatever system among the many, will carry with it an audio signal and, more likely, two. So we *will* be there. Moreover, the same corporations that fight our small-scale quadraphonic battles are involved in the more deadly hassling in TV. It really is one big problem. The characteristic symptoms of the Corporate Block have appeared equally in these two areas, the larger and the smaller. But ours is beginning to break.

Just maybe, we are small enough to get by. And we are much less radical than they are, in their play-it-yourself television systems. We build on familiar ground—home hi-fi, stereo, components and so on. We are adding merely wrinkles, if good ones. They are floundering in a vacuum of uncertainty, despite all the propaganda. They don't *really* know . . . or they disagree. We aren't so sure where we're going either, but we have strong hunches, well founded. Our innovations are much closer to the ground, nearer to present consumer habits. **WE** aren't tossing any TV newspapers onto suburban front porches, or sending the kids to borrow some comics from the TV library down the street! Radical stuff, that. So—we can see light. Maybe we're going to unblock.

Significantly, I note that, though we also have too many systems, ours are not *many* too many. And though ours, too, are incompatible, we are able to see (dimly) some workable approaches to compromise, whereby we might use them all, at least in part. I don't see that among the TV cassettes.

The day I watch a Sony color cassette plug into an EVR player, followed by an RCA SelectaVision laser tape, I'll concede that workable compromise has been achieved among the videocassettes. I'd even settle for less. If the relatively similar magnetic tape entries would somehow stretch their quarter-inch and shrink the one-inch tape to fit the half-inch player, for a species of compatibility, I'd say part of the big battle was won. Even without

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RCA, CBS and Teldec. But it won't happen. It can't.

I think I can envision the quadraphonic equipment that is going to head up *our* necessary compromise. It will be practical *and possible.* That's the big difference. But first let me look at that curious figure, 2½, which is crucial to my perception.

For instance, what would you say is the optimum number of competing systems, using different approaches, that can exist, with active business, in a particular consumer area? More than one, obviously. We have 'em everywhere. But how many? Well, I'll tell you. The number is 2½.

Look around for a moment. How many 35 mm still picture cassettes are on the market? 2½. The original Kodak film cassette, standard among hundreds of film and equipment manufacturers for forty years or so. And now, Poloroid, a specialized but widely available film-pack cassette. And, to fill out the extra half, a few sub-miniature film cassettes which have managed to endure, on a small scale.

How many 8 mm consumer film systems? 2½. The original 8 mm film, the Super 8 and the Single 8, half-twin to Super 8 and compatible in the projector. More than two, but less than three.

How many sound systems for professional film? Magnetic and optical, two basic approaches. But optical is a pair of half-twins again, variable density and variable width, compatible in the playback. That makes 2½, if you discount such refinements as stereo and Cinerama. Once again, the systems are made workably compatible via playback/projection equipment. They live together.

How many disc systems? The LP, the 45 and the semi-retired 78, still alive though out of production. 2½. These, too, meet in the playback equipment, which can take them all.

How many home sound media? Disc. Tape. With extra subdivision into cassettes, reel-to-reel, cartridge, to make up the extra half. 2½—and still again, they meet in the playback area via componentry designed to fit the need.

How many radio systems for public broadcast? AM, FM, and a small area of citizens' radio and walkie-talkie. 2½. Or maybe you'd like to put it down as entertainment radio—AM, FM, and stereo multiplex, a halfway offshoot.

To be sure, my categories are somewhat arbitrary. But there is a real point to be noted.

Go further. Today, our groups of systems tend more and more to interpenetrate—films, cassettes, records, tuners, projectors and so on. You can find more 2½ examples within these areas. How many audio tape cassettes? 2½. The Philips musicassette. The 8-track cartridge, and as an extra half, the obsolete 4-tracker and such side operations as the PlayTape cassette. Not to mention the new HiPac.

How many disc speeds? 2½—the 45, the 33 and an occasional 16 or 8 in specialized areas. How many home tape speeds? More than two but less than three! 7½ and 3¾ for reel tape, 1⅞ for cassette. You can split them 3 ways if you want. Or call it 2½.

OK—I'll let you have it. How many political parties? 2½, what with "3rd party" splinters. How many major leagues? I could go on & on. It is obviously a way of life with us. If you don't like 2½, call it two-plus. How many Presidents? 2½, if you're thinking hard about Mr. Agnew and Mr. Kissinger. . . .

Quite seriously, I suggest that the figure 2½ represents the *normal acceptable complement* of non-compatible or semi-compatible systems, within a given consumer area. Deny the rule if you dare.

We *will* usually take on more than one system. But not much more. That is the important conclusion. And so we may derive some quick futurist info from the cloudy crystal ball. If we aim for the 2½ figure, we're going to be OK. But more systems—no! Tell *that* to the TV cassette people.

Thus in the quadraphonic area things look ultimately good. Because the tendency is now towards consolidation at just about this level of overlap and redundancy—however tough the in-fighting at the moment. Not so in TV. There, things look really bad. Is it a dozen systems, or 20? And virtually no chance of compatibility.

I think, then, that we are going to live with our two basic four-channel approaches, the discrete and the matrixed. Both of them. Discrete naturally favors tape. Matrix is most favorable on disc, though it can go in cassettes too. There are good advantages each way and room for motion.

On a narrower scale, I think too that we will go along with *two* kinds of quadraphonic disc, in case RCA comes out with its modified JVC wide-band supersonic model, the discrete disc. They are incompatible. But the playback equipment, in time-honored fashion, can be built to take them both, all in the same package. A single cartridge and turntable (putting aside the present need for a modified stylus/cartridge to play the RCA disc),

feeding into a dual decoder unit, or built-in circuitry, for matrix *and* discrete. It won't be too complicated in the long run, nor too ruinously expensive, what with ingenuity and a few ICs to take over some of the load. We do these things already. My Lafayette 524 quadraphonic rear-speaker amplifier, just out, already has two built-in decode circuits, and it isn't an expensive unit at all.

In fact—there can be automatic switching, from one type disc to the other, actuated like the FM stereo light via the supersonic signal on the discrete-type disc. How's that! All this, you see, is clearly *within the possible*, and therefore probable. I think the 2½ principle indicates that most of us would welcome a real business test of these two discs in terms of workable home equipment, plus discs available on the market. And may the best system win—in the home and in the market place.

But not before the matrix disc itself has settled down and the matrix fights are put aside. Frankly, most of us are tired of the corporate rows in this area. Last fall, a reluctant getting-together of the major matrix interests made it clear that a single decoder circuit can in fact decode virtually any of the variant matrix systems into satisfactory four-channel sound. That was good news—but the required sequel is mandatory—get on with it!

In the public interest, and in the face of RCA just outside the door, the matrix people will just have to forget their differences and come to an agreement, however much somebody's skin is peeled off. E-V has its patent. Columbia has the music. If these two have accommodated their differences by the time you read this, the rest of the disc industry will soon get nicely in line—either behind the unified matrix idea, variable but playable on *all* matrix decoders, or behind the discrete RCA disc, when & if. And so we'll be in business at last, the Corporate Block Unblocked.

I haven't heard any good news lately—I've been elsewhere. But I'm optimistic simply because I can see that the 2½ factor really will work in quadraphonics, given half a decent chance. The stage is thus set. If the quadraphonic disc untangles itself and gets on the market—whether in one form or two—the rest will fall into place. Much of it, actually, is already there in advance. Hope springs eternal, and our equipment makers have gone far out ahead, with four-way hi-fi all over the place, just waiting to play whatever comes along. So—Big Corporations—let's get Unblocked. It's about time. Æ

Weingarten Looks At the bangla desh album

THE SKY is falling," cried Chicken Little, and, as usual, the bleeding hearts talked up an alarmist storm. Also, as usual, no one actually *did* anything to help the situation. But the day was saved, accidentally, when the wayward sky was bolstered by all that hot air.

Admittedly, that's kind of a bastardized version of the childhood tale. Nonetheless, even if the sky isn't really falling, the level of sanity seems to be—for lessons of history go unheeded as mankind continues to indulge in maniacal wars, consuming people as easily as Americans devour sugary, useless breakfast cereals.

The latest insanity was the India-Pakistan thing, a skirmish that hardly lasted long enough for most Americans to work up a good cocktail party routine. Yet long before the war that resulted in East Pakistan's transformation into Bangladesh (Bengal nation), there were millions of victims there, the hungry and homeless refugees from the storms that racked the area.

Bleeding hearts by the score sounded off. As in the days of Chicken Little though, no one acted. Except ex-Beatle George Harrison.

Sitarist Ravi Shankar, a Bengali, last summer proposed to Harrison the notion of a benefit concert, not as a political propaganda but as a means of aiding the refugee hordes. Harrison within weeks rounded up some friends, including Bob Dylan, ex-Beatle Ringo Starr, guitarist Eric Clapton, and blues singer Leon Russell. Result: the historic day and night concerts held August 1, 1971 at Madison Square Garden in Manhattan.

Shankar originally had visions of making perhaps $50,000 for the refugees, but the displaced persons actually received $243,000 from the concerts themselves. And, according to Allen Klein, president of Abko Industries, which governs the affairs of Apple Records, the three-disc recorded package of the event is expected to raise over $14,000,000 more by year's end, the money to be administered by the United Nations Children's Fund.

The recordings almost didn't make it into the public sector however. As the chill of winter set in, the corporate temperatures and blood pressures were rising; wranglings over profits and distribution of the super-sessions hit the boiling point, with settlement coming only last November after Harrison took to the airwaves, via Dick Cavett's late-night video talkathon, and detailed the trouble he was having controlling the royalty arrangements.

Thus, finally, the refugees benefited, and so did all rock-pop audiophiles, for **THE CONCERT FOR BANGLA DESH** (STCX 3386) is a gig that captures all the excitement of the extravaganza while neatly summing up the music of the 60s. And, unlike many live recordings, sound is excellent throughout, perhaps because two dozen microphones were used, and maybe because the performers (all of whom donated their services) were conscious of the need for a quality playback to ensure more sales.

The boxed set, which includes a magnificent 64-page booklet filled with color photos of the participants, follows the natural flow of the concert, giving an on-the-spot feeling to the listener.

It opens with Harrison's somewhat elongated introduction and Shankar's

setting the mood for the event via a 16-minute "Bangla Dunn" duet with Ali Akbar Khan, master of the sarod. Shankar, noting that the concert is non-political, explains to the crowd that Eastern music is misunderstood (obvious when the crowd applauds his tuning) and that this song is intended to "free from pain and agony" those suffering in the Pakistan-India area.

Harrison excels on "Wah-Wah," "My Sweet Lord," and "Awaiting On You All," and Billy Preston offers soul-rock by means of "That's The Way God Planned It." Next comes Ringo Starr's version of "It Don't Come Easy," a vocal curiosity proving once and for all that he *can't* sing and is just a latter-day Fabian. Harrison is then joined by Russell for a smooth-rough vocal duet, "Beware Of Darkness." After Harrison introduces the band, he sings "While My Guitar Gently Weeps," a rendition which includes lengthy guitar solos by Clapton and himself. Russell borrows from the Rolling Stones next, talk-screaming his brand into "Jumpin' Jack Flash" and sequeing "Youngblood" into it. "Here Comes The Sun" finds Harrison again using both vocal cords and guitar chords.

Before Harrison closes the concert with "Something," a gas by any standards, and his hit single, appropriately enough, "Blangla Desh," there's an explosion. Not a literal one, but one of crowd enthusiasm and ecstasy stemming from Dylan's appearance.

Backed by Russell on bass, Harrison on electric guitar, and Starr on tambourine, Dylan wails on five of the tunes few expected to hear him do again in live concert, having cut his in-person shows to the bone, seeking privacy as the end-all in lifestyles.

Dylan's voice is countrified, almost hillbilly in character, not unlike that of a decade ago. And despite his rebel blood thinning through the years, all the old feeling seems to bubble to the surface as he pours out "Blowin' In The Wind" and "A Hard Rain's Gonna Fall." Sandwiched between are "It Takes A Lot To Laugh, It Takes A Train To Cry," and the troubador's section concludes with "Mr. Tambourine Man" and "Just Like A Woman," the latter being joined vocally by Russell and Harrison.

There have been name super-sessions put before the public, many of them rip-offs; never has there been one as well-constructed as this. It makes you think there's really hope for popular music—and that maybe the sky won't fall after all. Æ

Tape Reviews

Bert Whyte

Somethin' Else: Danny Davis and the Nashville Brass. RCA PQ8-1692, Q8 four-channel stereo cartridge, $7.95.

RCA has released nine new Q8 cartridges, the first since the initial 70-odd issued some time ago. You may recall I took RCA to task for what they did to their classical Q8 recordings, and it is perhaps significant that no classical material is in this new batch. In fact I have been assured by a highly placed RCA official that any classical Q8 cartridges henceforth will be properly recorded for ambient rear channels. Hoorah! I was back-ordered on the other 8 cartridges in this release, but if the rest are as good as this, we have made some good progress. I know nothing whatever about the performers here, nor is country western music my bag, but they are quite obviously darn good musicians in their field. Soundwise this Q8 tape is head and shoulders over RCA's previous efforts. As I noted in my earlier reviews, there was nothing basically wrong with the RCA brand of pop "surround" sound, but it was a bit static and lacked the "motion dynamics" of the Enoch Light four-channel stereo. This is fine, and with an excellent apportioning of instruments to each speaker, to the extent that, with the overall clean sound, I really enjoyed some of this CW music! For the second generation of RCA Q8 cartridges, an auspicious start.

The World's Greatest Jazz Band of Yank Lawson and Bob Haggart. Project Three PR4C-5039, Open reel four-channel stereo, 7½ ips, $14.95.

This is one of the new four-channel stereo tape releases on Enoch Light's "Project Three" label. I can't say enough good things about this recording. The title sounds like the boys must be on an ego trip, but believe me, with such stellar personnel as Yank Lawson, Bob Haggart, Billy Butterfield, Lou McGarity, Carl Fontana, Bob Wilbur, Bud Freeman, Ralph Sutton and Gus Johnson, Jr., who can argue with them? Everyone of these men a virtuoso of his chosen instrument. Individually they are brilliant. Their ensemble playing is superb, their overall musicianship impeccable. The basic sound might be described as "Dixie" and "modified Dixie." In any case they are both exciting and tuneful in such numbers as "Love Is Blue," "I'm Prayin' Humble," "Alfie," "Wichita Lineman," and that big Dixie rouser, "South Rampart Street Parade." The arrangements used here are very important, because Enoch Light tells me they were written with the knowledge that the recording was to be in four-channel stereo, and in this way maximum exploitation of the medium could be achieved, rather than with the usual method of creating the four-channel tape from scratch on the mix-down from 8 or 16 tracks. The effect is stunning and with the instruments seemingly in their "logical" positioning at each speaker, although of course, logic can't be a factor in this kind of recording. The overall sound is ultra-clean and brilliant, miked closely but with that right leaven of reverb to give it great presence. A winner in every sense and a fabulous introduction to the medium for four-channel "first timers."

Music From Great Film Classics. Conducted by Bernard Herrmann with the London Philharmonic Orchestra **Ampex/London-L74144,** open reel, 7½ ips, $7.95.

I'm glad to see that London has evidently become attuned to the remarkable talents of Bernard Herrmann, honoring him here with a potpourri of some music from his film scores and giving him conductorial assignments as well. Mr. Herrmann's recent recording of Holst's "Planets," was warmly praised by most critics. On this tape we hear excerpts from "Citizen Kane," "Jane Eyre," "The Snows of Kilimanjaro," and "The Devil and Daniel Webster." This is music a far cut above ordinary film scores. It is well constructed, cleverly scored, and is properly evocative—as good program music should be. Understandably, Mr. Herrmann elicits a fine performance from the London Philharmonic, who obviously play his music without condescension. The sonic values are fine too, with exceptionally good balance, spacious acoustics without blunting orchestral detail, wide dynamic and frequency range and a moderate level of tape hiss. One of the best-processed tapes in some time, and very pleasant listening.

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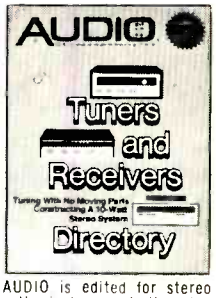

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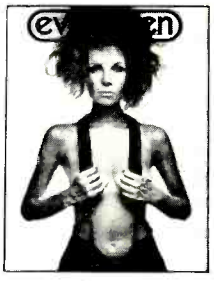

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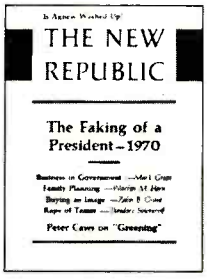

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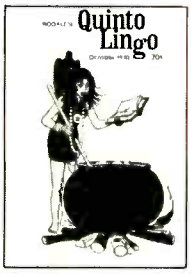

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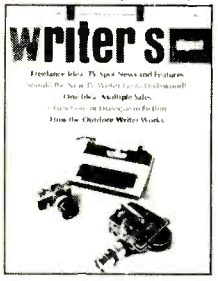

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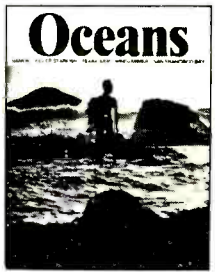

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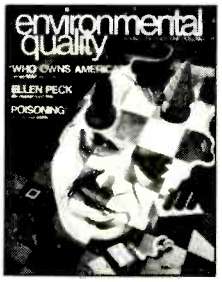

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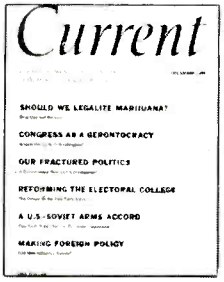

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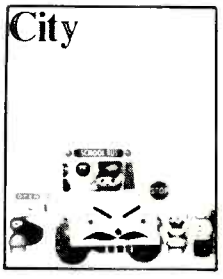

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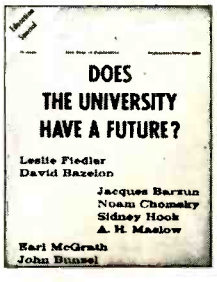

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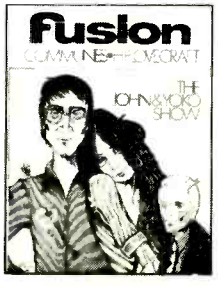

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Jazz & Blues

Martha Sanders Gilmore

Ira Sullivan Quintet: Nicky's Tune

Musicians: Ira Sullivan, trumpet; Nicky Hill, tenor saxophone; Jodie Christian, piano; Victor Sproles, bass, and Wilbur Campbell, drums.

Songs: My Secret Love; When Sunny Gets Blue; Nicky's Tune #2, #3, and Wilbur's Tune.

Delmark DS-422, electronic stereo, $5.98.

This gloriously uncommercial LP containing but five cuts, two of the same tune, was recorded from 5:00 to 8:00 a.m. on December 24, 1958 in Chicago. The set is dedicated to the late tenor saxophonist Nicky Hill who died five years ago. Hill is listed here as a sideman with the tremendously talented Ira Sullivan, but the record is actually more Hill than Sullivan.

An attempt to resurrect BeBop (Re-Bop), a jazz genre which flourished from roughly 1943-1953, the tunes are in that style of taking bee hives of notes to say what you have to say. Coupled with this rhapsody is a pungent humor brimming with quips and puns, witticisms and sarcasms, the so-called trademarks of bop which essentially was a way of looking at life and punching musical holes in hypocrisies.

Delmark has brought bop back, but so woefully altered to electronically simulate stereo that the reproduction is unsound and tincannish, with nothing left to do but turn up the volume for that extra-sensory perception audio buffs crave. Although apparently covered with a membrane, the music breaks through nostalgically, Sullivan and His Quintet playing unpretentious straight-ahead bop that warms the soul.

"My Secret Love," a tune popular at that time, is taken at break-neck speed with Hill out front, very much alive, and Sullivan scittering above him, the two musicians speaking openly of their romantic interests. The truth will out, sparkling Sullivan shimmying down the scale, as firemen down a pole, and sounding somewhat like a cross between Art Farmer in tone and Freddie Hubbard in technique. Pianist Jodie Christian is capricious, cleverly courting triplets on piano, while drummer Wilbur Campbell strikes his cymbals on the downbeat and approaches the tune with the pomp and stance of a Bengal lancer.

The most outstanding cut comes early with a totally inspired original treatment of "When Sunny Gets Blue," which has to be one of the prettiest tunes ever written. Sullivan states the theme poignantly, Hill instilling it with a velvety, crepuscular tone, then picking it up at the bridge and embarking on a subtle journey which tastefully leaves things to our imagination, spreading it over with a mahogany wash shaded with violet fading into raw umbre. Tenorist Hill plays in octaves with a yawning cavern of a tone in the tune that *makes* the album.

"Nicky's Tune," of which there are two takes, is traditional bop, #2 taken at a more sprightly gait and held to be this listener's choice, as #3 tends to drag and sound a bit flat by comparison. It is typically bop with lots of stop and go and soloists converging octaves apart only to disperse again. That the rhythm section is vital to bop is evident here as the drum shoos it along and Victor Sproles plucks a walking bass that doesn't excite but acts as an indispensable slide rule to the exercise.

In "Nicky's Tune #2" Hill is looser, making a blistering attack after which the two gentlemen simultaneously state the theme and bring it on home. Jodie Christian's piano technique, although measured here, is delightfully unpredictable as he combines treble single note explorations with octaval spans that suggest the awesome reaches of a Phineas Newborn and the bass chordal chromaticism of a Henri Renaud. An undisputed denizen of the deep, Christian plums the depths of the keyboard with skillful deep sea dives that unveil jazz jewels hidden under rocks and shells.

Drummer Wilbur Campbell's "Wilbur's Tune" is pure bop-propelled by Hill who generates a bellow and is given to corkscrew motions on tenor sax. Sullivan is bold, blatant, blissful, a most capable technician on trumpet, horning in at the appropriate moment. Can you believe he also plays flute, soprano sax, alto, and tenor?

This LP gives an invaluable perspective to Sullivan's current work and provides insight into the musician who played in Chicago until 1960 and who worked with giants such as Art Blakey, Sonny Stitt, Roland Kirk, Eddie Harris, and Herbie Mann.

Sound: C+ Performance: B

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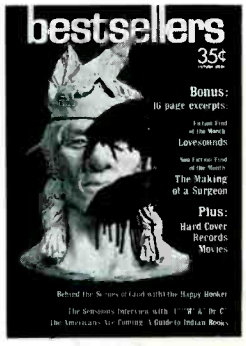

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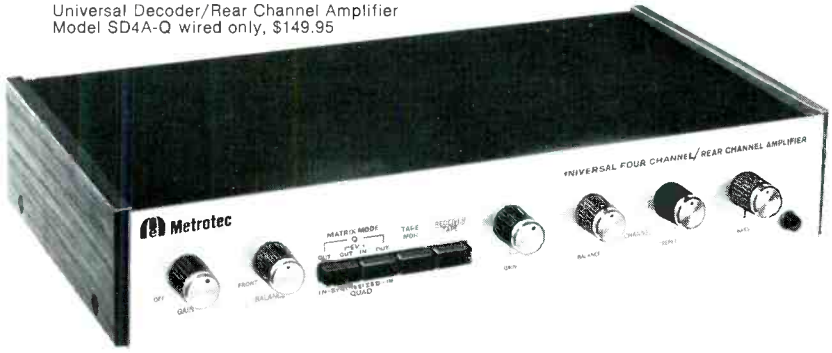

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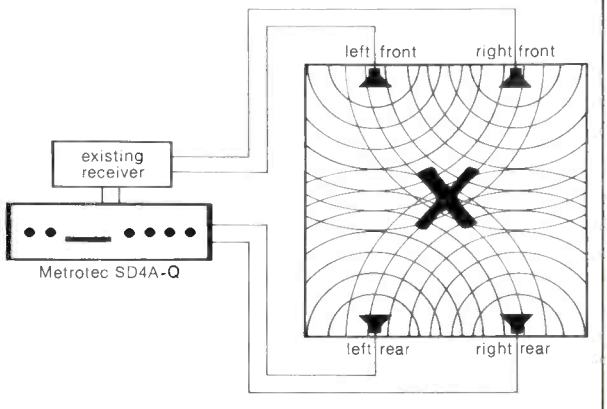

Frequency Equalizer

Be sure to look into the Metrotec Stereo Frequency Equalizer. Match the speakers to your room. Guaranteed to improve any stereo system. You've got to hear it to believe it.

Model FEW-1 wired $99.95
Model FEK-1 kit $79.95

Metrotec Electronics, Inc.

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Middle-of-the-road stereo people are missing the fun of Marantz.

BLAH PEOPLE. Middle-of-the-road people who only listen to the midrange because their power amplifier DISTORTS the high and low frequencies. Because their 250 watt amplifier is really only 250 watts right in the middle. Because that's where it's measured SMACK DAB IN THE MIDDLE! So when the power drops off on either side they miss the BOOM, KA BOOM of a bass and the crisp swissshh of the wire brushes.

Now take the Marantz amplifier Model 250. Marantz says it delivers 250 watts RMS. That's 250 watts total RMS CONTINUOUS power. Over the whole powerpushin' listening range. Right through from 20 Hz to 20,000 Hz with total harmonic and intermodulation distortion at less than 0.1%! Fantastic!

Uncompromising music lover. Professional sound engineer. The Marantz 250 amplifier working in *any* system delivers continuous power at the critical EXTREME frequencies. EXTREME right. EXTREME left. EXTREME high. EXTREME low. Pure sounds. Total reality. Your kind of stereo.

Priced at $495, the Marantz 250 professional power amplifier is only one of a brilliant line of components, receivers and speakers from the makers of the world's most expensive stereo equipment. Including a $149.95 console amplifier.

Visit your Marantz dealer and listen to our line. Marantz stereo at any price is damn well worth it.

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