Liv Taylor in Concert

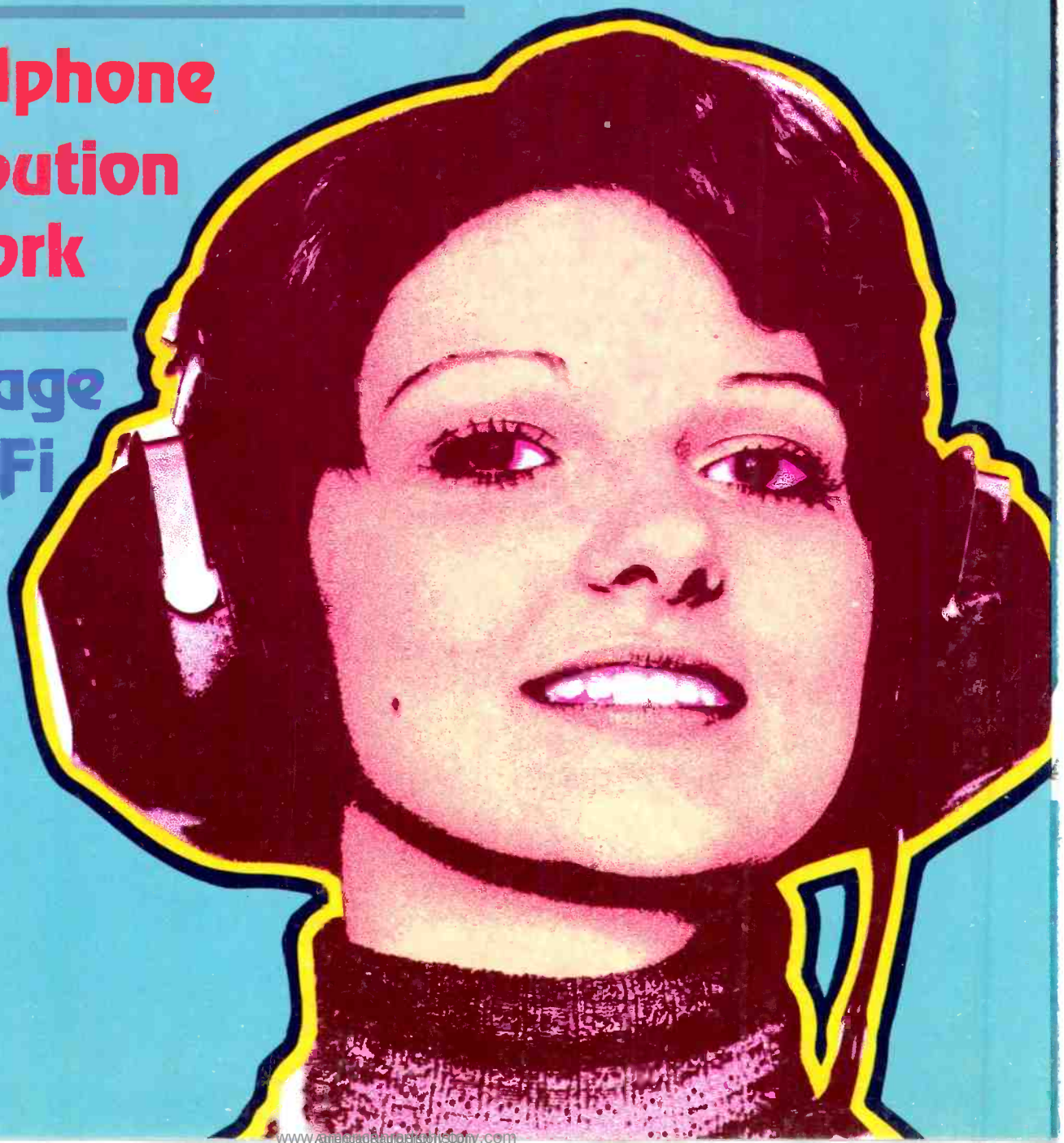
Audio

THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY • MAY 1974 75¢ ® ©
47425

Electrostatics for Headphones

Headphone Distribution Network

Language of Hi-Fi



lifiers,

phase distortion, plus substantially better stability with four double tuned phase linear ceramic filters and four monolithic IC's in the IF section.

6-stage limiters

The IF section includes 6-stage limiter circuits. Used in conjunction with differential amplifiers in monolithic IC's, noise interference is completely elimin – ated with a signal to noise ratio of 75dB.

Exclusive Phase Lock Loop (PLL) IC circuitry in the TX-9100 multiplex section

Developed and used for the first time by Pioneer, the Phase Lock Loop (PLL) circuit is actually an electronic servomechanism. It maintains continuous and precise phasing between the pilot signal and the subcarrier, supplying optimum channel separation. Completely drift free, no alignment is ever required.

The PLL cannot be affected by humidity or temperature since there are no coils or capacitors to be detuned. This provides complete stability and reliability.

New pulse noise suppressor in the TX-9100 operates with computer control

This circuit operates automatically when it is switched on. It effectively blocks radiated noise from airplane and auto ignition systems, neon and traffic lights, etc. It does not interfere with frequency response and stereo separation. Whether the signal is weak or strong, this automatic 'brain' decides when the PNS gate circuit is to operate.

Unique muting control

A 2-position variable muting control uses electronic switching as well as reed relay switching. This eliminates interstation noise and the popping noise of tuning and detuning.

Complete command with a wide variety of controls

Whether it's for AM, FM or headset output levels, Pioneer provides greater operating precision with three independently operated output level controls. A headset may be used without a following power amplifier. Precision tuning is achieved with the aid of signal strength and tuning meters.

AM section highlights IC's

The entire AM section, following the front end, is a unitized IC. A monolithic IC replaces 84 individual components plus a ceramic filter. By using a differential amp circuit and a balanced mixing circuit, there are better spurious characteristics and special AGC amplification.

Great specs for great performance

	TX-9100	TX-8100	TX-7100
FM Sensitivity (IHF)	1.5uV	1.8uV	1.9uv
Selectivity	90dB	80dB	60dB
Capture Ratio	1dB	1dB	1dB
S/N Ratio	75dB	70dB	70dB
Image Rejection	110dB	100dB	85dB
Stereo Separation	40dB	40dB	40dB
Distortion (THD)			
Mono	0.2%	0.2%	0.2%
Stereo	0.3%	0.4%	0.4%
Spurious Response	110dB	100dB	100dB

The Amplifiers: SA-9100, SA-8100, SA-7100

Two separate power supplies utilize 30,000 uF total capacitance

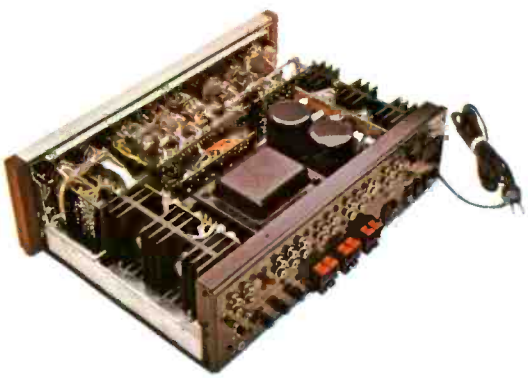
You read it right. The power supply in the SA-9100 uses a total capacitance of 30,000 uF. 15,000 uF each for the balanced positive and negative power supplies. This completely eclipses anything now available in integrated amplifiers. This super high capacitance results in an absolutely pure DC voltage supply. There's constant DC voltage regulation regardless

Two 15,000uF power supplies eclipse anything now available in integrated amplifiers.

of line voltage changes and signal input. Even at extremely low frequencies there's stable power output, excellent transient response and minimum distortion — only 0.1% at any frequency between 20-20,000Hz for 60 watts output per channel.

These positive and negative power supplies provide absolute stability in all stages, even in the equalizer amp and proceeding to the control and power amps. Therefore, the signal lines become zero potential to completely eliminate the usual (and annoying) click noise of operating controls and switches.

Stability is increased even further by the differential amplifier used in the first stages of the equalizer and control amplifiers (also the power amp.) 100% DC negative feedback supplies excellent stability and transient response; it also eliminates distortion. To further increase



Interior view. SA-9100

In tuners and amp Pioneer is the very best.

The time has come to completely re-evaluate the standard you now use to judge high fidelity performance.

With this new line of tuners and amplifiers, Pioneer presents many ingenious innovations in circuitry that are being used for the first time. However, this exclusiveness is only secondary. While each new circuit can be considered revolutionary by itself, what is even more important is that their combined capabilities achieve precision and performance heretofore unattainable.

The Tuners: TX-9100, TX-8100, TX-7100

FM front end — an engineering triumph

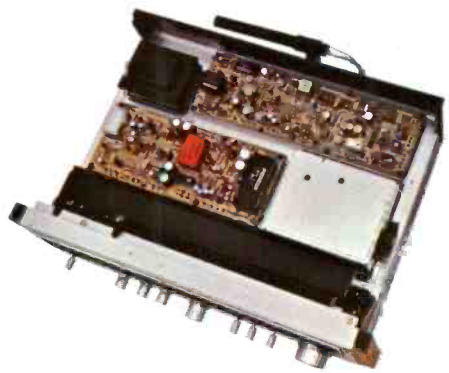
The height of sophistication, the TX-9100's stabilized, drift-free front end replaces printed circuit boards with completely metallized construction. The same used in high precision communications equipment.

Employing three dual gate MOS FET's and a buffer circuit in the local oscillator, there's exceptionally high gain with extremely low noise. Two tuned RF stages with a 5-gang variable tuning capacitor contribute to the highest selectivity (90dB) and astonishing FM sensitivity (1.5uV). The exclusive use of a heavy gauge die cast aluminum housing assures uncanny stability.

IF section — the epitome of advanced research

In the pursuit of excellence, significant new IF section technology was developed. The result is optimum selectivity with minimum

Exclusive heavy gauge die cast aluminum housing assures uncanny stability.



TX-9100 interior view. Chrome plated shielded front end housing and multiplex section.

Critics acclaim...

HIGH FIDELITY: "... The performance of the SA-9100 is so exceptional and the many extras in the way of switching options, and so on, so eminently useful, that we find it the most exciting piece of audio hardware we've yet tested from this company."

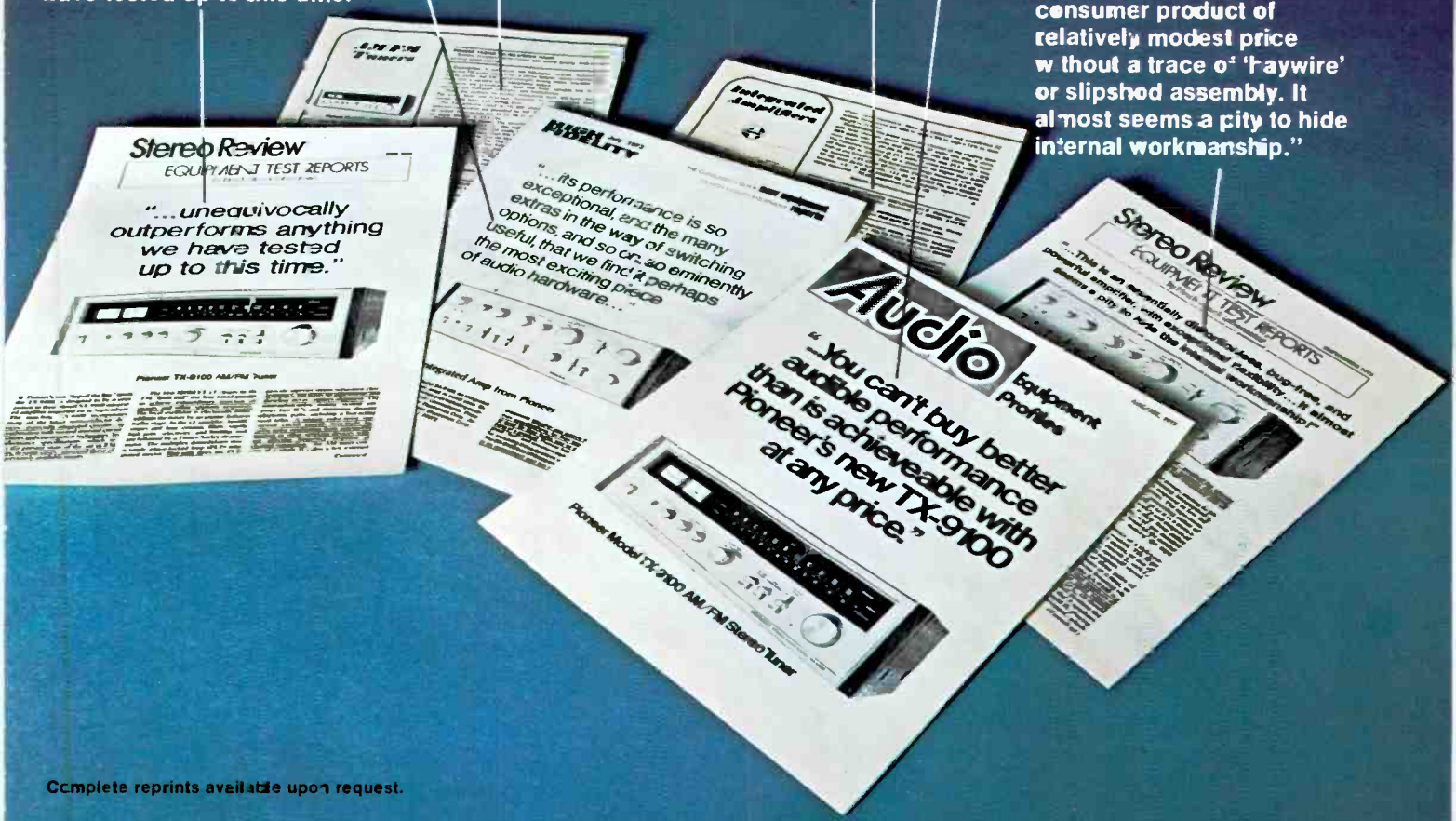
HI-FI STEREO BUYERS' GUIDE: "(The SA-9100) is a powerhouse of sound level, performance and features. Works like something the chief engineer had built for his own use."

"The Pioneer TX-9100 AM/FM stereo tuner offers notably excellent performance and sound quality."

AUDIO: "You can't buy better audible performance than is achievable with Pioneer's new TX-9100 (AM-FM stereo tuner) at any price."

STEREO REVIEW: "This (SA-9100) is an essentially distortionless, bug-free, and powerful amplifier with exceptional flexibility... A highly complex array of electronic circuitry has been packaged into a consumer product of relatively modest price without a trace of 'haywire' or slipshod assembly. It almost seems a pity to hide internal workmanship."

STEREO REVIEW: "... The TX-9100 unequivocally outperforms anything we have tested up to this time."



Complete reprints available upon request.

stabilization, special electronic regulator circuits are used. Transient response is also improved with a superb damping factor of 70.

The unique equalizer amplifier

To make certain that extraneous signals do not interfere with the input signal, the equalizer amp is totally enclosed and sealed to shield it against leakage.

There's also extra assurance of precision with special low noise metal film resistors and styrol capacitors. Both are manufactured under continuous computer control to highest laboratory test equipment tolerances: ±1% for resistors; ±2% for capacitors. Until now such precision has been unheard of in hi-fi equipment. Deviation from the ideal RIAA curve is only ±0.2dB.

Since a direct-coupled SEPP complementary circuit is used in the equalizer amplifier, virtually any dynamic phono cartridge can be accommodated without overloading or distortion. For example, with 2.5 mV sensitivity, the overload at 1KHz is an unbelievable 250mV, and 1200mV at 10KHz!

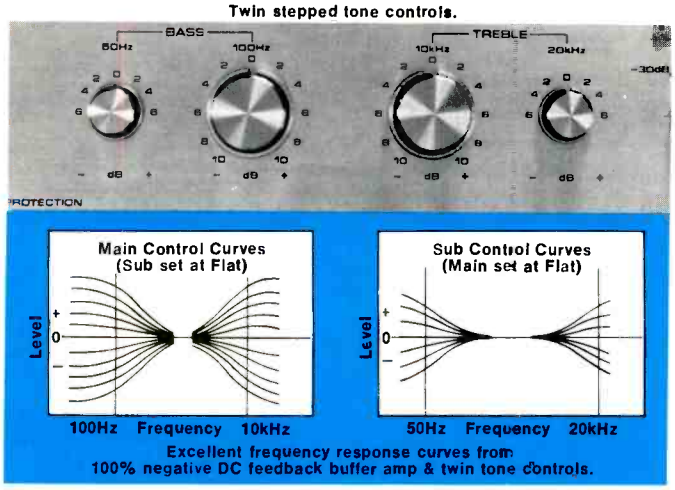
The power amplifier

To sustain the ultra sophistication of the equalizer and control amp sections, the power amp has a direct-coupled pure complementary SEPP circuit, double differential amplifiers and two constant current loads. The combined effect is the achievement of wide power frequency range and excellent transient response. 100% negative DC feedback is supplemented by 66dB dynamic negative feedback for minimum distortion and absolute stability. The pre and power amps can be used independently with a separation switch.

Exclusive direct-coupling in all stages

Until now direct-coupling has been used only with the power amplifier. Pioneer takes it a dramatic step further in the SA-9100 and SA-8100. Direct-coupling in all stages from the equalizer amp to the control amp to the power amp. More effective? Absolutely. It achieves the finest transient response, wider dynamic range, THD and IM distortion of only 0.04% (1 watt). It's an incredible achievement.

Twin stepped tone controls.



Excellent frequency response curves from 100% negative DC feedback buffer amp & twin tone controls.

Level set, volume and loudness contour controls adjust to listening preference

Three controls working together adjust to any degree of loudness. The level set control is the primary volume control. Its maximum loudness setting is 0dB.

Successive settings of −15dB and −30dB result in lower gain. Once the desired volume is obtained, the volume control is used for fine adjustments within the given range. While the loudness contour boosts bass and treble, it may also be used with the level set control. The more advanced the position of the level set control, the lower the effective range of the loudness contour.

The control amplifier: Twin stepped tone controls custom tailor your listening.

Now you can make the most critical bass and treble adjustments with supreme ease. In fact, there are 5,929 tonal combinations to suit your listening room acoustics and to compare or compensate for component frequency response.

On the SA-9100 and SA-8100 four tone controls (two for bass, two for treble) make 2dB (2.5dB with SA-8100) step adjustments for the entire audio spectrum. Working together with the tone controls is a buffer amplifier with 100% negative DC feedback. The main bass control governs ± 10 dB at 100 Hz; the sub-bass, ± 6dB at 50 Hz. The main treble control governs ±10 dB at 10KHz and the sub-treble, ± 6dB at 20 KHz. This, plus the tone defeat control (described in the next paragraph) makes the SA-9100 the most exciting-to-use amplifier that has ever powered any hi-fi system.

New tone defeat switch

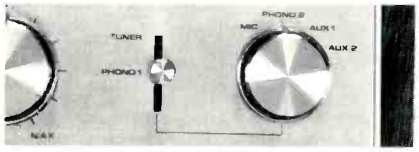
Because of the extremely wide variety (5,929) of frequency adjustments made possible by the twin tone controls, the tone defeat switch adds extra flexibility. Adjusting the tone controls to your satisfaction, you can flip the tone defeat switch. Bass and treble responses instantly become flat. When it is switched off you return to the original tone control settings.

The original and positive speaker protector circuit

Since the signal is fed directly to the speakers because of direct-coupling, an automatic electronic trigger relay system is incorporated into the power amplifier. This protects the speakers against damage from DC leakage which can also cause distortion. It also prevents short circuits in the power transistors.

Maximum convenience for program source selection

While there is a multiple function rotary switch for microphone, phono 2 and two auxiliaries, Pioneer has included an additional convenience. A separate flip type lever control for instant switching between the more widely used tuner and phono 1 and any other single program source. Incidentally, both switches are shielded to protect the input against undesirable extraneous signal pickups.



Convenient program source selection switch & control lever.

Two-way tape duplicating and monitoring

There are two separate flip type switches on the front panel of the SA-9100 for tape-to-tape duplicating and monitoring. Two tape decks can be connected for recording, playback and duplicating in either direction, with simultaneous monitoring.

Level controls for phono 2, aux 2

In order to match the level of various inputs, individual level controls are provided for phono 2 and aux 2.

Speaker B control

This special control helps in the use of two pairs of speaker systems of different efficiencies. There is no sacrifice of damping or distortion when switching from one pair to the other.

Impedance selector for phono 2

An easy-to-use switch allows you to employ any phono cartridge input (25K, 50K, 100K ohms).

Two-position high & low filters

The low filter switch on the SA-9100 and SA-8100 has subsonic (below 8Hz) and 30Hz positions. The high filter switch has 12KHz and 8KHz positions.

Maximum versatility in program sources

	SA-9100	SA-8100	SA-7100
Inputs			
Tape monitor—S/N	2-90dB	2-90dB	2-90dB
Phono—S/N	2-80dB	2-80dB	2-80dB
Auxiliary—S/N	2-90dB	2-90dB	2-90dB
Microphone—S/N	2-70dB	2-70dB	1-70dB
Tuner—S/N	1-90dB	1-90dB	1-90dB
Outputs			
Speakers	3	2	2
Headsets	1	1	1
Tape Rec.	2	2	2

Consistent power for every requirement

	RMS power both channels driven 20-20KHz	RMS @ 8 ohms both channels driven @ 1KHz	RMS @ 4 ohms single channel driven @ 1KHz
SA-9100	60+60 watts	65+65 watts	100+100 watts
SA-8100	40+40 watts	44+44 watts	60+60 watts
SA-7100	20+20 watts	22+22 watts	36+36 watts

This new lineup of Pioneer tuners and amplifiers is unquestionably the most advanced available today. Yet despite this overwhelming sophistication, they're sensibly priced.

See your Pioneer dealer. He'll show you how this series of fine instruments can outperform any units in their price range. All prices include walnut cabinets.
SA-9100—$449.95; SA-8100—$349.95;
SA-7100—$249.95
TX-9100—$349.95; TX-8100—$249.95;
TX-7100—$199.95
While not discussed here, Pioneer is also introducing the SA-5200 stereo amplifier and the TX-6200 stereo tuner for high quality hi-fi on a low budget. Only $139.95 each, with walnut cabinet.

U.S. Pioneer Electronics Corp.,
75 Oxford Drive, Moonachie,
New Jersey 07074

West: 13300 S. Estrella, Los Angeles 90248 / Midwest: 1500 Greenleaf, Elk Grove Village, Ill. 60007 / Canada: S. H. Parker Co.

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FEATURE ARTICLES

EQUIPMENT PROFILES

RECORD AND RECORDED TAPE REVIEWS

AUDIO IN GENERAL

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"COMPLIMENTS OF A FRIEND"

Anonymity is fine. Sometimes.

But when a company like ours has been a leader in its field for 37 years, one begins to wonder whether being anonymous is all that good for business. So, after mulling it over, we've decided to shoot for a little visibility among you who have known the products we sell (Garrard turntables, B·I·C Venturi speakers, to name two) but not our company name.

British Industries Co. will henceforth be known as B·I·C INTERNATIONAL™ (pronounce it "bee eye see" please, not "bic") and will be identified by this logo. B·I·C

We hasten to add that while we believe it is good business to change our name, we don't intend to change our ways.

We will continue to be innovators in the component field. We will continue to emphasize honesty, fair dealing, and all those other business virtues that mean so much when you're laying out several hundred dollars for a piece of equipment.

So remember us. B·I·C INTERNATIONAL. The name stands for more today than ever in our history. And as the man said, "you ain't seen nothin' yet."

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coming in June

Record Changer and Turntable Issue

Joe Lesley explains the "intricate ballet" that goes on under the platter of a changer.

Magnetic Cartridge Preamplifier—A construction project from overseas by Alan Ogilvie

Special Music Feature—Ragtime On Record Plus all the regular columns and equipment reviews

About the cover: This month our editorial focus is on headphones, as shown by our artist's rendering. Len Feldman tells how you can spin your own headphone network all around the house, and Jacob Turner discusses the electrostatic headphone principle.

Audioclinic

Joseph Giovanelli

Input Noise and Phono Cartridges

Q. How can any cartridge be instrumental in lowering the input noise from the first stage of a modern transistorized amplifier?—Steven Heinisch, Prior Lake, Minnesota

A. The first stage of a phonograph preamplifier, either tube or transistor, generates noise. If its input is not connected to anything, this noise will be high. When the input is shorted, noise will be reduced to some minimum value. A cartridge, when connected to the input, acts more or less like a short circuit and thus reduces to a minimum any noise generated by the first stage. The lower the inductance of the cartridge, the more it will act like a short.

Note

With the November issue I began my 19th year with AUDIO. I have managed to do this without missing a single installment.

This seems a fitting time to say just a few words.

I have noticed in some letters that readers are very much surprised that I answer every letter, even though the material was not used in the column. While this is a time-consuming task, I believe that this is a better way to perform this service than to answer only those questions which appear to be of sufficient general interest as to be printed in "Audioclinic." To aid me in this work, I would really appreciate it if each correspondent would send in a stamped, self-addressed envelope. When you think about it a minute, you can see that the time required to make out numerous envelopes leaves less time to answer your letters.

Another way in which you can help me serve you better is if you could place your return address on your letter. When this is not done, I have to check with the original envelope or, where there is one, your own stamped, self-addressed envelope. Again, I suppose this does not sound like much when it comes to one letter, but all of this does add up when we are speaking about hundreds of letters.

One of the most common questions I receive deals with product selection and evaluation. Such questions would perhaps be in the form of a list of specific products, and I might be asked to say which ones are the best ones. So much of product selection and evaluation is subjective. Yes, we can measure an amplifier and know that it has less distortion than another one, but our measurements just don't tell all the story. We are all too often influenced by things such as the appearance of the equipment; or perhaps we don't like the way the tone controls work. Maybe we might not like the physical layout of the controls. Loudspeakers offer their own kind of problems. No matter what we do, we have really not yet brought the concert hall into our living room. We are asking a small piece of paper, or perhaps a few small pieces of paper to attempt to reproduce all of the complexities of today's stereo and quadraphonic recordings. With all of our scientific know-how, loudspeaker manufacturing is still an art. We can make all kinds of measurements on speakers, but these measurements do not tell us the complete story. We simply have to listen to a loudspeaker to see if the sound it produces fits our own, private feelings as to what constitutes good sound.

While I realize very well that there are those who will completely disagree with my views on this matter, I can only say that I really believe it is completely unfair of me to impose my own subjective feelings on any one else.

The only answer I can give to any one who wishes to know what he should buy is to listen to the equipment to see if he likes it. If you can't listen to certain items because they are not stocked by your dealer, you probably should not consider them. Would any one buy a television set without seeing it? Would any one buy an automobile without having first taken a test drive? I think that buying audio equipment is much the same thing. It can very often be a major investment, and should be handled like the auto or TV set.

About all I can saying in closing is that I will look forward to whatever questions arise during the coming year. No one should ever feel that a question is "silly." I ask more questions than I answer, and I can say that there are more bad answers than "silly" questions.

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.

Instead of talking about a cassette deck with 3 heads we make one.

The RS-279US.

It has an HPF™ monitor head. So every recording you make will be as sharp and clean as it should be. That's recording insurance. The kind of insurance that great specs alone can't give. Only a monitor head can.

The monitor is more important in cassette than it ever was in reel-to-reel. Because the cassette can drag or jam without warning. And it's prone to recording overload. Which can ruin a potentially great recording if it isn't detected.

The RS-279US also has many other desirable design and convenience features. Like a dual motor system. With a DC motor for the reel-table-drive and our exclusive direct drive DC motor for the capstan. Adjustable Dolby*. Switchable bias for CrO_2 tapes. Solenoid-operated function controls. Locking pause. Memory rewind. And Auto-Stop.

And the specs are just what you'd expect from a deck with those credentials. The signal-to-noise ratio is better than 59dB. Frequency response is from 20-16,000Hz. And wow and flutter are less than 0.10%.

The RS-279US has the hallmarks of a great cassette deck. Plus one that puts it ahead of other decks. Our patented HPF™ monitor head.

The concept is simple. The execution is precise. The performance is outstanding. The name is Technics.

*Dolby is a trademark of Dolby Laboratories Inc.

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Tape Guide

Herman Burstein

Radio Interference

Q. I own a KLH model 11W stereo module and a Sony 105 tape recorder. When I tried to copy records, I found that I was picking up shortwave broadcasts from a "gypsy" cab office down the street. My cable assembly was two phono plugs to one phono jack y-adapter to a mini-jack input/phono plug output adapter to a miniplug cable. I also pick up radio broadcasts when I listen to the tape recorder with headphones, using a stereo phone jack to a miniplug adapter, but I only seem to pick it up off the external speaker jack, not the monitor jack. If there is a not too technically complicated way of filtering out the broadcasts it would be a great help.—Fred M. Schiller, Brooklyn, N.Y.

A. Your type of problem often presents a great deal of difficulty, particularly when the interfering signal is strong. The usual simple solution is to introduce a small capacitor, of a few pFd, between input and ground at the first amplification stage. If this is beyond your ability, you should consult your audio dealer as to whether he has some kind of trap or filter that can be used between your tape recorder and the rest of your audio system. If he does, try to get it on a trial basis in case it doesn't work.

I strongly suggest that you eliminate your complicated system of plugs, jacks, adapters, and cables; use instead one simple cable between the tape deck and the receiver. And use as short a cable as possible. Rectification of the undesired signal may be occurring as the result of imperfect contacts among your plugs, jacks, etc.

Hook-up for TV

Q. After recording from my RCA portable black and white TV, I get a terrible buzz when playing back the tape. My TV has no outlets in the back for a tape recorder. I've tried putting my microphone farther away from the TV, but this hasn't helped too much. Could you give me some advice on what to do to reduce this buzz?—Elizabeth Kaponya, Brighton, Massachusetts

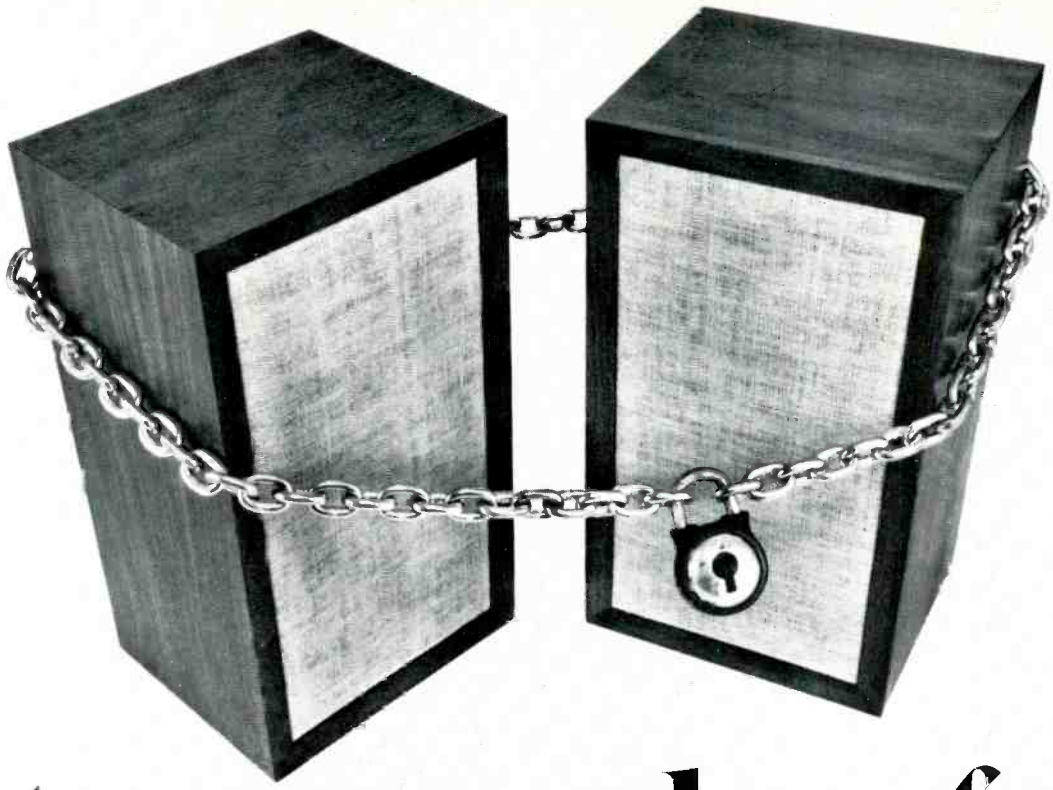
A. Perhaps you can reduce the TV buzz by carefully adjusting the fine tuning knob after you select a station. Adjust the knob for minimum buzz with an acceptable picture. It may also be that your microphone is particularly sensitive in the range of the buzz frequency and exaggerates this frequency. You may get less buzz—and doubtless you will get better overall sound—if you do not feed your tape recorder through a microphone in order to record TV sound. Instead, connect your tape recorder directly to the TV. One way is to connect a cable from the two speaker leads of the TV to the high-level input of your tape recorder. Such cables are sold in audio stores. One end comes with alligator clips for connection to the speaker's leads; the other end has a plug for connection to your tape recorder. The preferable but more difficult way of making the connection is to place the TV side of the cable across the hot and ground terminals of your TV set's volume control. However, unless your TV has an isolating power transformer, do not use the second form of connection. In fact, unless your TV has such a transformer, the first type of connection I described may also present a shock danger; this depends on whether either speaker lead is grounded; if neither lead is grounded, there is no danger.

Reducing Hiss

Q. I have been using a Sony TC-355 deck for quite a while for echo effects on guitar. Is there some type of filter I could build or buy to stop hiss or fried eggs noise when treble boost is applied during playback? How long would you recommend using a tape?—Francis Miller, Duluth, Minnesota

A. Your first question is somewhat contradictory, because treble boost accentuates the hiss you want to reduce. If your concern is with noise generated by the tape recorder system, rather than by other components, you should investigate the Dolby B noise reduction system. The life span of a tape depends on its quality. Generally, a tape of good quality should be serviceable for several hundred plays, and quite possibly for 1,000 or even more.

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.

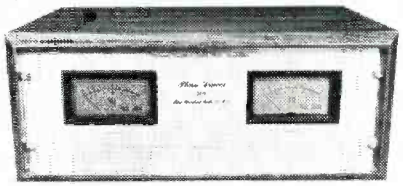


Set your speakers free!

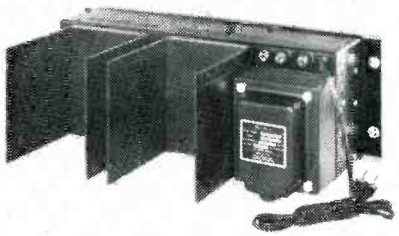
Your amplifier is probably too weak to break the chains that bind your speakers. An underpowered amplifier will lock your stereo system into clipping during low frequency passages or on musical peaks, forcing you down to a less than realistic listening level.

The key to the solution is a high-powered amplifier, specifically, the Phase Linear 400. Listen to Julian Hirsch of Stereo Review: "Anyone using a low efficiency speaker system with an amplifier in the 30 to 50 watt class cannot approach a realistic listening level without severe clipping."

The Phase Linear 400 will unlock music you never dreamed existed in your favorite records. How long has it been since you've had a dream fulfilled? Listen to the Phase Linear 400 at your dealer's soon.



Phase Linear 400
400 watts RMS direct coupled solid state stereo power amplifier.



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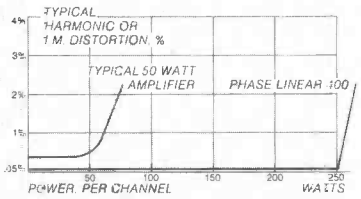

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POWER—Greater than 200 watts/channel RMS both channels driven into 8 ohms. Power at clipping typically 250 watts/channel into 8 ohms and 400 watts/channel RMS into 4 ohms.

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Behind The Scenes

Bert Whyte

IT HAS BEEN almost a year since the "universal" or "everything" receivers arrived on the quadraphonic scene. These units, with their facilities for handling CD-4, SQ, and QS recordings, brought some sense of order to the muddled world of quadraphonic sound.

At this point in time there still are those who wish that this whole thing would just dry up and blow away. Still others have been hoping that by this time one of the competing systems would have been chosen as the industry standard. I'm afraid all this is just wishful thinking. With the June Consumer Electronics Show looming on the horizon, there is every indication that the present state of co-existence between the three quadraphonic disc systems will continue. There have been technical advances this past year which we will surely see in a new generation of four-channel receivers. The most speculation is centered on whether these new universal receivers will incorporate the new IC chips that have been specially developed by the proponents of CD-4, SQ, and QS. If most of the new units have the full complement of chips, it is easy to predict that in the ensuing months, quadraphonic sound will take a quantum jump forward in popularity. If the units do not have the chips, the progress of four-channel sound will continue at its present pace.

Why are the IC chips so important? Because with rare exceptions, few hi-fi dealers, and even fewer consumers have ever heard the CD-4, SQ, and QS disc formats with optimum quality! Startling statement? Not really. It is all a matter of the dictates of economy and marketing policies of the manufacturers of quadraphonic receivers. The receiver market is fiercely competitive in all price levels. As these units become ever larger, more complex, and more difficult and costly to manufacture, there are just so many features and facilities at certain levels of quality that can be incorporated into a receiver before the manufacturer prices himself out of the market. Thus, depending on the particular manufacturer, priorities must be assigned to the CD-4, SQ, and QS formats. Obviously, the people at JVC and Technics/Panasonic can be expected to concentrate on the CD-4 system, Sansui on the QS system, and Sony on SQ. The other receiver manufacturers have had to take a long hard look at the overall quadraphonic scene and make some educated guesses on which disc system they should focus their attention. As long as the manufacturers have to use discrete components in their disc circuitry, some compromises in the efficiency of these circuits is to be expected. Now, don't get me wrong! For the most part, quadraphonic receivers are well made and represent a helluva good buy. For the average user of a universal unit, disc playback through the decoders and the demodulators is quite satisfactory. For the more knowledgeable audiophiles, and the nit-picky purist types, more sophisticated quadraphonic circuitry is desirable.

Dealers can't be expected to carry every line of universal receivers, so we get situations with many variables. For example, depending on the brands the dealer stocks, you could get a pretty good demonstration of the CD-4 system, but less than adequate representation of the SQ and QS systems. And conversely, good demos on SQ and QS, but not very satisfactory CD-4 demonstration. And on and on and on . . .

When I stated earlier that the use of discrete components in disc circuitry meant some compromises, I meant, of course, that there was a cost element involved. It is entirely possible to build optimum CD-4, SQ, and QS circuits into a four-channel receiver. The cost is so prohibitive, however, that usually two of the disc circuits have to be considerably simplified, with subsequent degradation of playback quality in those areas. The cost of the IC chips for CD-4, SQ, and QS should be low enough so that they could reasonably be expected to show up in most of the new generation of quadraphonic receivers. Furthermore, these IC chips will have a standard level of quality and efficiency of decoding and demodulating. The Sansui chip will offer the excellent separation of their Variomatrix circuit. The SQ chip will incorporate full logic and wave-matching along with Variblend, which is a sort of interchannel "bleeding" of signals to compensate for imaging problems with center channel soloists. There are some radical new advances in the CD-4 chip which I will detail shortly.

Leaving the quadraphonic receivers for the moment, the IC chips are of great importance to the manufacturers of high quality pre-amplifiers. With all due respect to the receiver people, even if their particular four-channel disc circuit is of good quality, their associated phono pre-amp circuitry is not low enough in noise and distortion and in other parameters to satisfy the requirements of the kind of audio purists who purchase separate pre-amplifiers. With the new IC chips, the high quality pre-amps are assured of optimum decoding and demodulating, without compromising any of the traditional standards of quality.

As it stands now, on the threshold of the June CES, the most sophisticated circuitry for SQ playback is to be found in the Lafayette LR-4000 receiver, which offers full logic and wave-matching, and in the separate "add-on" Lafayette SQ-W decoder, which adds the Variblend improvement to the logic/wave-matching. Thus in terms of discrete components, the SQ-W is the equivalent of the SQ LT3 IC chip. I have been using one of these SQ-W decoders for some time now, and it does a really excellent job. On surround style quadraphonic music . . . with equal amplitude in front and rear . . . channel separation is well maintained and the "pumping" action of the earlier logic circuits has been virtually eliminated. Combined with my high quality playback system, the SQ-W affords a degree of resolution and quadraphonic imaging that makes four-channel music in this format newly interesting. As noted earlier, few dealers and fewer consumers have any idea that the SQ format has such potential and is capable of such high quality playback.

Unfortunately, I have not had a chance to try out the new Sansui Variomatrix. I would suggest to the Sansui people that when their IC chip is available, it be incorporated in an "add-on" unit, for those who have separate pre-amplifier/amplifier

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AUDIO

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systems. I have heard the Variomatrix chip at a professional demonstration, and its performance certainly bolsters the claim of close to 20 dB of separation.

While certain circuitry is basic to CD-4 demodulators, various engineers have different ideas and approaches to the CD-4 functions. This is mainly in the area of the carrier signals. Thus, in the Panasonic demodulator which was given to me in Japan, there is a separate left and right carrier adjustment, with so-called "radar" lights which go on when the levels are correct. Some other CD-4 units use just a single potentiometer for carrier adjustment, while others have a pre-set carrier level, with no pots at all to adjust. It should be noted that because there are a number of different type CD-4 phono cartridges on the market, that with the "add-on" demodulators and with those built into receivers, some combinations seem to be more compatible and work better than others. I had one cartridge/demodulator setup that resulted in a complete phase reversal! Here again, I doubt that many dealers or the public have heard the kind of quality possible with the best CD-4 facilities. In spite of this, the new CD-4 chip from Lou Dorren's QSI company will afford CD-4 playback considerably improved over my discrete component demodulator. The QSI chip will have as much as 40 dB limiting ahead of the phase-lock loop, resulting in a very pure FM signal with no AM present. There is a high speed muting circuit which operates within 15/20 milliseconds, if there is momentary loss of carrier, and changes the quadraphonic presentation to four-channel monophonic. As soon as the carrier is restored, it reverts to the quadraphonic mode. In CD-4 cutting, the burnishing angle has been changed, and along with the 35-degree back angle now used, the stylus now presents a more chisel edge to the lacquer with less carrier erase. Thus, the carrier can now be used over all the full range of record diameter cutting, which of course solves the timing problem. This is borne out with an RCA recording of the Philadelphia Orchestra with Ormandy conducting a suite from Tchaikovsky's *Swan Lake* ballet. I checked out the first side as just a few seconds short of 27 minutes, all with no attenuation of level or bass.

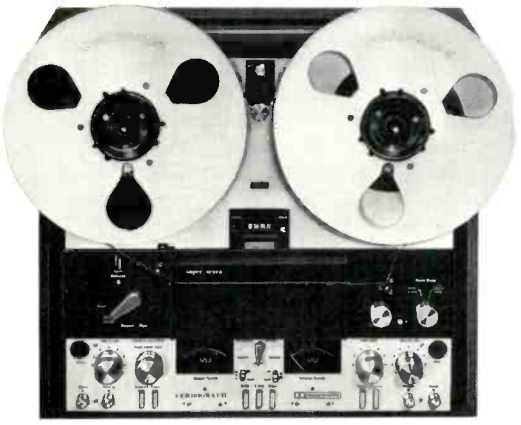
It is obvious that the new IC chips for the CD-4, SQ, and QS disc systems will really put quadraphonic sound on the map. One can but hope that they really will make their debut at the June CES.

This year only 1200 perfectionists will satisfy their pursuit for excellence.

The new Ferrograph Super Seven takes its place alongside the finest high fidelity components in the world. Admittedly, it's not for everyone. Just the limited few who are able to recognize and appreciate its unexcelled capability for professional performance in the home.

The Super Seven achieves new heights in innovative tape recording with more than thirty advanced features including:

Exclusive variable speed wind and rewind—10½-inch reels—3 speeds: 1⅞, 3¾, 7½ ips or 3¾, 7½, 15 ips—Dolby B (on request with either speed configuration)—professional electronic editing—instant slur-free starts in record/playback—bias adjustment on front deck—pushbutton tape/source comparison—bias reading and tape track transfer.



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New Super Seven Ferrograph

Total versatility with tape.

What's New in Audio

Kenwood Automatic Turntable

Model KP-5022 features a fully automatic servo-controlled direct-drive system with an 8-pole brushless d.c. servo motor directly coupled to the center of the turntable, providing accurate rotation (± 3% with separate control knobs) at speeds of 33⅓ and 45 rpm. An elliptical cross-section, statically balanced, tubular tone arm reduces mechanical resonance to inaudible levels and prevents IM distortion. The cartridge shell is fully adjustable for precise stylus-to-record angle, said to assure optimum channel separation for both stereo and CD-4 discs. Also included is a direct-reading stylus balance gauge (0-4 grams), precisely calibrated anti-skating adjustment, stylus lamp gauge, automatic indexing of 7-, 10-, and 12-in. discs, repeat play, automatic arm return, and stroboscope speed adjustment. The KP-5022 measures 19 in. W x 6¾ in. H x 13⅜ in D and weighs 19.8 lbs. A $299.95 price tag includes base and dust cover.

Check No. 60 on Reader Service Card

Literature

AUDIO contributing editor Herman Burstein has authored a new book titled *Practical Advice on Everything Related to Recording.* A question-and-answer format is used in an organized and alphabetical manner. Sections include: Accessories, Basics, Connections, Distortion, Equalization and many more. The chock-full reference volume is available for $8.95. Specify No. 681 when ordering from Tab Books, Blue Ridge Summit, PA 17214.

The Japanese Radio, Record and Tape Player Schematic Servicing Manual is a complete sourcebook containing schematics, drawings, alignment info and service tips on a multitude of Japanese-import multiband radios, record and tape players, and auto stereo units. Major brands are covered along with a full list of names and parts location addresses. Hardbound, $7.95; paperback, $4.95. Tab Books, Blue Ridge Summit, PA 17214.

DuKane Corporation offers a 16-pg. booklet titled, "Sound Systems." The pamphlet gives basic data for the design of sound reinforcement systems. Included are flow diagrams and line drawings of actual components, elementary to complex, and a checklist to aid in assembling data necessary for construction of a sound system. Price: $1.50. Request Form 9310-B from DuKane Corp., 2900 DuKane Dr., St. Charles, IL 60174.

Stereo/Quad Hi-Fi Principles & Projects for the Audio Experimenter is a 2-part book. Part One is a discussion of the principles of stereo and 4-channel equipment illustrating simple projects to demonstrate the concepts in action. Part Two covers do-it-yourself projects from amps to preamps to speakers and more for the audiophile interested in high quality components at reasonable prices. Hardbound, $7.95; paperback, $4.95 from Tab Books, Blue Ridge Summit, PA 17214.

TDK "Guide to Cassettes," a free 48-pg. booklet, covers terminology, care of cassettes, routine maintenance of recording equipment, descriptions of TDK's full line of cassettes, and suggestions on selecting the best cassette for various types of recordings. Available from TDK dealers, or write TDK Electronics, 23-73 48th St., Long Island City, N.Y. 11103.

Tangent Template has made available a free short form catalog. Pictured and described is their comprehensive line of user designed templates for printed circuit design and drafting. Also included is a postage paid order card.

Check No. 61 on Free Information Card

Bulletin #231 from Grayhill describes their 61 different types of solid state relays. Included are control method, control voltages and currents, load voltages and currents, package size and termination. A helpful guide and stylized part numbering system aid in selection of the proper relay for a specific application.

Check No. 62 on Free Information Card

Nortronics' 32-page updated *Recorder Care Manual* is now available. The publication features detailed information on the principles of magnetic recording, magnetic heads, and maintenance operations. Also included in the illustrated booklet are a bibliography for further reference materials and a 7-pg. catalog of Nortronics recorder care products.

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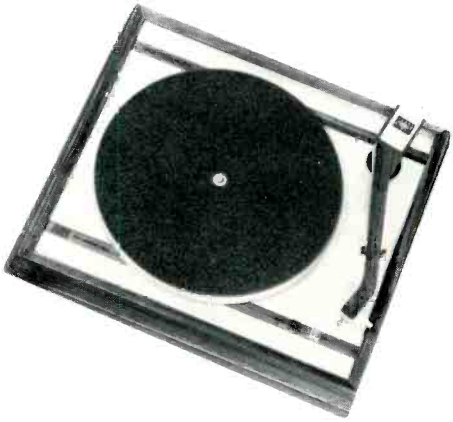
Win Labs Turntable



The Lab I utilizes dual synchronous drive motors to produce highly accurate speed. Idlers and belts which can be a source of rumble and flutter have been eliminated. The S-shaped tone arm is low mass, hand-polished and kiln-cured wood which is viscous damped and statically balanced by means of a variable counterweight. Chemical damping is used in both vertical and lateral movements of the arm resulting in discouragement of lateral thrust, which eliminates the need for leveling the turntable, and groove-skipping. A white light indicates that the power is on and a red one serves as a warning that the record has stopped and the arm should be lifted. Speed accuracy is ± 0.1%; wow and flutter, less than 0.1%; rumble, -70 dB.

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Introducing a small miracle

Miracles, even small ones, are hard to believe. We know.

When we first introduced our small 404 speaker some years ago, believers were hard to find. Today, our credibility is really being challenged. The new XT-6 is so good that even the people who know ADC's "small box, big sound" achievements find it incredible.

But it's true. This book-sized bantam outperforms anything its size. And rivals enclosures many times its size and price.

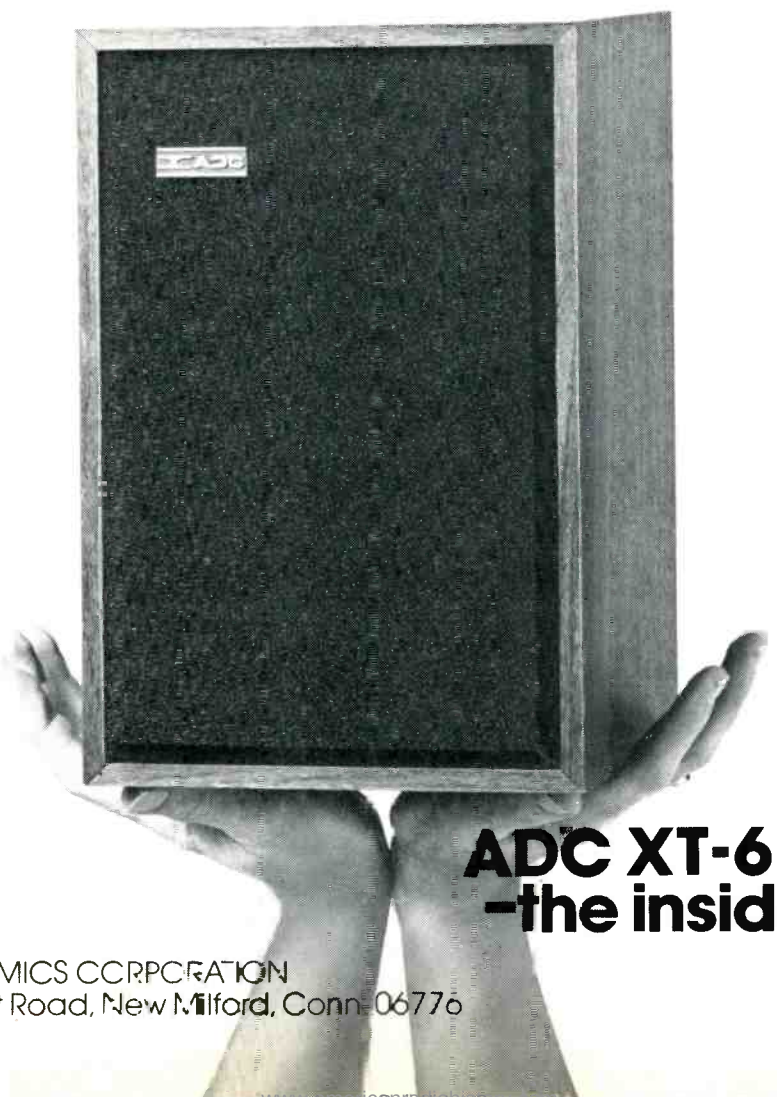
How do we do it? With a unique combination of cone structure, magnet force and coil configuration, for one thing; they interact to let a small woofer pump out a staggering amount of bass. Handle as much power as any standard-sized room requires. And keep distortion at a minimum.

Granted, the XT-6 has its limitations. It won't shake timbers. And it won't project massive sound into huge rooms. But in typical apartments, the ADC XT-6, at under $60, gives you more sound per dollar than any other bookshelf speaker on the market.

The specifications will confirm the technical capabilities of the XT-6. But we suggest you go to your dealer and listen...Even if you don't believe in miracles, the XT-6 will give you something to think about.

XT-6 SPECIFICATIONS

NOMINAL IMPEDANCE:	6 ohms
RESPONSE:	45Hz to 20 KHz ± 3dB in average listening room.
HIGH FREQUENCY DRIVER:	2½" viscous impregnated cone tweeter with 1½" Dia. effective radiating surface.
LOW FREQUENCY DRIVER:	6" with high compliance, soft suspension and viscous coated cone.
CROSSOVER FREQUENCY:	2000Hz Nominal.
HIGH FREQUENCY LEVEL CONTROL:	When in "treble down" condition tweeter level is pivoted from the crossover point to approximately 3dB down at 10kHz.
ENCLOSURE:	Walnut finish air-tight cabinet 12¾6"H x 7⅞"W x 8½"D. Filled with sound absorbent material.
POWER REQUIREMENTS:	10 watts RMS power output per channel.
PRICE:	$58.00



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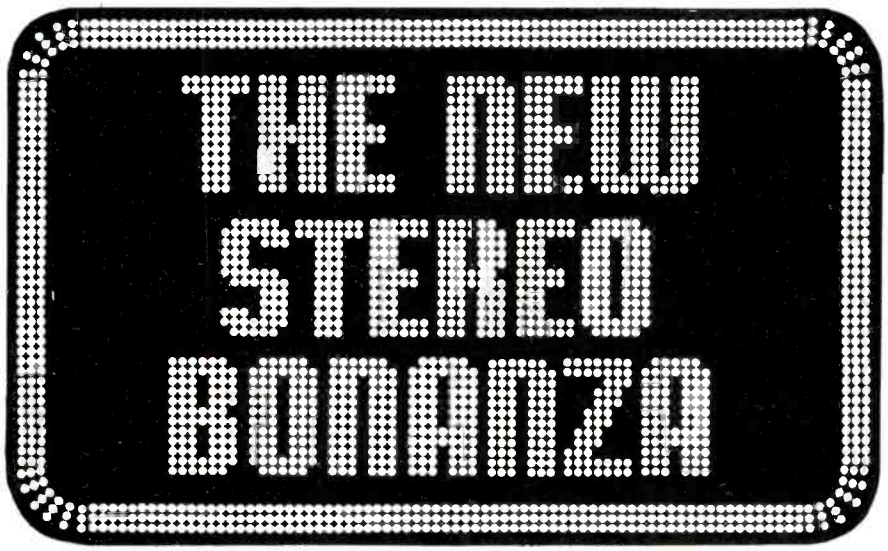

Edward Tatnall Canby

I DON'T KNOW about the rest of you, but things quadraphonic are crystallizing in my mind. About time. People have been blowing hot and cold on this subject for years now, and still there is confusion all over, indecision out among the fans. Now all these momentous threats occur, with the implication that super luxuries like this ought to be banned, or something, as part of the energy crisis. *Is* quadraphonic a super luxury? There's a spectre that dies hard. Too many people still cling to the simplistic thought that four is four times too many. Well, if this is your thought, then let's also get rid of the Four B's, Beethoven, Brahms, Bach and the Beatles. Superfluous. Especially for those who never did like them.

In times of incipient trouble, somebody is always going to say that ART is expendable and let's do it quick. No frills please, just more gas. The fact is, though, that in times of really serious trouble such things have a curious way of coming into their own. The modern record biz began in the Great Depression—for me, at least, since that's when I started buying up discs, one by one as I could. There was Myra Hess, the pianist, playing to thousands in London in the middle of WW II bombing. And the sensible WW II conviction in America was that this time around Beethoven and Wagner, though German, should NOT be suppressed. All this is not mere sentiment. It goes deeper; it is a feeling that one must desperately hang onto the fruits of a thousand years of human upbuilding, just at a time when those fruits are most in danger; a curious sense, even among people who don't know the difference, that suddenly music and its allied arts are more powerful, more real, more *needed.*

But quadraphonic? If music itself is needed in the home, and given importance, then quadraphonic is a part of it. A luxury, if you will, of the sort that becomes more cherished as things wax more difficult. You may gather that I assume quadraphonic to be integrated into the very substance of home listening. It will be! It should be. The more troubles we run into, the more ingenious will be our solutions to the problems of making it widely available.

You can understand, then, why—whammo!—what was once merely a hunch with me has crystallized into an overpowering conviction via recent developments. It needs to be said. A sort of much-delayed bombshell, which has been largely overlooked in the midst of all the revolutionary development. And will those Dyna people in Philadelphia laugh. They've been saying it for years.

The greatest single sales factor in the *present* quadraphonic market could be the four-way decoder *as applied to standard stereo discs.*

I am not speaking of quadraphonic discs, of course. They are better, whatever system. But they are also *fewer.* and will be for a time. What we have with us right now is STANDARD STEREO, in one of the greatest accumulations of recorded human intelligence ever assembled. All of it built up in a scant 16 years or so. Unbelievable. We need more than a passive "also-play" compatibility for these millions. We have it.

Look in Schwann. I've mislaid Schwann's annual statistics, always fascinating reading, and I don't remember whether it's now 60,000 LP items available, a large proportion in stereo, or maybe a mere 30,000. No one person is going to play or own all of these. But plenty of people jump to a horrendous non sequitur: who needs 'em? It does NOT follow that we need a mere handful of recordings! Your handful? My handful? Here is the very meaning, you see, of the term *library.* In recordings it is a monumental library of availability, like Macy's the World's largest store for everybody, or the Sears catalogue, or the Library of Congress. And what about the library at Alexandria in Egypt, back in classical times? It was destroyed, and with it vast quantities of the human legacy. Who is to say which parts were more important than others?

Whoa, Canby, you are starting to de-rail. But let's not de-rail.

I return to my point—the quadraphonic decoder of standard stereo records is the most important link between what has been done and what will be done. It is the *first* thing to consider, today, if you have any sort of accumulated library of stereo records and tapes of your own or plan to build one out of present available largesse.

The trouble is, you see, almost everybody has been putting this last, not first. "Composer circuits!" An extra quadraphonic filip, so you can compose your own on the side, out of your old records. How many engineers have realized the enormous transition importance of this very item? I suspect not even the big matrix boys, who have been so engrossed in their phases and quadratures and vectors that I do believe they have forgotten all about the lowly stereo disc in all its millions. More power to 'em—that is their business. But let's not let it happen to us, whoever we may be.

What has happened, more or less willy nilly (i.e. by sheer purposeful accident), is that these same matrix engineers have stumbled unintentionally on a bonanza and it's working better and better every week. (You have no idea. We reviewers and such are a few

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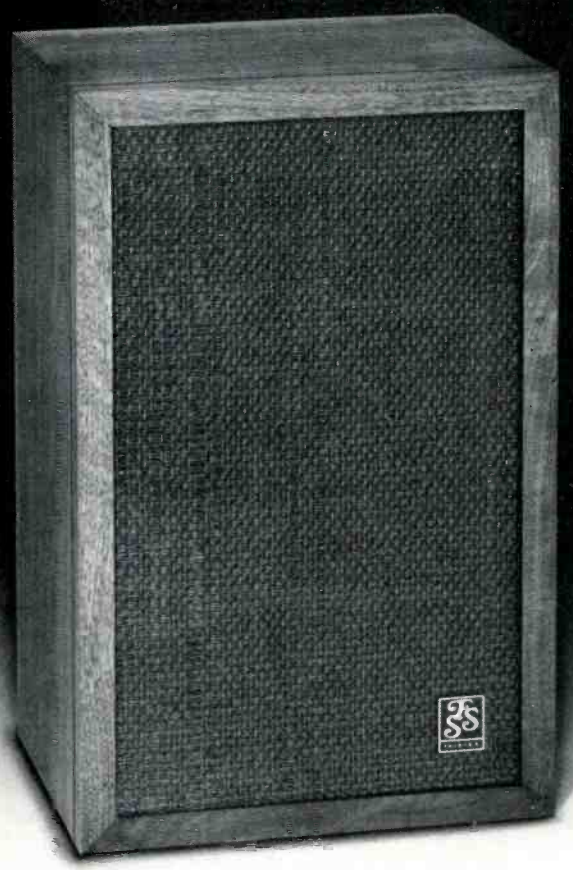
AT ANY PRICE



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The **Fairfax FX-300** was recently top-rated over 20 leading medium-priced speakers by one of the most respected consumer reporting organizations in the world.

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But in order for you to agree that the **FX-300** is the most accurate sounding speaker (rated at 8 ohms with a minimum of seven watts RMS required) you will have to listen to ours and compare it to theirs—any of the 20 other speakers we topped and then some.

Visit your nearest audio dealer and ask to hear the **Fairfax FX-300,** and compare it to any other speaker in its price range—even some costing considerably more.

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steps ahead.) This is a *fundamental* improvement in stereo reproduction, after the fact. Not merely a heightening of the fi, like, say, the ever-useful reissue of older records remastered for better sound and better surfaces, or the acquisition of improved playback equipment. The fundamental part is that now, with four speakers and amplifiers, we are able to place some of the ambient, reverberant sound of a stereo record *selectively* away from the direct frontal sound, into a back space where it provides new sorts of listening, a basic improvement in stereo impact from the same old discs. And what a superb difference this can make at best! Or even at average. It has been getting better and better, too, with more sophistication in the decoding. Decoding, remember, of standard records, *not* quadraphonics. Now we have reached the point of an explosive payoff.

We must be realistic and understand that without the enormous and intensely competitive research on actual quadraphonic sound, we never could have had the present advanced generation of decoding. The engineers could not have evolved the idea to its current sophistication except under duress. It has happened. And now is the time to rejoice.

Well, then, am I obliquely referring to *all* the various quadraphonic systems for playing stereo discs through four speakers? Well, yes, in a way. But I might as well say it: For me there is a definite hierarchy, and here is the inspiration for my present piece. You may take this from me as an honest and thoroughly tested personal ear reaction. The latest and best SQ decoding, the "three-chip" SQ-with-logic that is just now getting into marketable equipment is in this special respect ahead of all predecessors and in fact is something of a sheer miracle. It just has no right being as good as it is. It can't *be*! It is impossible! And yet, there the thing is, defying logic, sounding just superb.

As Pepsi used to say, this SQ logic hits the spot. It resonates, speaking purely aesthetically, of course. It is so instantly *right* in the stereo listening (and I have been listening for some eight or nine months) that I still find myself marveling each time a new stereo disc blossoms out through its circuitry. Crazy, considering the well-known complexities and compromises that are involved in all matrix decoding. Too good to be true, but it is true. Not a flaw that I can hear. At least in my own rather wide listening.

Note that the earlier and first SQ with logic was another story, full of all sorts of weird pseudo-effects of the very sort that its critics in other camps had expected. I liked it, but those strange pumpings and flutterings and flyings-about of stereo sound? Interesting, psychedelic, and what-not; but they were still too obtrusive, too distracting. Not good. Now, all that is gone. How did they do it? None of my business.

Why bother to buy quadraphonic discs, then? So simple. When they do appear, they are still better, a noticeable improvement in detail and order over the same music decoded from standard stereo. Don't think twice about that; buy quadraphonic discs by preference, tapes too, whenever the content is what you want. If and when the two types are priced the same (as happened eventually in stereo), the choice will be academic, anyhow. The point I am making in no way runs down quadraphonic itself, except that in my mind the BIG step is from standard stereo in two speakers to standard stereo decoded into four speakers, by SQ—or any other systems of equivalent sophistication.

So go right out and acquire your quadraphonic equipment. Just be absolutely sure that you can satisfy your ear on standard stereo discs—check that FIRST.

In the above perspective, you may now observe what may turn out to be a misjudgment, as of right now, in the CD-4 camp. Via CD-4 your stereo is also compatible, but you are mainly offered a type of passive four-channel playback, a sidewise or parallel stereo. The left stereo channel goes into both left speakers; front and back; same with the right side.

Of course you can listen this way. It's OK. But you can do more. Note that there is here no *selective* rear ambience at all. (Even the original Dyna three-speaker system, throwing the difference signal into the back of the room, does more for you, if with less sophistication.) What you have is simply one stereo channel on each side of you, via two speakers for each channel. According to the inevitable laws of monocity, to make a word, you hear each channel as a vague virtual image between those two speakers, a flat radiator coming at you sidewise. Pleasant but not really much improvement.

Note please, this is not a criticism of CD-4 in respect to its prime intention, quadraphonic reproduction of CD-4 encoded discs. I'm still talking about the things you can do with the discs you already own, the stereo discs still available (and not in quadraphonic) which you would like to hear, hopefully with improvements, on your four-way system. Can't say this too often. You should do the best you can for *those records.*

You can see where my thoughts are moving. Suppose we do get to have quadraphonic equipment, as we surely will, which at a reasonable cost and complexity will handle every sort of quadraphonic disc and decode standard stereo to its best advantage too, all at the proverbial flick of the wrist. A reasonable proposition, what with new cartridges, mass-produced chip units for both quadraphonic systems, and increasing understanding of what the consumer needs in the way of simplicity. (Plenty!) It'll all happen. The real problem right now with the CD-4 system is not what you think. Not the technical problems in the CD-4 type of quadraphonic. It is this: There just aren't enough CD-4 discs nor enough variety.

If RCA thinks we classical people (I won't speak for pop) are going to live off the nuts in the *Nutcracker Suite* and similar pleasant but overbaked Philadelphia chestnuts, they have a rethink coming. Nutcracker, my eye. Nice piece until you get tired of it. The SQ repertory in quadraphonic isn't by any means universal, but it goes out maybe 100 times as far already.

If it weren't for CD-4's Elektra/Nonesuch/Warner/Kinney Parking Lots stuff (all one big conglomerate), we'd be in a serious CD-4 software pickle at this precise point. Another biggie, with marvelous stuff on hand, is apparently in the CD-4 future and just about in time. It's starvation. Available repertory! That's what is needed to put over CD-4. And to sell CD-4 equipment. Plus, as I say, competitively adequate circuitry for playing standard stereo discs.

So let's everybody work to do a topmost job for standard stereo in fours. It is the transition hope for all of us, while fancier quadraphonic stuff builds repertory. It's easy, too, now that we see how. In another fifteen years, since most of stereo already comes from 3, 4, 8, 16 or even 32 tracks in the masters, we'll no longer be able to tell much difference—we'll decode or demodulate everything we have, old, new, middle-aged, come what may. Meanwhile, all of an accident, CBS and SQ have shown us the way for the present quick moment. Others can match the SQ marvels if they have a mind to. If I guess right, they soon will.

So, dealers, go out now and sell quadraphonic systems *for stereo records.* The new stereo bonanza. Just think. Millions of discs on hand, and every one wonderfully enhanced into four-way sound! P.S. You can also play quadraphonic discs to perfection. Wow! That's the angle, as I now see it. Æ

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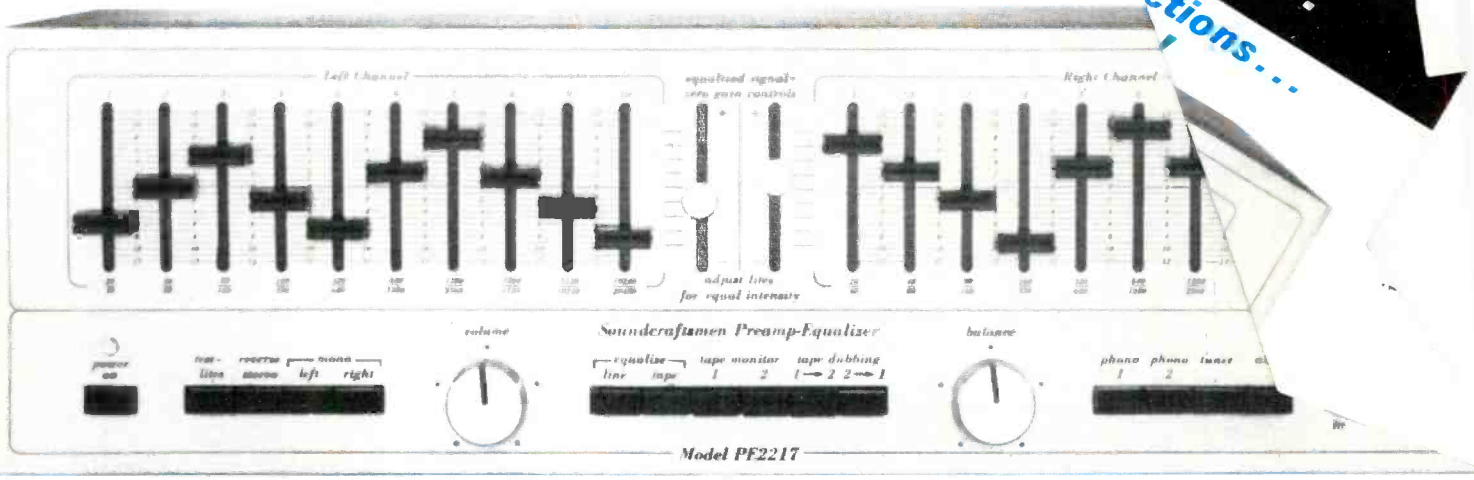

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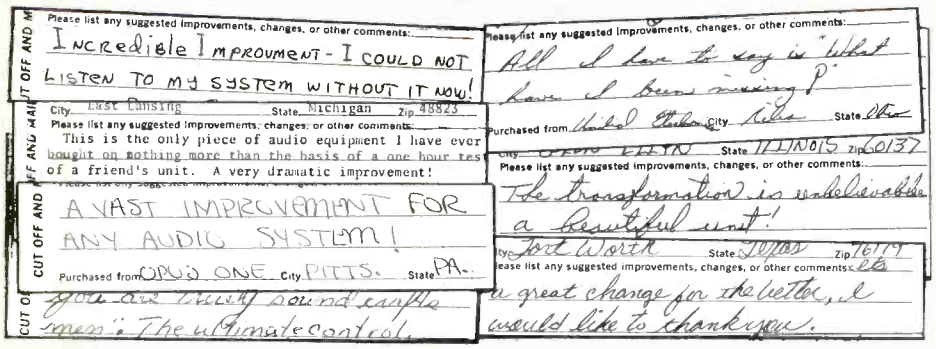

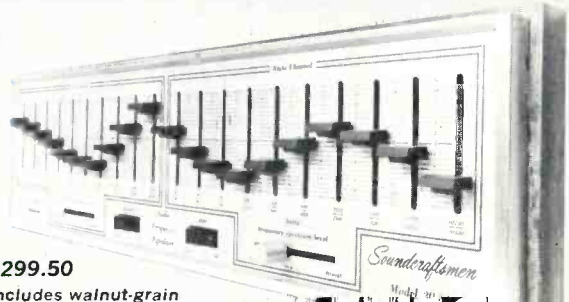

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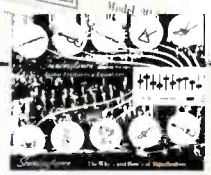

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Editor's Review

FROM THE NUMBER of telephone calls, and comments on our Reader's Service ite a few readers would like to know out AUDIO's equipment testing procedure, specifically why one piece of equipment viewed and another isn't.

Generally, the biggest single limiting factor s space in the magazine. Consider, for example, a review where we really wring out a piece of equipment. This can take as much as five pages, and certainly no major piece of gear would take less than a full page with our current test methods. What this means in that profiles of three items will take up at least eight or nine pages and possibly as much as 12 to 15. Because of the economics of magazine publishing, it is difficult to devote much more space than this to profiles and still be able to publish feature articles and our regular columns. As a result, we were able to publish "only" 41 tests in our Equipment Profiles and Workbench sections last year.

Now before you take me to task for not publishing reviews of a greater proportion of the products on the market, consider that AUDIO devotes more pages to reviews than any other comparable magazine. Consider too that many products remain in the market place for a number of years and that other products, even though newly introduced, can be considered as logical extensions of previous products, but incorporate enough design improvements to warrant a new model designation.

But to return to the central question of why one particular unit than some other. The first way a certain model will enter the test program is when enough readers ask for a review that I feel we ought to go out and get that item in for test. A second way is when either I or a reviewer sees a piece of equipment that looks interesting at a press conference or in an advertisement or news release. Yet another way occurs when one or another company representative tips me off that a "new and exciting" item will be released shortly and offers the item for review. Surprisingly, there is a good consensus between these three major ways. Generally, what you readers feel is worthy of review is what we editors think interesting and what the manufacturers find exciting and worthy of review.

Where does the equipment come from when it comes in for test? Almost always, it comes in from the manufacturer, with occasional units coming from a dealer. These are "loaners" and go back to the source when we've finished photographing and testing the unit. Why don't we purchase them on the open market from randomly selected dealers? Because of the expense, mainly, but also because we can get early samples from the maker so that you won't have to wait six months or a year after the unit's introduction to see a review. The open-market value, incidentally, for the equipment reviewed in 1973 was roughly $25,000, and this doesn't include payments to reviewers, photographers or shippers, whom we still have to pay.

A few readers have expressed concern that this practice, standard with all consumer magazines save one, I believe, might open up our test bench to specially "hyped up" units. However, we are pretty certain that this doesn't happen.

Why? First, consider the position of the manufacturer. While he is naturally desirous of the best possible review for his baby, it is much easier and better for him to recall or change a product design than it would be for him to regain the reputation lost if he were caught sending in a "ringer." The product might be the result of a year's work, but a reputation is won from a grudging public and critical reviewers and lasts a lifetime.

While it certainly is theoretically possible for a firm to hype up one, six or even 20 units to send to reviewers, it really wouldn't have the desired effect because there are too many audiophiles knowledgeable enough to catch any major difference from specified performance, either on the test bench or in the listening room. The dealer or repair station enters in here too, as it is part of their job to verify that a unit will perform as advertised since they would certainly be caught in the middle if the unit didn't deliver.

Incidentally, we've run cross-checks with other publications on random pieces of equipment. The serial numbers haven't matched yet, and usually there is some overlap of the test periods. And most reviewers are sharp enough to be able to identify a "one-off" or prototype unit.

I hope this answers most of your questions about how and why we test particular pieces of equipment. If you've any others, please don't hesitate to write. There's too much to do here for me to promise I'll answer every letter, but I'll do my best.

E.P.

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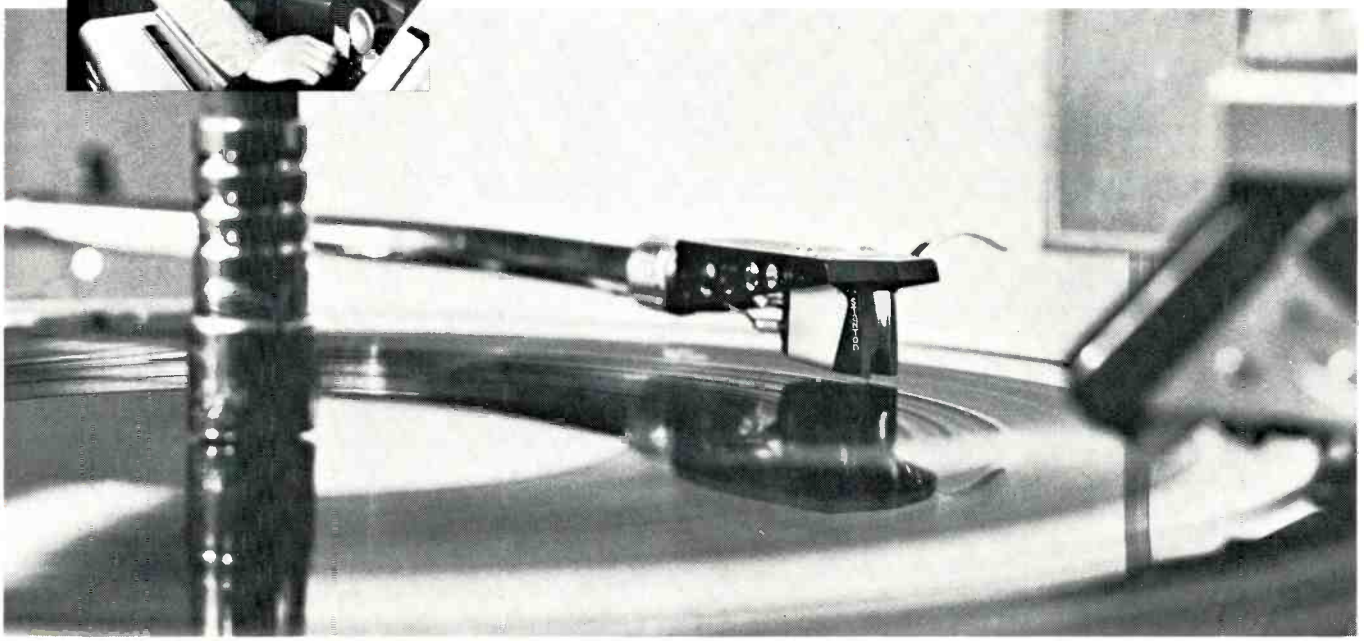

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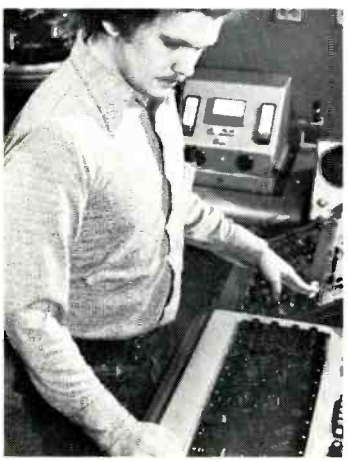

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WHY ELECTRO-STATICS?

Jacob Turner*

***With the assistance of Douglas Elliott, Koss Corp., Milwaukee, WI.**

SINCE THE LATTER half of the nineteenth century (circa 1871) the reproduction of sound through electrostatic transducers has stirred the creative vision of professional engineers and idle dreamers alike. It is an interesting fact of history that no other single device in the audio equipment hope chest has enjoyed such an extensive and prolonged courtship between engineer and audiophile as the electrostatic transducer. Early attempts to embody this means of sound reproduction were only marginally successful partially because of inadequate design but primarily because of the lack of suitable materials and processes.

What is the glamour of the electrostatic principle that gained it such extended, devoted attention? Why has the electrostatic transducer remained the standard of excellence by which other acoustic devices are so often measured?

The answer to these questions lies in at least three areas, which will be discussed in the following order:

1. Some peculiarities of the hearing process;
2. The nature of the acoustic medium, air, and
3. The operational features of electrostatic acoustic devices as related to the above and to dynamic acoustic transducers.

The recent increase of activity in the highly elusive area of psychoacoustics promises to contribute significantly to a more profound grasp of the complexities of man's perception of his sound environment. Several recent studies have been carried out concerning the sensitivity of normal adults' ears to different levels of harmonic distortion. The results suggest that relatively high levels of harmonic distortion (odd and even order) are imperceptible in the presence of normal musical program, while quite small changes in amplitude and phasing are readily ascertained. Amplitude changes were described as altering the tonal quality of the program, while phase displacement between two major frequency bands, e.g. bass and treble, of no more than 5° degraded the clarity and definition of musical transients and upset the homogeneity of the stereo image.

Other studies have pointed out that the inherent transient nature of musical and speech sounds dictates a high level of transient fidelity as a prerequisite of high quality acoustical transducers. The significance of these observations insofar as electrostatic transducers are concerned will be pursued a little later. (See Bibliography.—Ed.)

Another vital link in the chain is air, which has the following major characteristics of behavior that are germane to our topic.

Air is highly compressible, that is, the amount of air pressure (number of air molecules) in a given space can be increased or decreased beyond its normal condition. Air, then, can be said to be like a spring, a means for storing energy; a compliance.

Air also has weight or mass. Ten pounds of air are just as heavy as ten pounds of potatoes. Air is, therefore, like an inertance, which opposes an action or force; an inductance.

Air can also be placed in a condition of motion or vibration, so that when randomly excited, air molecules consume power by generating heat. Air can then be said to be like a resistance.

The combination of these particular properties of air can be labelled its acoustic impedance or radiation resistance. This acoustic impedance is normally very low, although at high audio frequencies it is considerably greater than at low audio frequencies. In order to insure that the transfer of diaphragm or cone motion to air motion occurs with the greatest efficiency, it is necessary that the total mechanical impedance of the device be as close to the acoustic impedance of the body of air it is exciting over as much of the audio range as possible.

To relate the preceding discussion to the topic of the electrostatic transducers, it will be necessary to outline the operational features of the push-pull electrostatic device. The previous points will be related at the same time to the operational features of the dynamic transducer.

As illustrated in Fig. 1, the electrostatic transducer is composed of a thin membrane (diaphragm) made of Mylar that is stretched and contained between two acoustically open plates. The two plates are connected to either end of a coupling transformer which provides the high voltage audio signal. The diaphragm is connected to a high voltage, low current bias supply, which provides an electrostatic charge that becomes trapped in the diaphragm. In recent years a method called "electretification" has been developed whereby the bias charge is permanently embedded in the diaphragm material, so that the diaphragm is self-energized without an external source of bias voltage. The net result is the same in both cases. The two plates provide an electric field that is the voltage equivalent of the audio signal. In the presence of an audio signal, the electric field exerts forces on the electrostatic charge that is trapped in the diaphragm. These forces are transferred to the diaphragm, causing the diaphragm to move in synchronization with these forces.

By contrast, Fig. 2 will illustrate make-up of a dynamic driver, which consists of a frame housing a magnet, and a voice coil attached to the apex of a cone which is suspended at its edge by a flexible cloth or other material. The voice coil is positioned in the magnetic field of the magnet

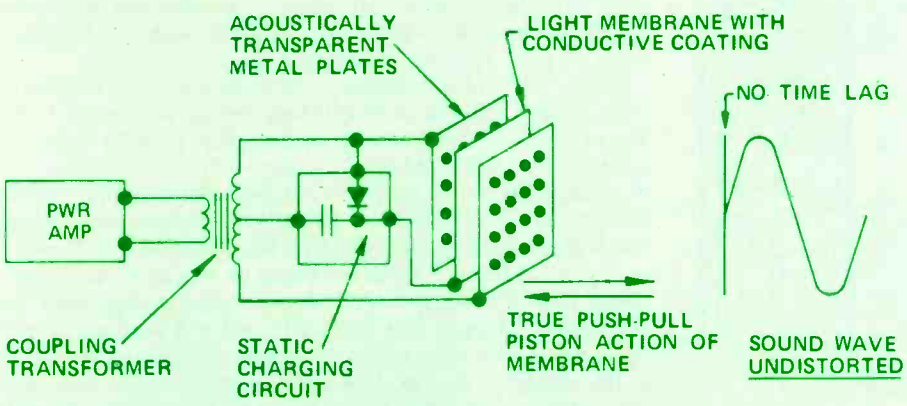

Fig. 1—Electrostatic operating principle.

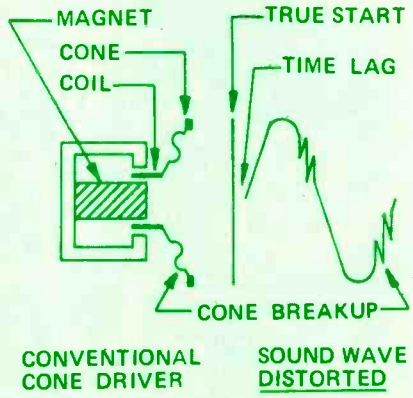

Fig. 2—Dynamic driver operating principle.

structure, and is set into motion in synchronization with an audio signal that causes current flow through the coil. As the coil is set into motion by this signal, it in turn sets the cone into motion.

Although both units achieve air excitation through diaphragm or cone motion, the manner in which this is done involves radically different techniques and results. The electrostatic device employs the use of a moving member for all its operating frequencies that is usually only 0.0004 in. thick and weighs only as much as a body of air 7 mm thick whose boundaries are equal to those of the moving diaphragm. The electric field, which acts to make the diaphragm move, exerts its actuating force uniformly over essentially the entire area of the diaphragm.

A diaphragm of such extreme lightness, in combination with an actuating force that is uniformly distributed over the entire surface of the diaphragm, results in a transducer whose transient response closely duplicates the electrical input.

The net result is a diaphragm motion that is a very good replica of the electrical forces acting upon it, with all sections of the diaphragm surface moving with highly accurate phase and amplitude linearity throughout its entire range of travel, at all frequencies within its area of operation.

The forces acting to move the dynamic transducer's cone, however, produce different results. The application of the driving force only to the apex of the cone necessitates a sufficiently stiff cone to prevent buckling and deformation of the cone structure. Such a stiff cone normally has considerable mass, which degrades its efficiency, its transient response capabilities, and its high frequency performance. In addition, the forces applied at the apex do not act uniformly over the surface of the cone, causing the cone to "break-up" into an infinite variety of vibrational modes, only one of which is truly representative of the original signal. This mode of operation produces amplitude and phase non-linearity often of considerable magnitude, and these tend to increase as the cone is driven to greater excursions.

Obviously the discussion of dynamic driver operation relates quite strongly to the previous discussion concerning the unusual sensitivity of the human ear to the problems of transient response, amplitude linearity, and phase linearity. The basic conclusion is that an electrostatic unit behaves with better composure in all of the above areas.

The second major area of distinction involving electrostatic transducers deals with the considerable problem of coupling to the air with reasonable efficiency over the entire audio band.

The electrostatic unit, because of its extremely low mass diaphragm and the uniform distribution of the driving forces over the entire diaphragm surface, is inherently a unit with low mechanical impedance at all frequencies. As such, the coupling problem at low frequencies (where the problem is greatest) for electrostatic units is considerably less than for dynamic units, which are encumbered by a high mechanical impedance. The result of these conditions is that the electrostatic unit performs quite well down to its frequency limits and within its maximum excursibility with equal fidelity at all drive levels.

The dynamic cone unit, because of its poorer coupling, must be driven harder to produce satisfactory excitation of the air at low frequencies, and usually encounters a number of problems involving cone break-up, non-linear motion of the voice coil due to loss of magnetic coupling in the gap, suspension non-linearities, etc. In all fairness, it must be said that the performance level of today's highly popular dynamic acoustic transducer is incredibly good given the economic and operational constraints of that type of unit.

On the other hand, the superiority of the electrostatic principle has been demonstrated by the great acceptance of the increasing number of electrostatic headphones which have already emerged in the market. In addition, of course, several electrostatic loudspeaker products are highly regarded by the audiophile community. Koss Corp. will introduce early in 1974 a new line of electrostatic speakers, offering wide-range performance and small size, to complement the ESP-9 and ESP-6 electrostatic headphones already in the line.

We feel that this could be the year in which the electrostatic dream will finally be fulfilled. AE

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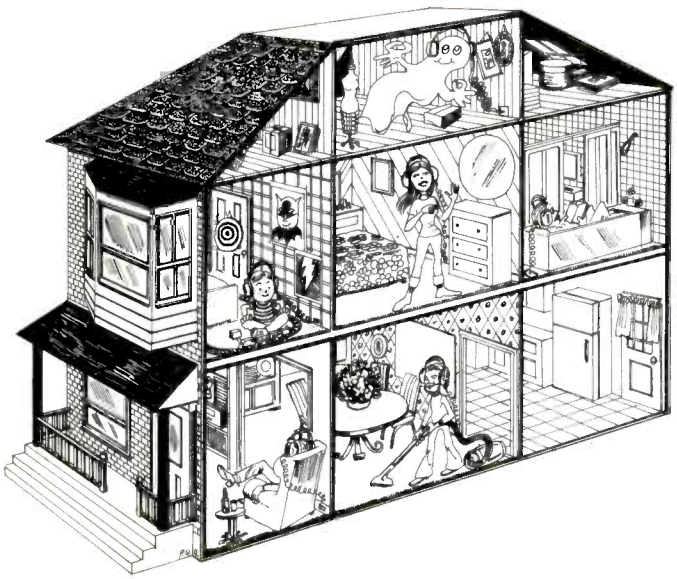

HEADPHONES around the house

Leonard Feldman

COUNTLESS ARTICLES have been written over the years concerning the problems and techniques employed in multiple speaker installations. Complex switching set-ups have been designed to maintain proper impedance match to each remote speaker system when all operate from a single channel of audio amplification. One of the virtues of a high fidelity component system is the fact that multiple speaker systems in more than one room can be tied to a single stereo amplifier or receiver. Normally, this "flexibility" is limited to two (or sometimes three) sets of speaker systems. Any attempt to increase the number of systems tied to a single stereo amplifier usually results in a net load impedance which is far too low for the typical solid-state output circuits used in today's component systems. Furthermore, with power subdivided amongst all the speaker systems, the audio power available to any single system (with all other systems active) is usually insufficient to produce sound pressure levels from the typical low-efficiency speaker systems which continue to dominate the high fidelity component scene. Table I shows what happens to the net impedance seen at the output terminals of an amplifier as more and more speaker systems are parallelled for simultaneous use, and it should be recalled that even so-called "8-ohm" speakers or 16-ohm speakers often exhibit impedances which are far lower than their nominal value at some specific frequencies.

Number of Speakers	Speaker Impedance (Ohms)	Net Impedance (Ohms)
1	8	8
2	8	4
3	8	2.67
4	8	2
1	16	16
2	16	8
3	16	5.33
4	16	4
1	4	4
2	4	2
3	4	1.33
4	4	1

Often, the audio enthusiast intent on having an elaborate multi-room, multi-speaker listening set-up will resort to the use of a 70-volt line system, such as that used in sound reinforcement (public address) systems, where distribution lines of hundreds of feet or more are required. For those not familiar with this system, let's review it briefly. A modern audio amplifier with a high degree of negative feedback may be regarded as a constant voltage source as long as its maximum undistorted power output is not exceeded. For example, an amplifier that can deliver 50 watts into an 8-ohm load will produce 20 volts rms of signal voltage across its output terminals when driven to full output. If the "load" is removed (speaker disconnected), the voltage across the amplifier's speaker output terminals will remain very close to 20 volts rms, because of the large amount of negative feedback applied from output to power amplifier input. If an audio transformer is connected to the output terminals, such that the voltage step-up is 3.5:1, the voltage observed at the secondary will be 70 volts. This voltage can then be "distributed" to various locations in much the same manner that the 117 volt a.c. power lines are distributed around your home. At each terminating point, another transformer is used to "step-down" the voltage to a suitable value for application to each loudspeaker. For example, if a given speaker is to draw 5 watts from the system, the secondary tap used on the terminating transformer at the speaker end of the line would be in the ratio of 1:11, since approximately 6.32 volts of audio signal would be required across an 8-ohm speaker load to develop 5 watts of audio power ($E^2/Z = 5$ watts; $E = \sqrt{5 \times 8} = \sqrt{40} = 6.32$). Such matching transformers have their taps labelled in watts, rather than in impedance or voltage ratio. A typical network of five remotely installed speaker systems is shown in Fig. 1, with each speaker connected so as to "draw" a different amount of power from the amplifier.

While this type of distribution system is perfectly suitable for public address or voice reinforcement systems, the interposing of audio transformers in the system is generally frowned upon by the knowing audiophile who is more often than not delighted with the fact that a modern amplifier no longer requires an output transformer of any kind between the output stages and the speaker system. The output transformer used in the days of vacuum tube amplifiers was long regarded as the most critical part in an amplifier—the one most likely to introduce distortion and non-linearities in the system.

Headphone Distribution System

With the growing popularity of headphones for stereo (and even quadraphonic) music listening, I have been asked on many occasions to describe what would be needed to wire up every room in a home for stereo (or four-channel) headphone listening. Fortunately, most stereo headphones require just a fraction of the power needed by loudspeaker systems to produce high sound pressure levels. So sensitive are the average pair of stereophones, that power requirements are usually stated in milliwatts rather than in watts. As a result, if you were to examine the output circuitry of almost any stereo or quadraphonic amplifier you would find that a series resistor is usually wired between the actual power output stage of the amplifier and the familiar headphone jack terminals. Typical values for this resistor range from 56 ohms to 270 ohms and the purpose of the series dropping resistor is two-fold. Suppose, again, that we have a 50-watt per channel amplifier. Still treating it as a "constant voltage" source, if we were to disconnect all speakers from the amplifier, the rms

voltage available at the output terminals would be close to 20 volts. Figure 2 shows what happens if we connect a headphone via the 100-ohm dropping resistor. If the nominal headphone impedance is 8 ohms, and the amplifier is driven to its maximum voltage output (remember, we can't speak about *power* in this circuit, only voltage, which at full output will be 20 volts rms), 7½% of the total available voltage will appear across the phones, while the remaining 92½% of 20 volts will be dropped across the series 100-ohm resistor. Under these conditions, approximately 1.48 volts will appear across the phone "voice coil," which corresponds to about 275 milliwatts for an 8-ohm phone. This is a value of power input that most stereo phones can sustain safely.

There is another reason for the series-dropping resistor and it has to do with the conversion efficiency of headphones. Intuitively, you know that with phones tightly secured to the side of your head, it takes far less power to produce high sound pressure levels than is the case with even the most efficient type of loudspeaker. With a loudspeaker positioned many feet away from your ears and depending upon room air coupling to bring sound to you, sound pressure level is highly non-linear. In a dead room, volume decreases as the square of the distance from the listener. Thus, if you stand 8 feet from the speaker, loudness level will be one-fourth as great as if you were only 4 feet from the speaker. In the case of a set of phones, this relationship no longer holds true. Coupling is "almost direct," with a minimum volume of "trapped" air between the diaphragm of the phone and your auditory system. Today's amplifiers have residual hum levels which are truly low—on the order of –90 dB or more with respect to full power output. If you were to connect a pair of phones directly to the speaker output terminals of an amplifier and, assuming you could reduce the master volume control until it is low enough so as not to "blow up" the phones, you would be faced with another problem—hum. As we have seen, if 275 milliwatts produces the same sound pressure level from the phones as we would have heard from a typical speaker with 50 watts applied, then the relative efficiency of the phones is nearly 23 dB higher than that of the speaker. Considered another way, the residual hum level heard over the phones when directly connected to the speaker terminals would be –67 dB, even with the volume control turned all the way counter-clockwise. At actual listening settings, hum level would be worse than that and clearly audible. By inserting the series resistor, maximum signal-to-hum capability is maintained and audible hum during phone listening is no more audible than when listening through loudspeaker systems.

A Stereophone Network

Wiring up your house for headphone listening in each room is a good deal simpler than the same project applied to speakers. If you are going to use more than one type of stereophone, determine which is the least sensitive model you plan to use and how much audio input it requires for the sound levels you plan to use. Sometimes the input for phones is stated in millivolts for a given sound pressure level while in some instances a figure of milliwatts is given.

Consider, as a fairly typical example, the Pioneer SE-405 phones shown in Fig. 3. The specifications for this model tell us that maximum power input should be limited to 500 mW. Since they are 8-ohm phones, that means a maximum voltage input of 2 volts. However, the specs also spell out sensitivity as 113 dB with an input of only 0.3 volts. Suppose you want a sound pressure level capability of 119 dB (anything greater is likely to be painful, even if the phones can take it). To achieve the extra 6 dB you will have to double the voltage applied to the phones. Assuming a constant voltage amplifier,

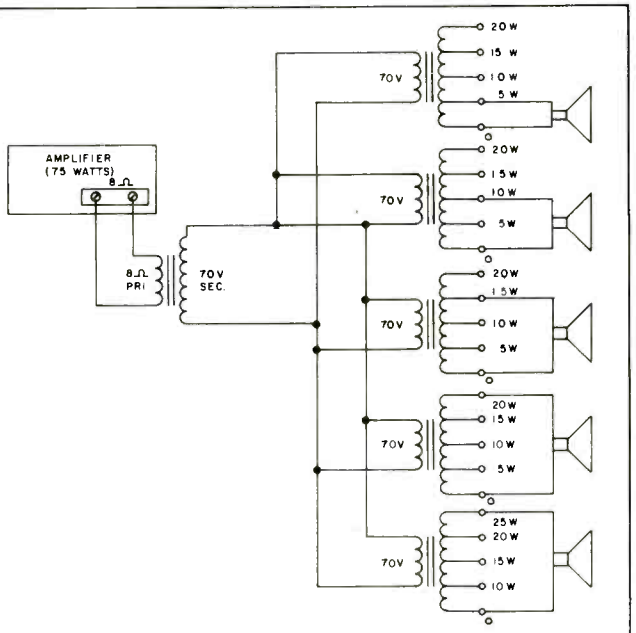

Fig. 1—"70 volt" sound distribution system using appropriate taps on 70-volt matching transformers to determine maximum power delivered to each of five remote speaker systems.

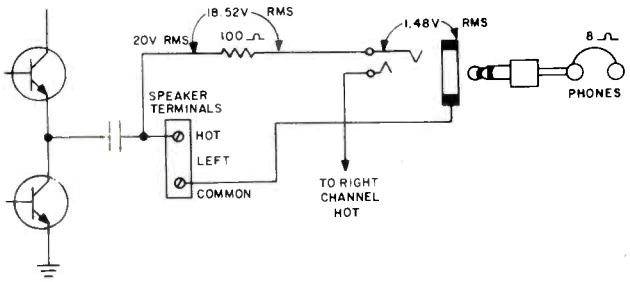

Fig. 2—Series resistor (100 ohms) drops most of output voltage permitting maximum of 275 mW to reach headphones.

Fig. 3—These 8-ohm phones, Pioneer SE-405s, can handle 500 mW; require only 11.25 mW to produce 113

you can easily translate the maximum continous power output capability of your amplifier to a voltage value. A few typical values are given in Table II, but if you own an amplifier with some other power output capability, the formula for figuring the maximum available undistorted voltage is:

$$V = \sqrt{P_{max} Z}$$

in which P_{max} is the maximum continuous power output (rated power) of the amplifier, per channel, and Z is the impedance for which that maximum power output has been stated.

Calculating the Series Resistance

Again, using a 50-watt amplifier as an example of the power amplifier to be used in driving the SE-405 phones, the value of series resistor needed is now calculated so as to obtain a maximum voltage across the phone jack (for each ear-phone) of 0.6 volts (double the 0.3 volts listed in the spec sheet for a 113 dB SPL).

$$R_s = \frac{Z_p(V_t - V_p)}{V_p}$$

R_s is the required series resistor, Z_p is the impedance of the phones to be used, V_t is the total voltage available at the output of the amplifier at full power rating, and V_p is the desired voltage to be applied across the phones. In the case of our example,

$$R_s = \frac{8(20 - 0.6)}{0.6} = \frac{155.2}{0.6} = 258.67 \text{ ohms}$$

A 270-ohm resistor will be suitable, since it is the closest value available in 10% tolerance. In order to make sure that the resistor chosen can dissipate the power that will be developed through it, calculate the power from the voltage which is to be dropped across this series resistor. In the case of our example, 19.4 volts will be the maximum that will ever be dropped across the 270-ohm resistor, so power will be a maximum of $19.4^2/270 = 376.36/270 = 1.39$ watts. A two-watt resistor would be used to provide more than adequate safety, since under musical listening conditions, average power is likely to be much less than the maximum calculated.

Total wattage dissipated in each series resistor plus headphone of such a system would be $20^2/278$ or 1.44 watts maximum. That means that using our 50-watt amplifier (with no loudspeakers operating simultaneously) we could wire up as many as 34 headphone outlets. While no home we know of has that many rooms, there is nothing to prevent you from wiring two or more outlets in a single room so that more than one person can enjoy headphone listening in the same room. From the point of view of the amplifier, even if you had 34 such systems going at once, the net load impedance would be safe, at 278/34, or 8.18 ohms!

Since there is a substantial amount of resistance in series with each phone outlet, it is perfectly all right to use thin wire (22 gauge or even 24 gauge) since even several hundred feet of this kind of wire will not contribute a significant percentage to the overall dropping resistance in each line. Using thinner gauge wire makes it easier to wire the system around the house, since such wire (often erroneously sold as "speaker wire") can be purchased in flat, almost invisible form and can be tucked under carpets, tacked along baseboards and the like, if you're not ambitious enough to run it through walls, under flooring or above ceilings.

Since the system was based upon the least sensitive phones to be used, if you plan to purchase more sensitive phones for additional locations, it would be a good idea to equip each phone outlet with a dual L-pad, gauged for stereo use. These are available in either 8-ohm or 16-ohm impedances. They serve not only as attenuators for the more sensitive phones in your system but can be used to turn off the phones entirely, at which time the line is loaded with a constant 8 ohms of impedance, maintaining the overall net impedance of the system regardless of how many phones are actually in use.

Naturally, if you plan to use 4-channel headphones now or in the future, you will want to run pairs of stereo lines to each location, with appropriately marked "front" and "rear" jacks at each outlet. It is not too important where you position the series-dropping resistor, although in very high powered amplifiers you may want to wire the series resistors near the amplifier end of each run, so that the actual voltage along the long length of wire is very low. Any convenient small chassis can be used as a terminal-box, with each resistor wired from the amplifier terminals to the terminals to which the long run of wire is connected. Of course, in the arrangement shown in Fig. 4, connection to the amplifier is made at the *speaker* terminals and not at the built-in headphone jack, since that self-contained jack already has a series resistor built into it which would upset all the calculations shown above.

Power (Watts)	Volts Across 8-ohms	Volts Across 4-ohms
0.1	0.894	0.632
0.5	2.000	1.414
1.0	2.828	2.000
5.0	6.324	4.472
10.0	8.944	6.324
20.0	12.649	8.944
30.0	15.492	10.954
50.0	20.000	14.142
75.0	24.494	17.320
100.0	28.284	20.000

Table II—Voltage required across 4-ohm and 8-ohm loads for various powers.

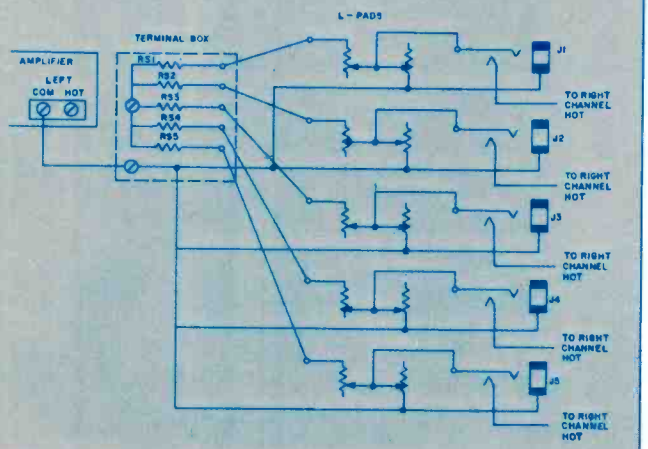

Fig. 4—One half (one channel shown) of five-location headphone distribution system. Dual L-pads can be used for single-knob control of volume at each location.

Precautions for Quadraphonics

Many of the new four-channel receivers available today feature "stereo strapping" circuitry, in which a four-channel receiver can be used as a stereo receiver for higher power output by effectively parallelling pairs of amplifiers. When the receiver or amplifier is operated in this mode, most such components will not work properly if there is a common ground involved in the speaker (in this case, phone) hook-ups. Since standard stereo phone jacks do share a common ground for both stereo channels, the entire "terminal box" should be disconnected from your amplifier if it is to be used with stereo speakers in the "strapped" mode. Alternatively, you may want to include a toggle switch right on the terminal box so that the connections from amplifier outputs to distribution system can be broken when you want full power to be available for your speaker system listening or in cases where you are using a four-channel amplifier or receiver in the "strapped" stereo higher-power mode.

There are some things you'll appreciate about a Dual right away.

Others will take years.

You can appreciate some things about a Dual turntable right in your dealer's showroom: its clean functional appearance, the precision of its tonearm adjustments and its smooth, quiet operation.

The exceptional engineering and manufacturing care that go into every Dual turntable may take years to appreciate. Only then will you actually experience, play after play, Dual's precision and reliability. And how year after year, Dual protects your precious records; probably your biggest investment in musical enjoyment.

It takes more than features.

If you know someone who has owned a Dual for several years, you've probably heard all this from him. But you may also wish to know what makes a Dual so different from other automatic turntables which seem to offer many of the same features. For example, such Dual innovations as: gimbal tonearm suspensions, separate anti-skating scales for conical and elliptical styli, and rotating single play spindles.

It's one thing to copy a Dual feature; it's quite another thing to match the precision with which Duals are built.

The gimbal, for example.

A case in point is the tonearm suspension. Dual was the first manufacturer of automatics to offer a true twin-ring gimbal suspension. More importantly, every Dual gimbal is hand assembled and individually tested with precision instruments especially developed by Dual. The vertical bearing friction of this gimbal is specified at 0.007 gram, and quality control procedures assure that every unit will meet this specification. Only by maintaining this kind of tolerance can tonearm calibrations for stylus pressure and anti-skating be set with perfect accuracy.

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Despite all this precision and refinement, Dual turntables are ruggedly built, and need not be babied. Which accounts for Dual's unparalleled record of reliability, an achievement no other manufacturer can copy. Your Dual includes a full year parts and labor guarantee; up to four times the guarantee that other automatic turntables offer.

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Language of High Fidelity - Part XI

Martin Clifford

RADIO WAVES are far from genteel, for they cannot be so and survive. But the strongest signal isn't always the most preferable, and so we now have tuners capable of reaching out and succoring those emaciated signals that, a technical decade ago, would have perished. That ability of a tuner to respond to the weakened remnant of a signal is called sensitivity, a good word, a pleasant word, but a most unfortunate one since it implies a certain sensibility and kindness on our part. Nothing of the sort, of course. We want tuners having high sensitivities to be able to pick up weak signals for the sole practical reason that those signals may be the ones we want. The desideratum of a signal isn't its strength or ability to survive, but simply a relationship to our own personal wants.

The FM band covers a range of 88 to 107.9 megahertz, a total of almost 20 megahertz. You can realize how wide this band is by comparing it to the AM broadcast band which extends from 535 to 1635 kilohertz, a total of 1100 kilohertz or 1.1 megahertz. And so the FM band is approximately 20 times as wide as the AM band. Into this FM band playroom are crammed all the broadcast FM stations with each occupying individually much more band space than comparable AM stations.

AM vs. FM

Per se, audio waves have a very short travel span. If you want to know how far audio waves can travel unassisted, and are willing to experiment in the name of science, try shouting out of your bedroom window in the quiet early morning hours. If you can avoid capture and confinement, you will have learned that the distance covered by your voice is a few hundred yards, if that. To overcome this limitation, at the broadcast station the audio signal is electronically loaded on another, much higher frequency wave, called a carrier for very obvious reasons. (The carrier is the assigned frequency in the FM band.) The loading process is called modulation, whether for AM or FM (Fig. 1). The reverse process in the tuner, that of discarding the carrier and recovering the original audio signal, is demodulation. Amplitude modulation, or AM, changes the strength or amplitude of the carrier wave; frequency modulation changes its frequency.

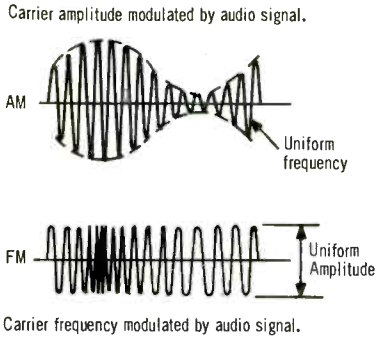


Fig. 1—In AM, the carrier strength, or amplitude, changes during modulation. With FM, the carrier strength remains unchanged.

At the Antenna

Just as eating and breathing are our two fundamental survival processes, so too are sensitivity and selectivity the basic functions of all tuners. While these are inherent to the tuner, we can consider the antenna as an extension, a sort of probe stuck into the murky ocean of radio signals. The first steps toward selectivity are taken by the antenna, for it is broadly resonant to the FM band, and, hopefully, rejects all other signals. But, inducing voltages across the antenna are not only FM signals, but all other radio signals as well—tv signals, communications signals, and electrical noise. Some of these signals, outside the FM band, are more or less successfully rejected by the antenna, depending on the antenna itself, its number of directors and reflectors, and the strength of a particular signal. The whole polyglot assortment of those that remain are given the opportunity of entering the FM tuner via the transmission line, either twin lead or coaxial cable, acting as the connecting link between antenna and tuner input.

The sensitivity of a tuner is a measure of its ability to be activated by the signals proffered by the antenna. It can also be described as the minimum signal to which the tuner will respond and still produce a satisfactory output. Sensitivity is measured in terms of microvolts, or millionths of a volt, per meter. A meter is 3.28 feet, and so an antenna of this length, producing 6 microvolts of signal, supplies 6 microvolts per meter. Whether the receiver will respond to such a small signal is another matter, for it depends on the receiver's sensitivity. A receiver with a sensitivity of 6 microvolts conceivably could; one with a sensitivity of only 10 microvolts will not. Receiver sensitivity is indicated on manufacturers' spec sheets in microvolts; the smaller the figure, the better. However, these numbers refer to the minimum antenna signal which the tuner can convert into a satisfactory sound signal. By itself, the sensitivity figure is meaningless, for if the signal is weak, it may be overwhelmed by electrical noise. The ratio of signal to noise, written as S/N, is the ratio in dB between a 400 Hz fully modulated signal and the noise component. 60 dB means that the signal is 1,000 times stronger than the noise. The higher the value, the better. 50 dB is about the minimum requirement for hi-fi.

It is also possible, of course, for two signals to be close to or to occupy the same frequency, particularly if the originating stations are widely separated geographically. The ability of the tuner to suppress the weaker of the two while receiving only the stronger, is called the capture ratio. Capture ratio is also related to the tuner's suppression of random noise. On spec sheets, capture ratio is given in dB, and the smaller the value, the better. 4 to 5 dB is usually adequate.

The tuner must not only be able to respond to signals, but having done so, must separate the one desired signal from all the others fighting for attention. This ability is called the tuner's selectivity (Fig. 2). Expressed in dB, higher values are better. 50 dB is generally regarded as sufficient.

The Front End

The FM antenna not only responds to a tremendous number of signals simultaneously, but delivers them all to the input of the tuner, via the transmission line. The tuner input, then, is a scene of chaos, for one, and only one signal must be permitted through. This is an impossible task

and since it is impossible, just isn't done. However, the process of selectivity, initially started in a rather general way by the antenna, is continued here. The first processing department reached by the signals is the radio-frequency amplifier (Fig. 3) consisting of one or more tuned circuits. Better grade FM tuners may have between three and five tuned circuits; the more, the better and the more, the more it costs.

The selectivity process is accompanied by amplification, with the signal successively strengthened by a series of solid-state amplifiers, often special types of transistors called FETS, or field-effect transistors, especially selected for their ability to behave well at the high FM frequencies, supplying sensitivity and amplification with minimum fuss and noise.

The various RF amplifier stages are part of a larger circuit carrying the general name of front end. Included in the front end is an AC generator, a circuit which produces a high-frequency signal. Known as a local oscillator, its output is made to mix or beat or heterodyne (from which we derive the name—superheterodyne) with the incoming signal. The purpose is to produce a signal having a constant center frequency. For FM tuners and receivers this frequency is 10.7 megahertz. Known as the intermediate frequency, and variously abbreviated as I.F., IF, or if, it enables the tuner to have the tremendous selectivity for which the superheterodyne is noted. No matter what the frequency of the incoming signal, adjustment of the tuning control on the front of the tuner also adjusts the frequency of the local oscillator. The result is a constant intermediate frequency. Since the intermediate frequency is 10.7 megahertz, it is much lower in frequency than either the incoming signal or that generated by the local oscillator.

The intermediate frequency is a sort of low-frequency carrier, for it now becomes the delivery medium for the sound signal, previously carried by the radio-frequency carrier broadcast by the FM station. Thus, all that has happened to the audio signal is that it has been transferred from one carrier to another, sort of transshipped as it were. However, the intermediate frequency amplifiers all behave as tuned circuits, and so the selectivity process continues here. This is done by a series of filters of very precise electrical dimensions.

The IF section does more than select —although a properly designed IF will do that remarkably well—but it also fulfills a most important function—the elimination of electrical noise. Specially designed IF circuits, called limiters (Fig. 4), begin to work only when a signal of sufficient strength is present. Electrical noise behaves like an AM signal, a signal characterized by amplitude variations. The IF limiter, as its name implies, promptly guillotines these amplitude excursions, while the FM signal, whose amplitude is constant anyway, emerges unscathed from this electronic decapitation technique.

The muting circuit, usually switchable with a control on the tuner's front panel, has a similar intent. It cancels the noise encountered on unused FM channels, a sort of irritating hiss that can be heard between stations. Since the muting control cancels weak stations along with the noise, it should be turned off or adjusted to a more minimum muting position, if a weak signal is to be received.

Back to Audio

Once a truck has made a delivery, it moves on to become part of a general traffic pattern. Not so with the carrier wave that has successfully transported the audio signal to the antenna, down the transmission line, through the front end, then suffering the indignity of having its original frequency changed to the much lower intermediate frequency. At the output of the I.F. circuits, the audio signal, still cuddled by the carrier (now called the intermediate frequency) is delivered to the demodulator. Here the carrier is summarily dismissed, its efforts from the broadcast station, through space, and through half the circuits of the tuner counting for naught. No gold watch, no encomiums, no pension. Simply kaput, made so by grounding.

The audio signal, standing alone, deprived of its carrier, is by now a million or more times stronger than when it first met the antenna, and is in the order of about 1 volt, or more. It is still too weak to drive a speaker sys-

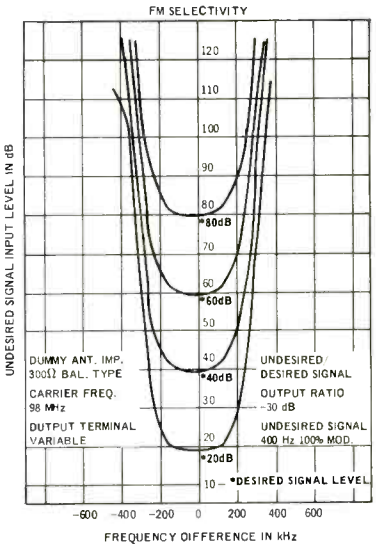


Fig. 2—Selectivity characteristic curve.

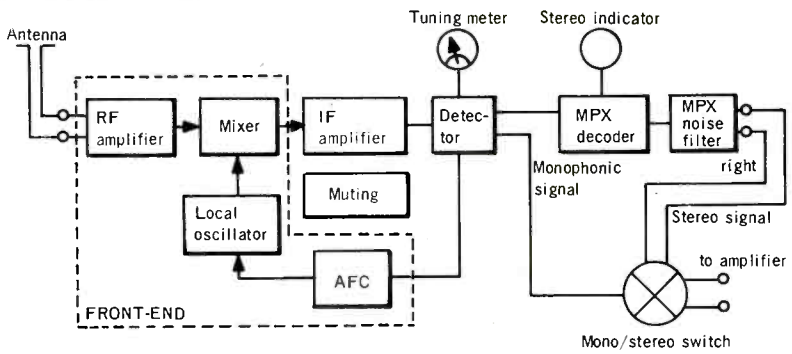


Fig. 3—Block diagram of FM stereo tuner.

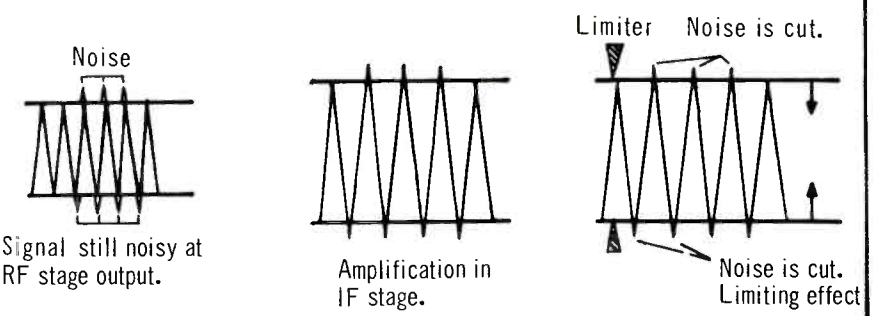


Fig. 4—The limiter cuts off the noise pulses.

tem, but it can be heard with a headset. However, this is the terminal point of the sound, for what we have here is a tuner, a kind of emasculated receiver. With a receiver, the signal would proceed through a pre-amp, then a main or power amplifier, finally reaching the speakers. Tuners aren't equipped with pre- or main amps, and so they require these as separate, additional components.

Mono vs Stereo

What has been described so far is the traditional path followed by a monophonic signal. The modern tuner, though, is capable of responding stereophonically. When a station broadcasts in stereo—also called multiplex or MPX—it transmits a subcarrier wave (Fig. 5) alongside the main carrier and separated from it by 38 kilohertz, plus a pilot frequency of half the subcarrier, that is, 19 kilohertz (Fig. 6). In the tuner, a pilot detector recognizes the presence of the 19 khz signal and activates an FM MPX decoder circuit.

In a stereo transmission, the sound is distributed to two channels, a left or L and a right or R channel. In the stereophonic FM broadcast, the main carrier contains the sum of both signals. Sum means addition, and so the sum of both signals is L + R. A mono tuner or receiver will get the L and R channels, treat them as though they were combined, and the speakers will deliver the doubtful pleasure of single channel or mono sound.

If we can have an L + R signal, we can also have the difference between these two. Difference means subtraction, and so L – R means the right channel subtracted from the left channel. The subcarrier transports this L – R difference signal. In the FM tuner's MPX decoder these two L + R and L – R signals are added and subtracted to regain the signal for each channel. (L + R) + (L – R) = 2L or left channel sound. (L + R) – (L – R) = 2R or right channel sound. It appears complicated only if you haven't studied high school elementary algebra for a long time, or if you were never wildly enthusiastic about it to begin with. The point is that a signal can be divided into portions which represent the positioning of an orchestra on stage, hypothetically divided at some approximate center, with the sound from center to left ultimately and hopefully issuing from your left speaker and the sound from center to right, equally hopefully, coming out of your right speaker.

It's a bitter note, but a true one, that everything has its price, and stereo isn't about to establish an exception. An FM stereo broadcast has only about half the reach of a monophonic program transmitted with the same power. A way to overcome this deficiency is to move to a strong signal area but it is possibly more practical to have a good outside FM antenna and to give the stereo signal a chance for survival by carefully selecting your tuner from among all those that are offered.

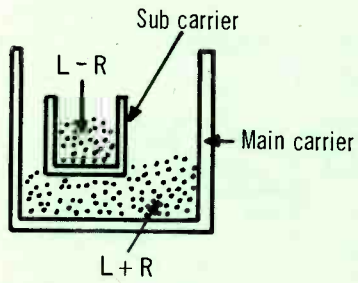


Fig. 5—Carrier of FM MPX stereo.

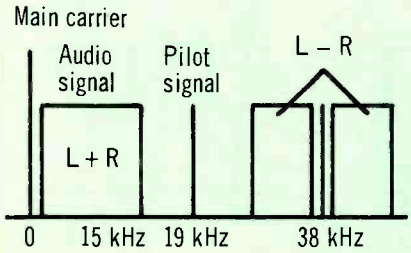
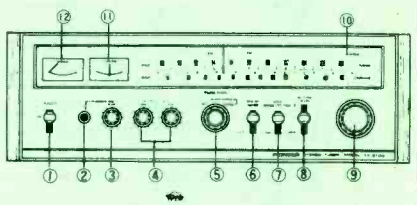


Fig. 6—Spectrum of FM stereo.



(1) POWER SWITCH
(2) HEADPHONE JACK
(3) HEADPHONE OUTPUT LEVEL CONTROL
(4) AM & FM OUTPUT LEVEL CONTROLS
(5) FUNCTION SWITCH
(6) PULSE NOISE SWITCH
(7) MPX NOISE FILTER
(8) FM MUTING LEVEL SWITCH
(9) TUNING KNOB
(10) FM STEREO INDICATOR
(11) TUNING METER
(12) SIGNAL METER

Fig. 7—Controls of a quality FM tuner.

Tuner Construction

At one time, FM tuners were made by the 'point to point' method. The various parts, resistors, coils, capacitors, and tube sockets were individually mounted and then hand wired. Testing was done after assembly, and so chassis sections sometimes had to be repaired prior to shipping. The more modern and superior technique consists of building tuners in modular form, with each module representing one or more complete circuits. The modular sections are tested prior to main assembly, and again afterward. Modules may contain integrated circuits, called IC's, consisting of elements that are practically invisible. An IC about the size of a postage stamp (or smaller!) may contain several dozen transistors, some forty or fifty capacitors and resistors.

One of the main improvements in the front end was the introduction of the field-effect transistor, characterized by excellent linearity, a high input impedance, good gain and low noise.

Other tuner innovations are the elimination of the variable tuning capacitor and its replacement by semiconductor diodes known as varactors or varactor diodes. These units can be made to behave as capacitors by controlling the voltage that is put across them. They lend themselves well to automatic scanning of the FM band, so it becomes possible to cover the entire band just by pushing a button, with each station being tuned in precisely, in turn. Some tuners are also available with indicator tubes instead of a tuning scale. These tubes show the frequency in digital form. Other tuners are really posh, containing a miniature oscilloscope tube that lets you adjust your FM antenna for least multipath distortion. Multipath distortion is the unhappy ability of FM waves to bounce from building to building, or other reflecting surfaces, arriving at your antenna by a somewhat devious route. The various reflections do not all reach your antenna at the same time, producing the somewhat anomalous condition of the same signal fighting with itself. It results—what else—in distortion.

In the IF section, early FM tuners used transformers which required individual adjustment. Vibration would inevitably detune the transformers, causing loss of selectivity and gain. Modern IF stages use multistage filters, either ceramic or crystal types. Not only do these avoid the detuning problem presented by transformers, but electronically they are much more well-behaved, by allowing a correct band of frequencies to pass through.

AKAI's 4-Channel Challenge

We challenge any other manufacturer in the world to surpass the performance of AKAI's new 4-channel component combination. You can pay more. But you can't buy better.

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Tuner Controls

If the front panel of a tuner looks like the answer to a knob manufacturer's prayer, let it not fret you, for all of the controls are designed to let you have precisely what the name implies—control (Fig. 7). The trend is toward more controls, not less, and that is as it should be. Controls add to the expense of a tuner, but they do let you adjust for all sorts of conditions, all usually bad, inside your home and external to it.

The operation mode is determined by a function selector which can have three or more positions: AM, FM mono; FM auto, and MPX noise filter. When this control is in the AM position, that is what you will get—AM stations. The FM mono position is for mono reproduction only. This doesn't mean you won't pick up stereo stations, just that the MPX decoder will be deactivated. In the FM auto mode, the tuner automatically switches to FM stereo reception when tuned to an FM MPX broadcast. Finally, when the mode selector is set to MPX noise filter, this adjustment eliminates noise (during FM stereo reception) having a fairly high frequency.

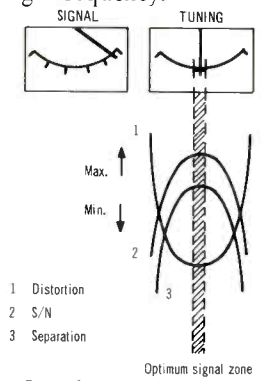

Fig. 8—Signal strength and tuning meters.

Better quality FM tuners have a pair of illuminated meters (Fig. 8) as tuning aids. One is a signal strength while the other is a tuning meter. The signal strength meter deflects to the right when the station is tuned in and the stronger the received signal, the greater the deflection. You can also use it for making comparison tests of FM antennas and for the best orientation of the antenna. The tuning meter is a center position type and helps in tuning in stations accurately. Accuracy means the pointer is at its center position when the station is tuned in properly. Some tuners also have a light which glows with the word 'stereo', possibly to condition you mentally for this kind of listening. Mental attitude and frame of mind are essential ingredients for the proper enjoyment of music, and for its improper enjoyment as well.

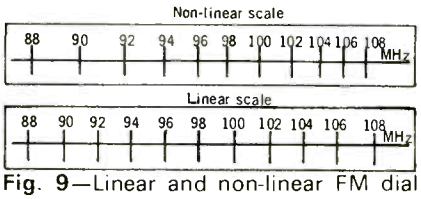

Fig. 9—Linear and non-linear FM dial scales.

Some FM tuners have nonlinear scales with the numbers toward the right getting more and more crowded. This sometimes requires a Raffles-like dexterity but since not all of us have safe opening or tuning ability, it is better to look for tuners having linear scales (Fig. 9).

In addition to the muting switch, upper grade tuners are often equipped with a switch or control called MPX noise filter or hi blend. Its function is to eliminate or at least reduce hissing noise often present in FM stereo programs of insufficient signal strength. As this circuit operates by blending a certain amount of the high sound frequencies of both channels, its use results in a certain loss of stereo channel separation.

Other controls on tuners include output level controls. On better quality tuners these are separate for AM and FM, letting you adjust the tuner's output voltage to match its sound volume with that of other source equipment, such as your turntable or tape deck. It also lets you 'drive' the following pre-amplifier properly—that is, the tuner can deliver the correct amount of signal to let the pre-amp function as it should. Some tuners have an extra pair of tape rec outputs permitting direct tuner-to-tape recording without going through the amplifier. The tuner may also have an AFC switch, but you should not gauge its presence or absence as an indicator of the quality of the tuner. AFC, an abbreviation for automatic frequency control, helps lock the selected station to the tuning circuits, thus preventing station drift and fluctuation.

Finally, there should be a muting level control to be adjusted for background hiss in the absence of a received signal, so that hiss cannot be heard during the tuning process. Correct setting of this control does take some little bit of practice since, if the control is advanced too far to the right, station signals may be muted also. With the muting control in its maximum clockwise position you will have absolutely quiet operation of the tuner, something that can more easily be achieved by turning the power switch to its off position.

Tuner Specs

There isn't that much difference in the front panel appearance of high-

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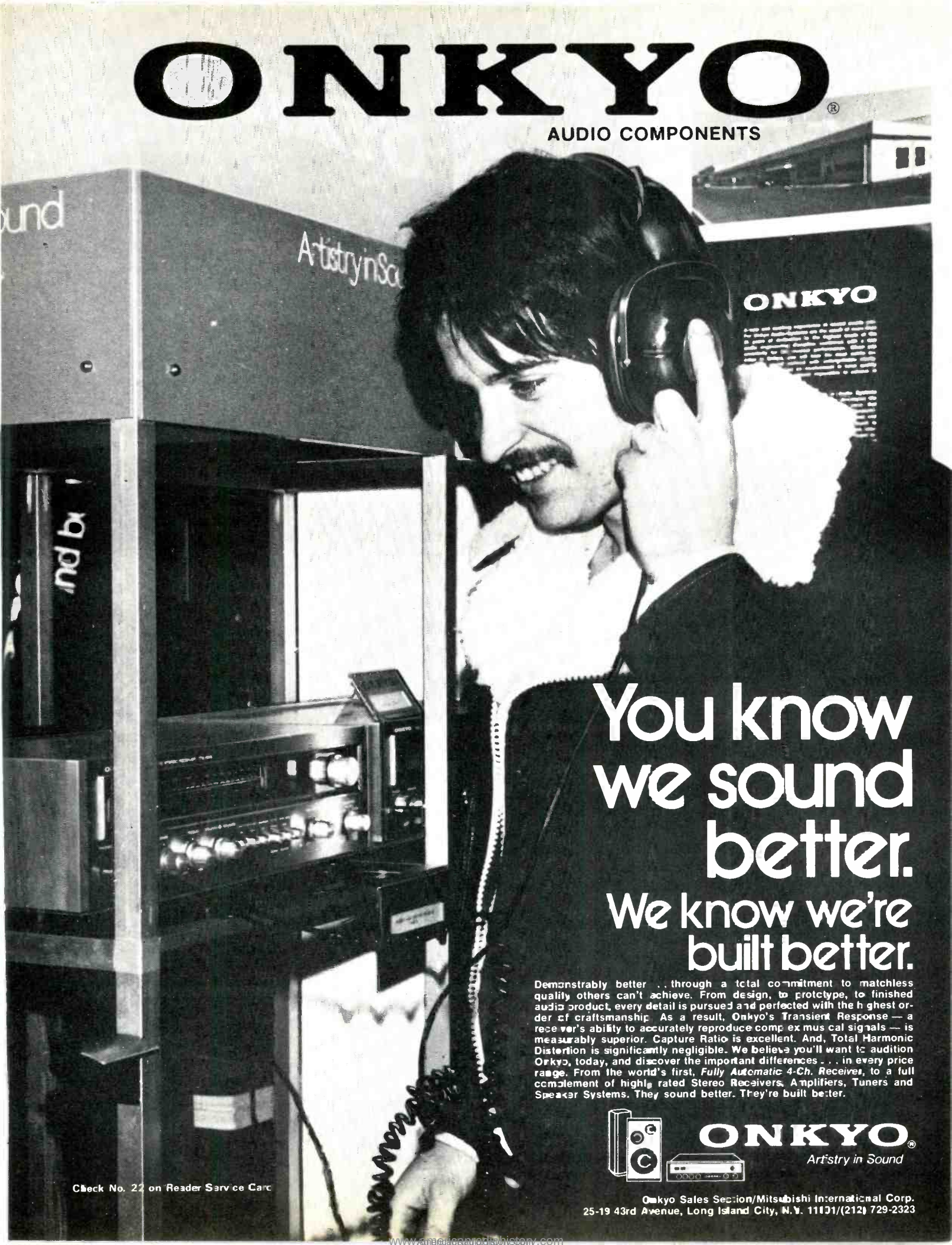

You know we sound better.

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Demonstrably better . . through a total commitment to matchless quality others can't achieve. From design, to prototype, to finished audio product, every detail is pursued and perfected with the highest order of craftsmanship. As a result, Onkyo's Transient Response — a receiver's ability to accurately reproduce complex musical signals — is measurably superior. Capture Ratio is excellent. And, Total Harmonic Distortion is significantly negligible. We believe you'll want to audition Onkyo, today, and discover the important differences . . . in every price range. From the world's first, *Fully Automatic 4-Ch. Receiver*, to a full complement of highly rated Stereo Receivers, Amplifiers, Tuners and Speaker Systems. They sound better. They're built better.

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grade tuners. Actually, you can put some of the bargain-basement types right alongside some of the really superb, more costly tuners, and find it difficult to reconcile the difference in price with the lack of difference in appearance. But in hi fi, quality is more than panel deep. It's what's behind the panel that counts, and so you must rely on the manufacturer's spec sheet and on the manufacturer's reputation.

Some of the important specs, sensitivity, selectivity, signal-to-noise ratio and capture ratio, were described a few paragraphs ago. Other specs include image rejection, spurious response or rejection, AM suppression, FM stereo separation, and output level. Signal images refer to the unhappy predilection of low-grade FM tuners for having the same signal appearing at two or more points on the tuning scale. Only one of these, of course, is the true signal, while the others are images. This situation arises out of the fact that the local oscillator signal, heterodyning with the original source signal, produces not one, but a number of signals.

For instance, suppose we have an incoming signal at 100 MHz. When the tuner is tuned to this signal the local oscillator will be at 110.7 MHz and the required 10.7 will be derived as the *difference*. But another signal at 10.7 MHz *higher* than the local oscillator (110.7 plus 10.7 mHz or 121.4 MHz) might also bear with the local oscillator and make itself heard. True, this particular frequency is outside the FM band but it *is* used by aircraft and you don't want to hear airline pilots' conversations as a background to your Beethoven or Brubeck! So image rejection is the tuner's ability to suppress these unwanted signals and it is ordinarily expressed in dB, generally somewhere in the middle of the FM band. The higher the value of image rejection, the better. An image rejection of 90 dB or more is excellent.

There may be other kinds of interference—breakthrough at the 10.7 MHz IF frequency or spurious signals caused by harmonics of the oscillator. Spurious rejection is often specified at a particular frequency, somewhere near the center of the FM band. Spurious rejection of more than 95 dB, at 98 mHz, is a very respectable figure.

AM suppression is still another spec sheet listing, but while its name implies some connection with AM broadcasting, there is no link between the two. In this context, AM (amplitude modulation) means the noise signals radiated by fluorescent fixtures, motors, neon lights, auto ignition systems, etc. These devices, which would perform much better minding their own business, all act as miniature AM broadcasting stations, not licensed, of course. Unless suppressed, they can produce an annoying crackle during FM reception. They are sometimes tunable, meaning you can escape them by running away toward the other end of the dial, thus making you an innocent fugitive and the victim of a gross injustice. It doesn't contribute to peace of mind, either. Well-manufactured tuners (Fig. 10) have AM suppression. Expressed in dB, higher values are better. 40 dB is about minimum. Look for 50 dB or more.

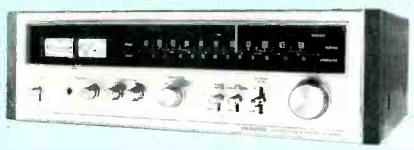


Fig. 10— Pioneer Model TX-9100

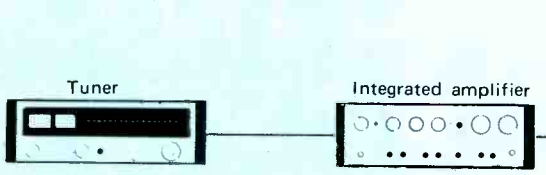


Fig. 11—Basic stereo system using a tuner.

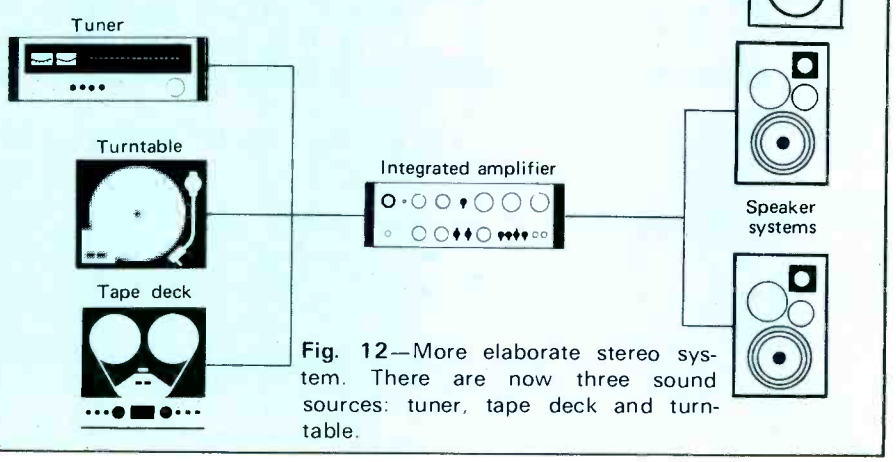


Fig. 12—More elaborate stereo system. There are now three sound sources: tuner, tape deck and turntable.

FM stereo separation is the FM MPX decoder's ability to separate the left and right channels of FM stereo broadcasts. For stereo effect, channel separation in the medium audio frequency range of 400 Hz to 1,000 Hz is most important. A good tuner should have 40 dB separation in this range, or 30 dB between 40 Hz and 8 kHz or 25 dB over the total 20 Hz to 15 kHz range. Beware of specs that don't mention the frequency range at all.

Good channel separation means there should be no leakage between the two channels—that is, the sound from one channel shouldn't dribble into the other. At the transmitting station, the separation between two channels isn't less than 30 dB—that is, it isn't if the station meets FCC requirements. While specs may indicate separation at a specific frequency, this doesn't mean that the same amount of separation extends all the way across the audio range. Separation may be less at the very low frequency and the very high frequency audio spectrum.

You should know something about the output level of the tuner. This is sometimes in the ½ to 2-volt range, and is adjustable on high quality FM tuners. The control range in a good tuner, for example, would be adjustable from about 60 millivolts (60 thousandths of a volt) to almost 2 volts. Still other specs would include harmonic distortion for both mono and stereo. Figures of 0.5% or less are good.

The Tuner and Your System

To get a bird's eye view of where a tuner belongs with respect to the remainder of the hi fi system, take a look at the basic setup shown in Fig. 11. The tuner is followed by a pre-amp, which, in turn is followed by a power amp. The two speakers are then connected to the output of the power amp. The pre-amp and the main or power amp can be combined into a single unit, an integrated amplifier. Fig. 12 is a more elaborate system, involving two other sound sources, a tape deck and a turntable, plus another listening device, a set of stereo headphones.

(To Be Continued)

We give you the softest soft to the loudest loud.

From our lowest price to our highest, you won't get 'clipped.'

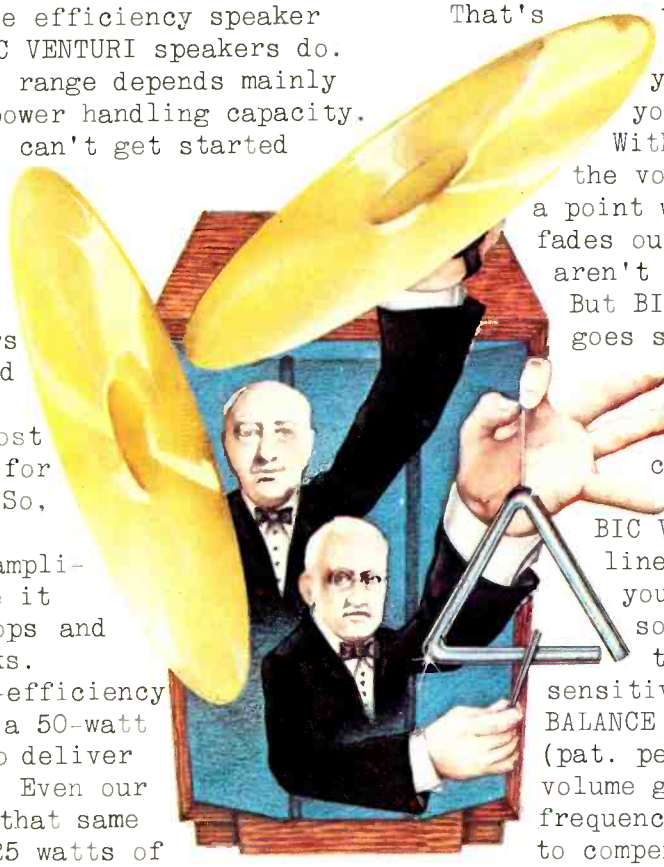
Today's best recordings can reproduce music's full dynamic range, from the softest soft to the loudest loud. Most of today's popular low and moderate efficiency speaker systems can't. But BIC VENTURI speakers do.

A speaker's dynamic range depends mainly on its efficiency and power handling capacity. Low-efficiency speakers can't get started without a good deal of input power. And, they tend to get stifled when driven beyond their capability.

BIC VENTURI speakers are efficient! They need as little as one fifth the amplifier power of most air suspension systems for the same sound output. So, you can listen louder without pushing your amplifier to the point where it starts clipping the tops and bottoms of musical peaks.

Today's popular, low-efficiency speakers require about a 50-watt per channel amplifier to deliver lifelike sound levels. Even our Formula 2 will deliver that same sound level with only 25 watts of amplifier power; the Formula 4 with 20 watts and our Formula 6 with only 9 watts! With BIC VENTURI, your amplifier can loaf along with plenty of reserve "headroom" to reproduce musical peaks cleanly, effortlessly. It's as if your present amplifier suddenly became two to five times as powerful. BIC VENTURI can handle lots of power, too. A typical, low-efficiency system is rated for a maximum safe power input of about 50 watts. Feed it more power and you're likely to push it into distortion, or even self-destruction!

With a BIC VENTURI you can turn up the power, without distortion or speaker damage. Even our compact Formula 2 can safely handle 75 watts per channel. With that much power feeding it, it will deliver 210% more sound output than a low-efficiency system will at its power limit. Drive our super efficient Formula 6 at its maximum, and it will deliver nearly 1300% more sound power!



That's the loud half of the story. With soft music (or when you turn down the volume) you want to hear it soft. With most speakers, turn down the volume slowly and you reach a point where the sound suddenly fades out because the speakers aren't linear anymore. But BIC VENTURI's are. The sound goes smoothly softer, without any sudden fadeout, retaining all the subtle nuances that add to the character of the music.

But, even though BIC VENTURI speakers remain linear, there is a point where your ears do not. At lower sound levels, your ears lose their bass and treble sensitivity. So, our DYNAMIC TONAL BALANCE COMPENSATION™ circuit (pat. pending) takes over. As the volume goes down it adjusts frequency response, automatically to compensate for the ear's deficiencies. The result: aurally "flat" response, always!

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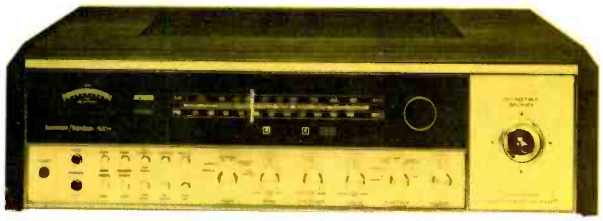
Harman-Kardon Model 900+ AM/FM Multichannel Receiver



MANUFACTURER'S SPECIFICATIONS

FM TUNER SECTION: **IHF Sensitivity:** 2.0 μV. **S/N Ratio:** 70 dB. **THD:** Mono, 0.4%; Stereo, 0.5%. **Capture Ratio:** 1.6 dB. **Selectivity:** 60 dB. **AM Suppression:** 60 dB. **Image Rejection:** 90 dB. **IF Rejection:** 90 dB. **Spurious Response Rejection:** 90 dB. **Stereo FM Separation** (1 kHz): 37 dB. **AM TUNER SECTION:** **IHF Sensitivity:** 300 microvolts/meter (internal antenna). **Selectivity:** Better than 35 dB. **IF Rejection:** Better than 60 dB. **Image Rejection:** Better than 60 dB. **AMPLIFIER SECTION:** **Power Output:** 4 x 32 watts continuous, into 8 ohm loads, at any frequency from 20 Hz to 20 kHz, all channels driven; in two-channel mode, 90 x 2 watts continuous power, 8-ohm loads, 20 Hz to 20 kHz, both channels driven. **THD:** Less than 0.5 per cent at rated output. **IM:** Less than 0.15 per cent at rated output. **Power Bandwidth:** 10 Hz to beyond 40 kHz. **Hum and Noise:** Better than −75 dB (unweighted). **Damping Factor:** 30 at 8 ohms. **Frequency Response:** 4 Hz to beyond 70 kHz, ± 0.5 dB; from 1 Hz to beyond 100 kHz ± 1 dB. **Phono Sensitivity:** Variable, depending upon separation of CD-4 adjustment. **Bass Control Range:** ± 12 dB at 50 Hz. **Mid-Range Control:** ± 12 dB at 1 kHz. **Treble Control Range:** ± 12 dB at 10 kHz. **GENERAL SPECIFICATIONS:** **Dimensions:** 20⅛ in. W x 17 in. D x 6¼ in. H. **Weight:** 45 pounds. **Price:** $749.95, including walnut enclosure.

Harman/Kardon was one of the first high fidelity component manufacturers to introduce 4-channel receivers that provided higher-powered stereo operation at the option of the user by permitting back and front amplifier pairs to be "strapped" or paralleled together until such time as the owner elects to purchase that second pair of loudspeaker systems and go "all the way" to quadraphonic sound. The success of the format is evidenced by the growing number of manufacturers who have followed this lead since H/K's introduction of the concept with their earlier 75+, 100+ and 150+ receivers more than a year and a half ago. Now, H/K has come up with more powerful (and much more flexible) receivers that combine the multi-channel 2/4 concept with a host of other features worth talking about—and listening to. The Model 900+, the most powerful of the three new receivers in the line, carries over into it many of the design innovations of that company's famous Citation components. For example, the left portion of the blacked-out dial area features a very large meter which operates differently from the usual signal-strength meter. Its pointer reads all the way up-scale until you tune to an FM station, at which point the needle deflects down scale and indicates noise quieting rather than just signal strength. Numerical calibration of the meter is opposite to that of conventional signal-strength meters and, while this might seem to be a minor point, we found the meter circuit to be far more useful in tuning for best signal than the other kind. As a further aid towards best, lowest-distortion tuning, the lighted words "IN TUNE" appear next to the meter when a station is correctly tuned. AM and FM dial scales are well spread out and a logging scale is also provided. Numerals below the dial scale light up to denote mode of operation, such as "1," "2," "4-2-4," "2-4," and "4-4" for mono, stereo, matrix, stereo enhance and discrete four-channel positions of the mode switch.

The lower section of the control panel contains an illuminated power on/off switch, a pair of phone jacks (for front and rear channels), the mode switch, bass, treble and mid-range tone controls (each of which is a dual concentric type for separate control of front and rear channel tonal settings), a program selector switch and the master volume control. Just to the right of the headphone jacks are a series of ten push buttons. Four of these individually control front and back main and remote pairs of speakers, while the remaining six control the two tape monitoring circuits, FM muting on-off, loudness on-off, and high and low filter on-off. The rightmost section of the front panel is entirely devoted to a joy-stick four-channel balance control, which H/K calls a sound-field balance control. We have reported on this multi-function control before, and again find that it is the easiest type of control with which to balance all four channels simply. This version of the joystick has very positive positions (at 45-degree angles to either the vertical or horizontal) which permit listening to a single speaker at a time with no audible sound coming from the other three—a feature we found particularly useful in adjusting the CD-4 calibration controls for proper operation with our test phono cartridge.

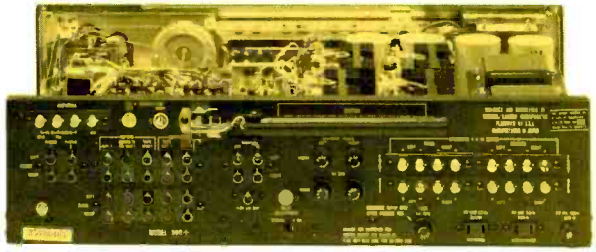


Fig. 1—Rear panel layout.

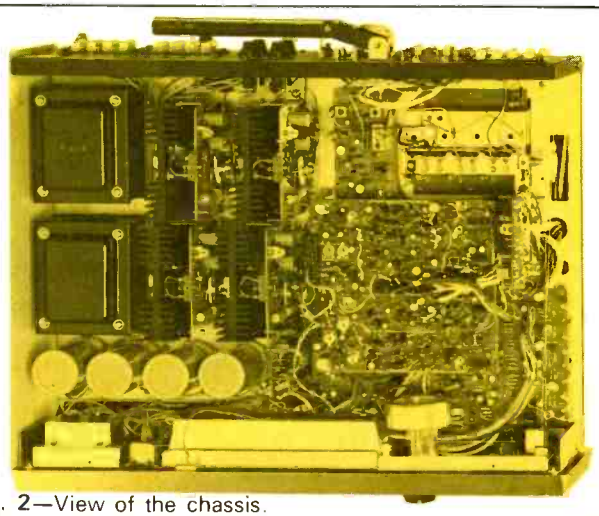


Fig. 2—View of the chassis.

These separation calibration controls, along with a muting threshold adjustment, are found on the rear panel, shown in Fig. 1. The rear panel also contains all the usual input and output jacks as well as a four-channel FM output jack for use with a future decoder when FM discrete four-channel broadcasting begins. There are two pairs of phono inputs, either one of which may be used for stereo or CD-4 cartridges. In addition to the two tape monitor groups, there are jacks specifically labelled for use with a Dolby external accessory box, which are part of the Tape Monitor 2 circuitry. Four speaker fuses and a line fuse are also replaceable from the rear panel. Antenna input terminals for both 300-ohm and 75-ohm connection are provided, as are front and back speaker terminal strips for main and remote quartets of speakers. A stereo/4-channel slide switch located below the FM mute adjust control has a protective metal strip retaining it in the four-channel position to prevent accidental switching. A pair of a.c. outlets (one switched, the other unswitched) and a pivotable AM ferrite bar antenna complete the rear panel layout.

We are unable to obtain a full schematic diagram of the H/K 900+, nor is one supplied with the owner's manual, so that a detailed description of the circuitry used cannot be given here. A look inside the chassis (Fig. 2) helps to explain how Harman/Kardon was able to build this much receiver into so small a cubic volume. Circuit board modules are actually "layered" inside the unit, which might make servicing a bit more difficult if it is ever required. However, all circuits are arranged in an orderly fashion and, visually at least, we could see no problems insofar as rigidity of mounting or potential heat problems are concerned. Neither the CD-4 demodulator circuitry nor the SQ decoder uses IC chips for complete decoding, although we saw a sprinkling of stock IC's in these and other circuit modules.

Laboratory Measurements

The FM tuner portion of the receiver was measured in our laboratory and was found to have an IHF sensitivity of 2.4 μV—a bit short of the 1.8 μV claimed. Quieting of 50 dB (in mono) was achieved with a signal input of only 3.8 microvolts—a very acceptable figure for this amount of S/N quieting. (See Fig. 3). Ultimate S/N measured 68 dB as against 70 dB claimed, but mid-frequency THD exceeded claims in mono mode, with a reading of 0.25 percent. In stereo mode, the reading was a bit higher than claimed, at 0.6 percent. We found, however, that if the unit was re-tuned in stereo, this figure decreased to 0.3 percent. However, the minimum distortion point in stereo tuning did not correspond with the separation point, as we learned when making separation measurements, later on. In terms of actual use, whenever we run into a situation of this kind, we favor the "low distortion" tuning point, since separation is usually more than adequate on modern stereo receivers even if it is not "meter optimized."

Stereo S/N was only about 55 dB, but the residual content was not really "noise," as such, but rather residual sub-carrier product outputs. If this output is ignored, actual S/N exceeds 60 dB in the stereo mode. Since we were concerned with this rather high level of 38-kHz residual output, we made some single tone recordings from FM, using a cassette deck (which usually has a lower bias frequency than do open-reel machines) and encountered no audible "beats" in the recorded results, despite the relatively high level of sub-carrier output.

Figure 4 reveals that stereo FM separation was better than 30 dB from 50 Hz all the way up to 10 kHz, reaching its maximum of 42 dB at mid frequencies. THD in mono remains under 0.5 per cent for all audio frequencies used in FM and under 1.0 per cent for stereo under the same conditions. In making this measurement, the tuner was re-tuned slightly to achieve lowest distortion readings, as previously noted. Other measurements made on the tuner section and not shown in the graphs included capture ratio, at 1.5 dB, selectivity, which measured just over the 60 dB claimed, and AM rejection which was 60 dB, exactly as claimed. I.f., image and spurious rejection were at least −90 dB, and possibly higher, measurements being limited by our equipment.

Amplifier Section

If tuner performance was a bit marginal (compared to published specs), amplifier capability of the H/K 900+ exceeded claims in almost every respect. Less conservative manufacturers would surely have rated the power output of this unit at 40 watts per channel, in 4-channel mode, for that is exactly what we measured with a THD of 0.5 per cent and a frequency input of 1 kHz. At lower power levels, THD measured a consistent 0.1 per cent, except at very low power levels when it tended to increase slightly, as shown in Fig. 5. IM distortion, also plotted in Fig. 5, was about 0.08 per cent at listening levels below rated output, rising almost exactly like the THD curve to reach 0.5 per cent at an output of 40 watts per channel. Power bandwidth, plotted in Fig. 6, extends from 10 Hz to 60 kHz—a good deal broader than claimed. Harman/Kardon has always believed in wide band amplifier response and the 900+ certainly

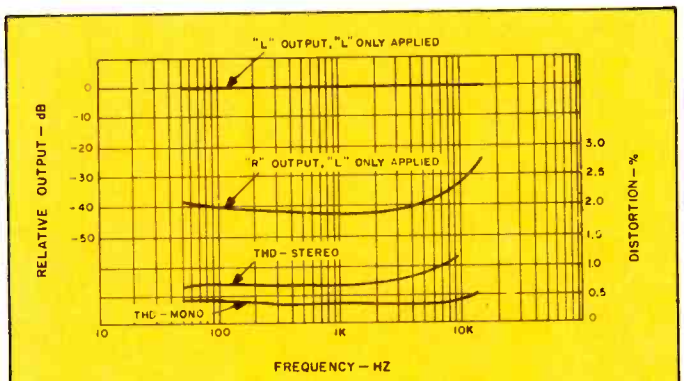


Fig. 4—Separation and distortion vs. frequency.

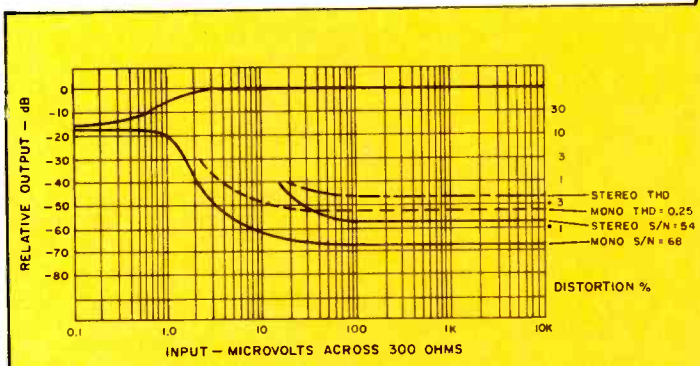


Fig. 3—FM quieting and distortion characteristics.

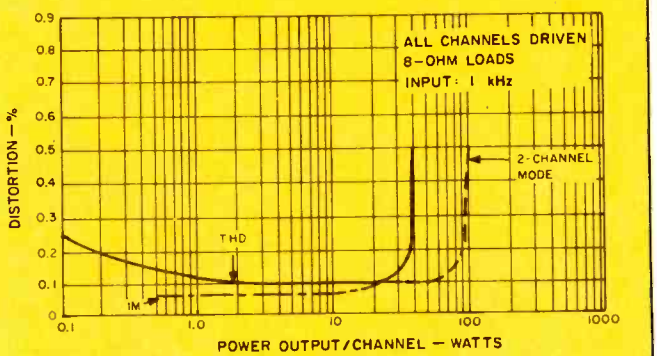


Fig. 5—Harmonic and intermodulation distortion characteristics.

follows that design philosophy. As shown in Fig. 7, rated output (32 watts per channel) is attainable from 20 kHz down to 30 Hz at less than 0.5 per cent. At 20 Hz, it is 0.6 per cent—certainly close enough to H/K's claims. Although all measurements were not repeated for the higher-powered "strapped" 2-channel mode, we did check for rated THD of 0.5 per cent and found that each channel produced 100 full watts (against 90 claimed) before this value of THD was reached. At half-power levels (also shown in Fig. 7), THD remained close to or under 0.1 per cent for all audio frequencies.

While we have previously tested other receivers and amplifiers equipped with separate bass, mid-range, and treble controls, the H/K mid-range control operates over a narrower frequency range than most, as can be seen in Fig. 8. As such, it provides a very immediate and noticeable effect on voice recordings and does not overlap the action of the bass and treble controls, also shown in Fig. 8. More about this feature when we discuss use and listening tests. Both high and low frequency filters have a slope of only 6 dB per octave and follow bass and treble cut curves almost exactly, making them not significantly more effective than these continuously variable controls. Loudness contour action, measured at -30 dB from full volume setting, conforms nicely with theoretical requirements. Hum and noise level of high level inputs, referenced to full output, was 84 dB, while phono hum and noise was 62 dB below full output.

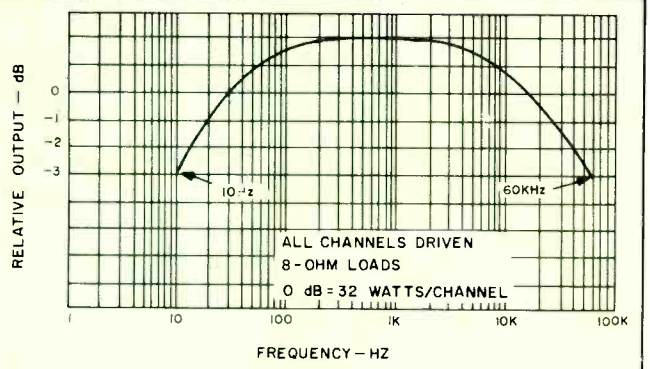


Fig. 6—Power bandwidth characteristics.

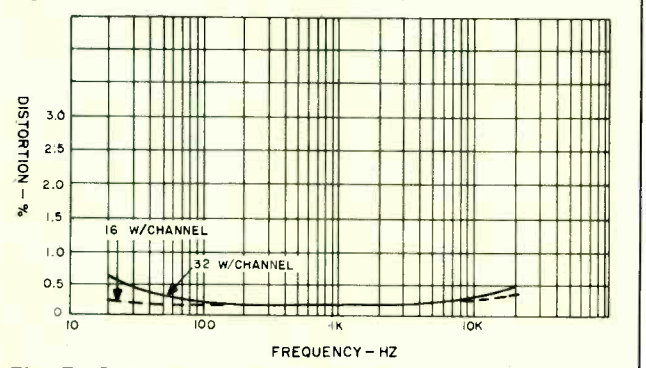


Fig. 7—Distortion vs. frequency.

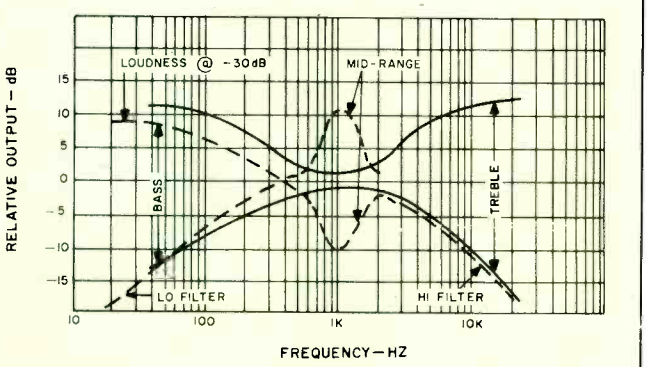


Fig. 8—Tone control range, filter and loudness characteristics.

Use and Listening Tests

It was only when we tried to use the tuner section of the H/K 900+ to receive a variety of stereo stations that we realized that there was another adjustment we had missed. It is not mentioned in the owner's manual and has to do with the stereo threshold settings. This additional adjustment is located under the chassis where you are unlikely to find it unless you know it's there. In any case, we were able to adjust the stereo threshold to a low setting of 15 μV (before our adjustment, it took over 25 μV of input signal strength to cause the circuits to "switch" into stereo—too high a figure in view of the good quieting characteristics of the tuner section). The muting range of adjustment is from 4.5 μV to 90 μV—a more reasonable pair of end points. Of the two tuning indicators present (the quieting meter and the "in tune" light), by far the most useful one is the quieting meter. It performs much better than a signal-strength meter and really does show the "quietest" (and therefore best) tuning point when used in accordance with instructions. The "in-tune" light, we feel, is more of a psychological "security blanket" than anything else, in that its "window" or the number of kHz over which it remains lit, is a little high. Fortunately, the i.f. and detection system of the tuner is so good that even if one tunes to the "edge" of the range over which the light stays on, distortion measures less than 1.0 per cent. Incidentally, we consulted some of the engineers at H/K and, after getting a brief description of how the quieting meter works, we can confirm that it is NOT just a signal-strength meter "hooked up to read backwards"—as one might at first suppose. We feel, therefore, that it is a significant contribution to good FM tuner design and use and hope that it will find its way into many more FM products.

In general, FM reception was clean, free of audible interferences, and as sensitive as we would expect from the measurements made on the bench. Dial calibration was a bit off at the high end (about -300 kHz at 108 MHz). The discrepancy between "best separation" tuning and "lowest distortion" tuning was really not observable in actual practical use of the receiver.

Four-Channel Use Tests

The 12-in. LP test record which H/K gives away with each receiver is a very good way to introduce the user to CD-4 records. In addition to containing a well-narrated calibration band (far better than the one contained in the older 7-in., 45-rpm disc made by JVC and distributed with most competitive receivers), the record contains a variety of well-recorded selections designed to demonstrate the virtues of CD-4 discrete discs. It succeeds in this respect, and so does the demodulator circuitry of the 900+, which afforded well over 20 dB of separation in every direction between all channels. Separation nulls achieved by varying the two separation adjustment controls on the rear panel were very positive and easily set even "by ear" (the way most users will have to set them). Several other CD-4 discs were auditioned on the H/K 900+, and all performed well, with noticeably lower distortion than we have heard on earlier demodulator circuitry.

As far as the "matrix" positions and the playing of matrix discs is concerned, the circuitry contained in the 900+ includes no logic and is therefore a bit limited in terms of front-back separation capabilities. In this respect it is no different from most other SQ circuits contained in the current crop of "all-in-one" four-channel receivers.

Harman/Kardon describes one very interesting mode of operation in their owner's manual which we could not resist trying. By connecting a pair of audio jumper cables from the

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tape monitor jacks to the tape out jacks (front channels only) and a stereo tape recorder to the back channel tape monitor receptacles, it is possible to use the 900+ as a "double stereo system." That is, when the tape monitor switch is activated, you can listen to any program source selected from the front panel reproduced over the front speakers, while the back speakers can be used to listen to the tape recorder. Obviously, this comes off a lot better if the pairs of speakers are in different rooms (or, if the front main speakers are used for one stereo program, and the back remote speakers are used for the other—which amounts to the same thing). A nice feature, and probably one of the reasons H/K refers to these receivers as "multi-channel," rather than just 2/4 channel.

Audio performance is excellent, transparent and powerful enough for our low efficiency speaker systems. We found that anything above moderate use of the mid-range tone control (on the "boost" side) leads to a rather high amount of "presence," but when used in moderation, the control is a welcome addition to the front panel. Action of the sound-field balance joystick is smooth and despite the limited physical travel of the stick in any direction we had no trouble balancing all channels or favoring any one of them to the precise degree desired. A wonderful control, as we've said before!

With such an excellent panel layout, compact size (for its power capability), and performance, plus the "bonus" CD-4 record, we wish H/K would devote a little more effort to their instruction manual. Besides overlooking reference to that "hidden" stereo threshold control, the book offers no data about the circuitry of the receiver, nor does it give performance specifications (we had to obtain these from a separate brochure supplied, after request, by H/K).

We realize that not every owner is "technically-oriented" and we are all in favor of "broadening the base" of high fidelity component acceptance, but since the reader is at liberty to "skip" those sections that seem too technical, we don't see any harm in including as much information as possible for the interested user.

At $750.00, the Harman/Kardon 900+ ranks right up there with the few "better" quadraphonic receivers available on the market this year.

Leonard Feldman

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Magnavox MAX 12

MANUFACTURER'S SPECIFICATIONS

System Type: Three-way air suspension. **Frequency Response**: 25 Hz to 20 kHz. **Impedance**: 8 ohms. **Drivers**: 12-in. high compliance woofer, 2-in. hemispherical dome midrange, 2-in. phenolic ring tweeter. **Crossover Frequencies**: 1500 Hz, 4500 Hz. **Controls**: Three-position midrange, three-position tweeter. **Cabinet Finish**: Oiled walnut veneer. **Dimensions**: 15¼ in. W x 13¼ D x 25¾ H. **Weight**: Approx. 40 lbs. **Input Power**: 10 watts minimum, 75 watts maximum. **Price**: $174.95 each.

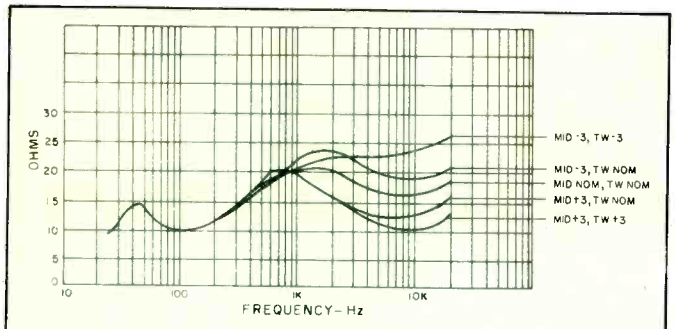

Fig. 1—Impedance plot for several combinations of midrange and tweeter control.

The Magnavox MAX 12 is a three-way loudspeaker system utilizing a 12-inch air suspension woofer, a 2-inch hemispherical dome midrange, and a 2-inch phenolic ring cone tweeter. While large enough to be treated as a floor-standing speaker, the cabinet is finished on four sides with an oiled walnut veneer and there is no provision for floor glides. The front grill is acoustically-transparent sculptured foam and the rear side of the cabinet, while not veneered, is stained to closely match the finished sides. Aluminum accent strips are attached to the front of the cabinet in such a way as to present a cosmetically attractive contrast to the walnut and black grill front. This reviewer recommends that this speaker be positioned in a living room in such a manner that there will be little temptation to place drinking glasses, ashtrays, or lamps on it, which could mar the finish.

The speaker grille is pressed onto Velcro fasteners and removed by pulling outwards on the handle formed by the black metal MAGNAVOX name tag. This name tag can be relocated to the long side of the grille for horizontal speaker box shelf placement, but this requires a Phillips screwdriver and locating a new hole on the backside of the grille frame. One should also consider that with a weight of 40 pounds, only a very sturdy shelf should be used for the MAX 12.

The midrange and tweeter level controls are located on the front panel behind the grille. They can readily be adjusted without requiring access to the rear of the cabinet. Each control is a three-position rotary switch and is marked: +3 dB, NOMINAL, and –3 dB.

Speaker connection is made to knurled twist-knobs located in a recessed cavity on the rear. This allows the speaker to be positioned flat against a wall. The terminals are well marked and widely spaced for safe, easy connection.

A complete set of specifications, hookup recommendations, and user-oriented suggestions on amplifier power restriction is firmly cemented on the back of the cabinet. This is exactly where it belongs and Magnavox is to be congratulated on this.

Technical Measurements

The MAX 12 is rated as an 8-ohm system. The measured impedance is well above this value throughout the useful frequency range as shown in Fig. 1. With three-position midrange and tweeter controls, nine measurements would be required for complete characterization. Five of the combinations are shown in Fig. 1 and these were taken to show not only the maximum and minimum impedances, but the slight interdependence of control settings. System resonance

anatomy of the total performers

If you take apart one of TDK's new Dynamic-series cassettes, you might think it looks pretty simple. Five screws. Two hubs. A length of tape. Two rollers. Two cassette shell halves. A few other parts. What's so complicated about that?

Plenty! Unlike open reel tape, a tape cassette becomes an integral part of your recorder. Not just electromagnetically, but also mechanically. So in addition to good sound reproduction capabilities, a cassette must be an absolutely precise mechanism.

It took years of research, development and testing to produce the present-day TDK cassette. The result is a unique combination of superior electromagnetic characteristics and mechanical precision that make TDK cassettes completely compatible with any cassette recorder. And it permits them to deliver total sound reproduction and mechanical performance unequalled by any other cassette you can buy today.

Take the tape, for example. TDK cassette tapes are coated with exclusive formulations of ferric oxide powders in special binders, using proprietary TDK methods which result in the most desirable electromagnetic characteristics. Not just full-range frequency response and high-end sensitivity, but the proper balance of all the other characteristics essential to the faithful reproduction of "real-life" sound. Like high MOL (Maximum output level). Broad dynamic range. Wide bias tolerance. High signal-to-noise ratio. Low modulation and bias noise. Low print-through. Good erasibility.

The housing is precision-molded of high-impact styrene. The transport mechanism uses tapered and flanged rollers with stainless steel pins, all-felt pressure pad, silicone-impregnated liners, and two-point hub clamps. Features first introduced by TDK. And all parts are manufactured to extremely fine tolerances to assure trouble-free operation and to resist jamming, stretching, warping and tangling.

What does all this mean to you? Just that when you record on one of TDK's new Dynamic-series "total performer" cassettes, you can be sure of getting everything! All the highs and lows. All the important harmonics, overtones and transient phenomena. All the natural richness, fullness and warmth of the original performance. Plus reliable, trouble-free mechanical operation.

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occurs at 45 Hz. This speaker could be safely paralleled for drive by any amplifier capable of driving 4 ohms.

The magnitude of the on-axis, one-meter, anechoic frequency response for one-watt drive is shown in Fig. 2. It is not possible to present a simple representative plot, not only because of the nine possible control settings, but also because severe acoustic interaction occurs between the midrange and tweeter. Figure 2 therefore shows two basic measurements which are separated by 10 dB for clarity of presentation on one graph. The lowest curve, with SPL coordinates on the right of the graph, is for the Magnavox recommended positions of nominal for both midrange and tweeter. Bass response extends down to about 50 Hz then rolls off at the 12 dB per octave expected for a well-designed air-suspension system with the measured resonance shown in Fig. 1. The hemispherical-dome midrange is simply too good a high frequency reproducer to allow only the tweeter to handle frequencies above 4.5 kHz. The result is a response dip at about 6.5 kHz where their contributions become out of phase. This may be seen from the phase plot of Fig. 3, which is made for the same nominal midrange and tweeter level control settings. What is happening is that the woofer and midrange are in phase, producing a sound pressure increase for a positive voltage applied to the plus speaker terminal, while the tweeter is phased so as to produce the reverse polarity of sound pressure. Because of the difference in acoustic position of midrange and tweeter, Fig. 3 shows two plots. The upper phase plot, near zero degrees from 1 kHz to 3 kHz, is made by correcting the air path delay to the midrange and shows it to be in phase. The rapid phase transition at 3.5 kHz is due to crossover between midrange and tweeter. The lower phase plot is corrected for nominal tweeter air path delay and shows a phase of nearly 180 degrees above 7 kHz. (The break in the lower phase curve at 6.5 kHz is due to a 360-degree phase lag transition at this frequency where the midrange is still exerting some control. The data is plotted as a break rather than a precipitous step in phase for ease of presentation.)

Referring back to Fig. 2, the dip due to nominal control positions can fortunately be overcome by readjusting the midrange control. The upper three amplitude response curves, with the left side SPL calibration, were measured for the midrange in the –3 dB position and all three tweeter control positions. The listening test, conducted prior to measurement, had indicated a more accurate sound for the –3 dB midrange position, hence this measurement. No phase data is included for this midrange position but suffice it to say the 360-degree transition at 6.5 kHz did not occur for the nominal and +3 dB tweeter positions.

The three-meter room response for the first 10 milliseconds of sound is shown in Fig. 4. The speaker was mounted against a wall, as recommended by Magnavox. The system was raised so that the center of the front face was at ear level, or one meter, in this test. The midrange and tweeter were set to NOMINAL and the measurement was made directly on axis and 30 degrees off axis in a stereo left channel position. The measurements are displaced 10 dB for clarity of presentation. The substantial dispersion of both midrange and tweeter allowed for a "filling up" of the dips of the anechoic response for Fig. 2 because of early sound scatter from ceiling and floor.

Harmonic distortion for the musical tones E_1, A_2, and A_4 is shown in Fig. 5. The intermodulation distortion of A_4 by E_1 when mixed in equal power is shown in Fig. 6. The harmonic distortion is primarily second harmonic for the lower pitched tones. The intermodulation of A_4 is mostly due to

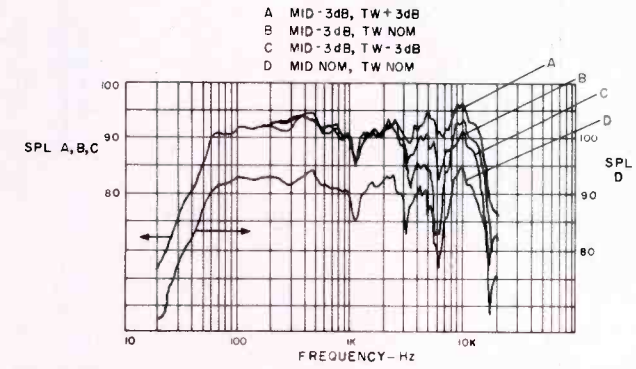

Fig. 2—One meter anechoic amplitude response for several midrange and tweeter positions.

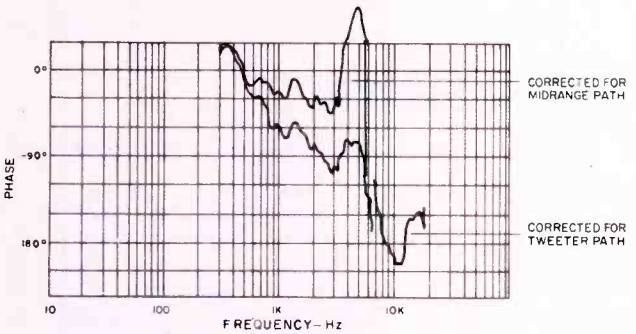

Fig. 3—One meter anechoic phase response for nominal midrange and tweeter control.

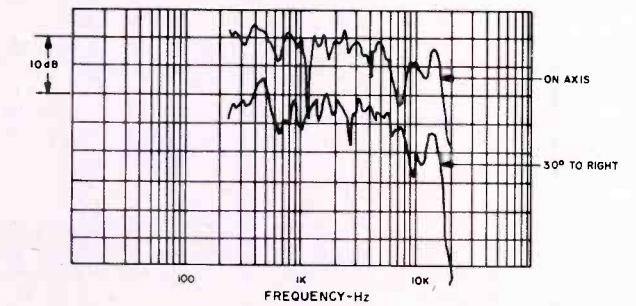

Fig. 4—Frequency response due to first ten milliseconds of sound in a preferred room position measured at three meters. Curves displaced 10 dB for clarity.

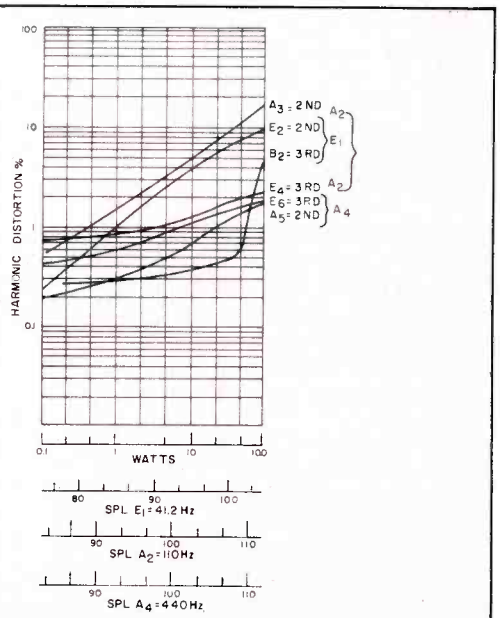

Fig. 5—Harmonic distortion for the musical tone E_1, A_2, and A_4.

SANSUI'S FOUR 4-CHANNEL RECEIVERS

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amplitude modulation with only a small phase modulation contribution at the maximum power levels tested. Crescendo handling measurements, as well as these more conventional measurements, suggest that the Magnavox-recommended power limitation of 75 watts is a realistic upper limit for quality reproduction.

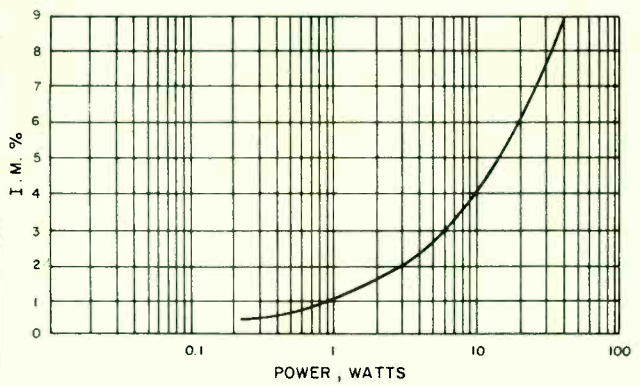

Fig. 6—IM of A_4 by E_1 mixed 1:1.

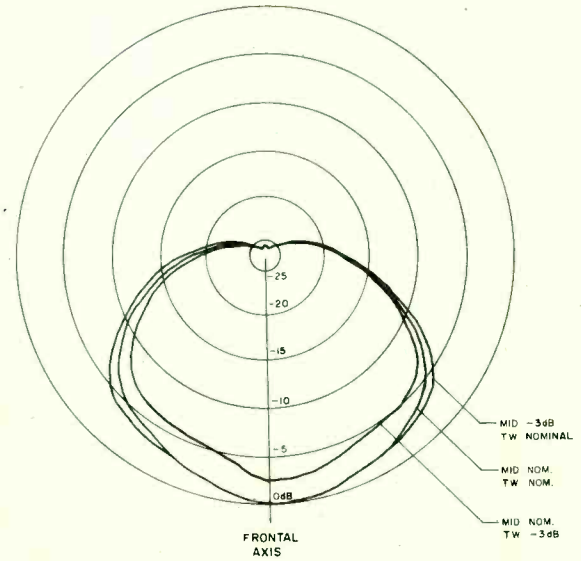

Fig. 7—Polar energy.

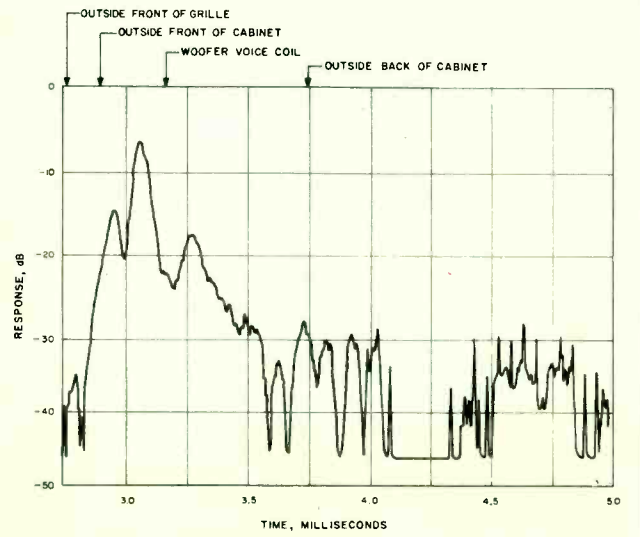

Fig. 8—Energy-time response to a perfect pulse band limited d.c. to 20 kHz.

The polar response for three combinations of midrange and tweeter control is shown in Fig. 7. The fact that both the midrange and tweeter have wide angular dispersion is quite evident. The partial cancellation of midrange and tweeter is indicated by the same frontal axis energy for two positions of midrange control. However, on an energy basis, the polar response indicates that relatively uniform sound should be obtained within 45 degrees to either side of the frontal axis. Strong room reflection may be expected due to this property and the speaker may tend to sound bright in a sparsely furnished room.

Figure 8 is the transient energy response measured one meter on axis. The position of some major physical elements in the MAX 12 is shown for comparison. The separate contributions of the tweeter, midrange, and woofer high frequency components are quite evident. As a basis for comparison, if this loudspeaker were perfect, the plot would yield a single energy hump around 2.9 milliseconds with most of its energy concentrated within a period of one-tenth millisecond. No speaker is perfect, however, and Fig. 8 is the amount by which the MAX 12 disperses an impulse.

Listening Test

Magnavox provides the purchaser of the MAX 12 a detailed set of recommendations for proper operation. These were followed as closely as possible for the listening test so as to best represent the conditions a purchaser might encounter. The speakers were placed along one wall and raised so that the center of the front face was approximately at ear level when sitting in a chair.

Vertical mounting, with the MAGNAVOX name tag erect, produces better stereo imagery than a horizontal mounting such as might be considered for shelf placement. This is probably because of the vertical "totem pole" alignment of woofer, midrange, and tweeter. A horizontal mounting produces audible stereo image wander as one changes his listening position. Good lateral stereo imagery, however, is available from a vertical mounting configuration.

Good high frequency balance may be obtained with the speakers flat against the wall. The general impression with both controls at NOMINAL is that of a "hot" midrange. While this provides a good sense of presence for vocals, particularly those with a center-stage position, a more realistic, overall balance was obtained with the midrange in the -3 dB position and the tweeter left at NOMINAL.

Though bass response measured down to 50 Hz, it appeared to this reviewer to be just a shade "thin" when compared to other acoustic suspension systems of the same physical size. Some bass equalization was thus felt necessary for a better sense of realism. Corner placement of the speakers may prove desirable in some listening situations in order to provide a firmer bass.

Close miced vocals and electronically reproduced instruments are quite adequately reproduced. Lateral stereo imagery was quite acceptable with no hole in the middle or jumping about of a center image with change of listening position. Radial stereo imagery, however, which gives the sense of depth, was not entirely to this reviewer's satisfaction. Most of the sound image appeared compressed in range so as to give a more nearly two-dimensional portrayal of some stereo material known to have good depth. Orchestral and choral presentations appeared to suffer from foreshortening.

The Magnavox MAX 12, in this reviewer's opinion, while doing a creditable job with wide-range material, appears best suited to the reproduction of contemporary music, which can place strong demands on the 1 kHz to 7 kHz range.

Richard C. Heyser

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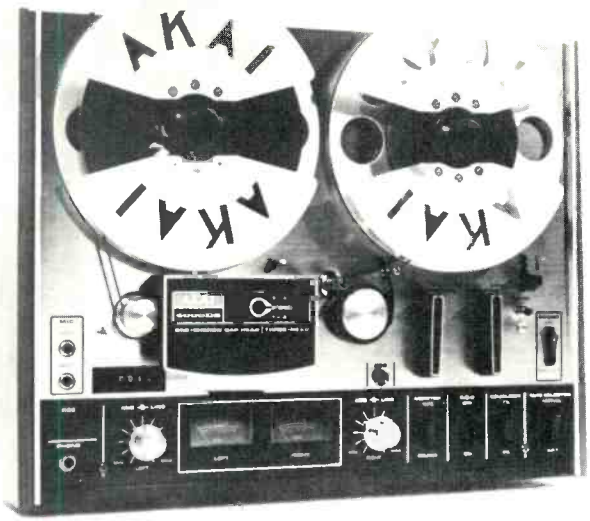
AKAI 4000DS Tape Deck



MANUFACTURER'S SPECIFICATIONS

Speeds: 3¾ and 7½ ips. **Frequency Response**: 30 to 23,000 Hz ± 3 dB at 7½ ips; 30 to 16,000 Hz ± 3 dB at 3¾ ips. **Signal-to-Noise**: Better than 50 dB. **Erase Ratio**: Better than 70 dB. **Wow and Flutter**: Less than 0.15% rms at 7½ ips; less than 0.2% at 3¾ ips. **Distortion**: Less than 1.5% (1000 Hz, 0 VU). **Heads**: Three, record, playback, and erase. **Reel Size**: 7-inch maximum. **Dimensions**: 16 in. W x 12½ in. H x 7½ in. D. **Weight**: 25 lbs. **Price**: $269.95.

The name AKAI is a well-respected one in the tape recorder world, and they are especially remembered for their pioneering work with the cross-field head technique—a remarkable innovation in the days before low-noise tapes. They now have a wide range of high-fidelity products including receivers, amplifiers and preamplifiers, loudspeakers, open-reel recorders and cassette machines. One of these cassette recorders, the GXC-46D with Dolby system, was in fact reviewed in the November, 1973 issue.

The Model 4000DS reviewed here is a relatively inexpensive 4-track machine with a good all-round performance and having some interesting features like provision for sound-on-sound, automatic shut-off, a track selector switch and a monitor head. It is somewhat smaller than most open-reel machines, measuring 16 by 12 inches high and about 7 inches deep. On the extreme left hand side are the microphone input sockets and one for headphones. To the right of these is a dual-concentric control for line and microphone inputs to the left channel. On the other side of the two illuminated VU meters is a similar dual control for the right channel and then come four rocker switches for tape monitor, sound-on-sound, tape equalizer for 3¾ and 7½ ips, and tape selector for normal and S.R.T. Above this one is another rocker switch for on-off. The front panel, on which are situated the VU meters and most of the controls, is finished in a charcoal black giving a pleasing contrast to the brushed silver top plate.

Tape control functions are shared by two large rotary lever switches, one for stop, forward, and record and the other for fast forward and rewind. The record push button is located below the capstan, and a digital counter is situated just to the left of the head cover. This cover is a handsome piece of die-casting on which is mounted a channel selector switch inscribed 3-2, stereo and 1-4. A pause control in the form of a lever is located above the on-off switch, and there is also a push button for a quick start. Input and output sockets (including a DIN type) are all located in a recess at the rear.

The equalizer switch does just that—there is no speed-change control as such and the user has to remove a sleeve from the capstan to change speeds from 7½ down to 3¾ ips. This sleeve

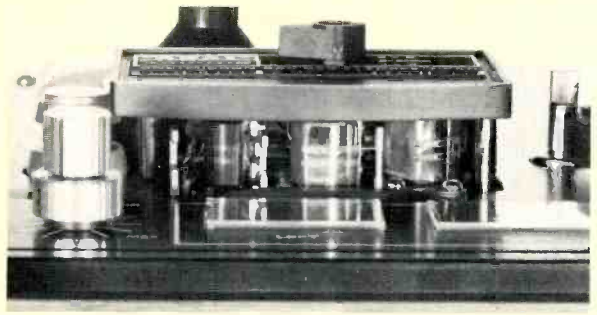


Fig. 1—Head assembly.

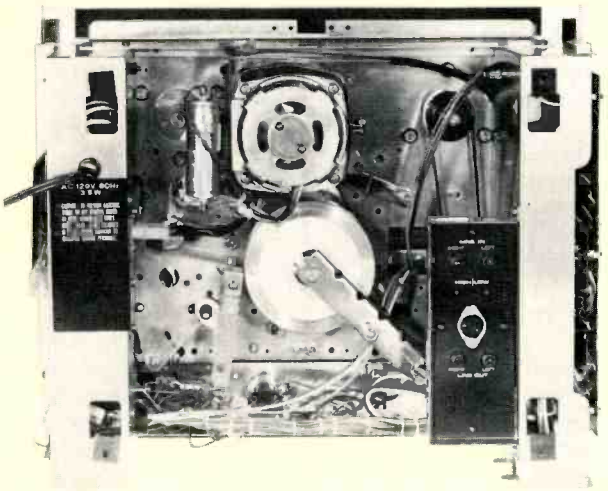


Fig. 2—View of the chassis.

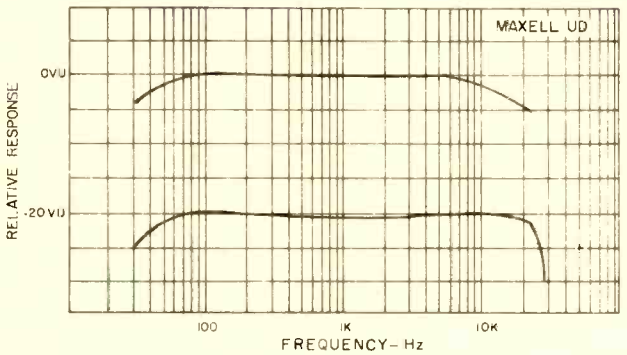


Fig. 3—Record-replay response at 7½ ips.

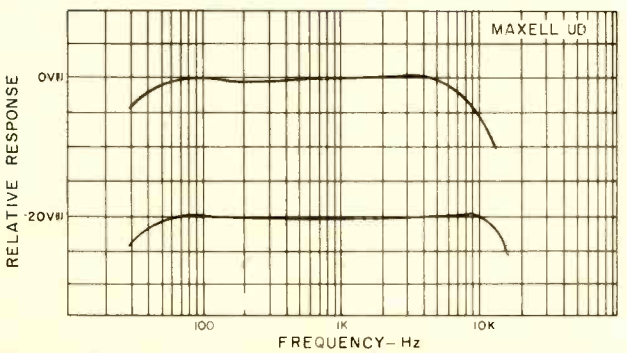


Fig. 4—Record-replay response at 3¾ ips.

is then placed (or should be placed) on a storage post which is mounted near the aforesaid capstan.

Although there are separate recording and playback heads, I was interested to see that both had one-micron gaps—most unusual (see Fig. 1). The motor is a 4-pole induction type turning at 1800 rpm (on 60 Hz, that is)—see Fig. 2. Eleven transistors are used, together with four ICs, and headphone output is taken through a step-down transformer. The bias oscillator is a normal push-pull arrangement with a frequency of 105 kHz.

Measurements

Figure 3 shows the frequency response at 7½ ips with Maxell UD tape. The 3 dB point is 24 kHz—slightly better than the specifications. Response at 3¾ ips is seen in the next graph (Fig. 4), and here the 3 dB point is nearly 17 kHz, which would be considered excellent for 7½ ips not so long ago! Figure 5 shows the playback response with a standard test tape, and the distortion characteristics are shown in Figs. 6 and 7. The THD at 0 VU is generally less than one percent, increasing to 3.8 percent at +5 VU. Signal to noise was 53 dB referred to 0 VU or 56 dB referred to +3 VU. You can put it another way and say it was 57 dB at 3 percent distortion. Figures for 3¾ ips were just over

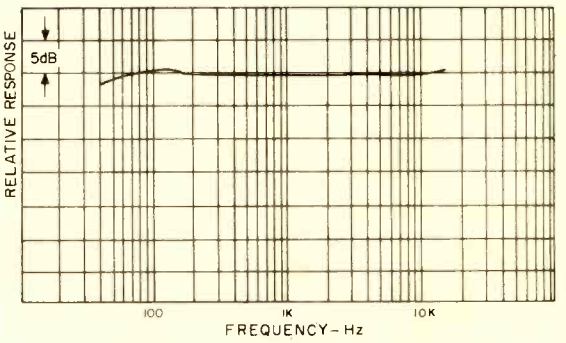


Fig. 5—Playback response with standard tape.

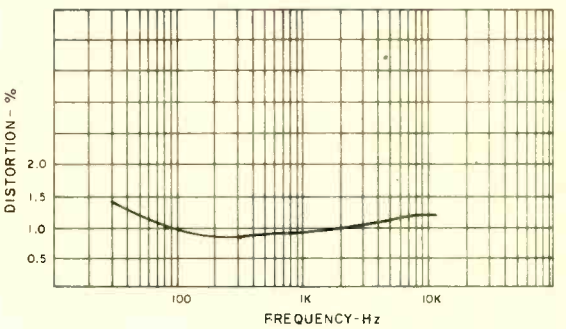


Fig. 6—Distortion vs. frequency (0 VU).

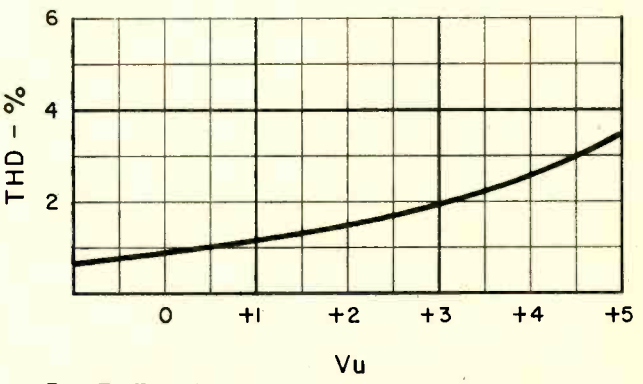


Fig. 7—Total harmonic distortion at 1 kHz.

Superb performance - lavish engineering - a new standard in high fidelity

THE ALL NEW REVOX 700 SERIES

Stereo Tape Recorder A700 **Digital Stereo Tuner/Pre-amplifier A720** **Power Amplifier A722**

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For other countries: Revox International, Regensdorf 8105 ZH Althardstrasse 146, Switzerland.

2 dB less in each case. Sensitivity for 0 VU was 44 millivolts line and 0.6 millivolts at the microphone input. Output was 1.2 volts. Wow and flutter was excellent for a machine in this price range being 0.12 percent at 7½ ips and 0.15 percent at 3¾ using the DIN record-replay standard. Finally, the tape rewind time was 210 seconds for 1800 feet. If these figures are compared with the specifications, it will be seen that the maker's ratings are quite conservative.

In-Use Test

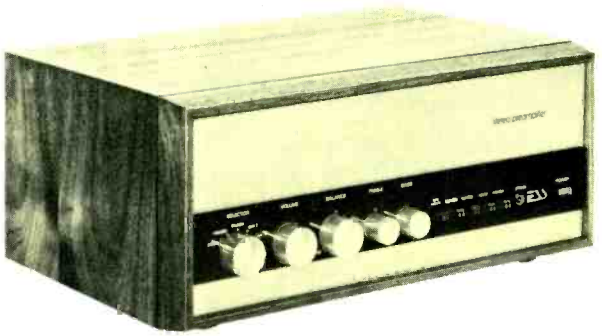
The 4000DS was used with a Sansui 9500 integrated amplifier and a Thorens 125 turntable fitted with a Shure Mk. III cartridge. Several tapes were made from records including some CBS SQ discs. Two sound-on-sound recordings were also made. To do this, a recording is made on one track in the normal manner. The tape is then rewound to the starting point using the counter and another track recorded while monitoring the first track. The tape is rewound again and the process is repeated again for tracks three and four. For playback, the track selector switch is set to the track on which the last recording is made and the mono mode selected by pulling the right level control knob outwards. This kind of thing is very useful for the amateur composer or possibly for language training. Full instructions are given in the owner's manual, which points out that as many individual recordings as desired can be transferred to a single track. The manual also describes the procedure for sound-with-sound, sound mixing, head cleaning, and tape splicing.

The two tape function knobs worked quite smoothly although it took some time before I got completely used to them. For instance, the stop position is not marked so I had to hesitate a split second before I turned the right knob the right way. I had no difficulty with the speed change *modus operandi*—mainly because I rarely use 3¾ ips. However, I can imagine that some people would feel a little frustrated at the lack of a speed-change switch. But again, this is an inexpensive machine, in fact, a remarkably inexpensive machine. In terms of basic performance, especially frequency response, distortion and wow and flutter, it compares very favorably with recorders costing much more. Certainly, it has more to offer than cassette units in the same price range.

George W. Tillett

Check No. 66 on Reader Service Card

ESS Preamplifier and Model 200 Power Amplifier



MANUFACTURER'S SPECIFICATIONS

Bandwidth Preamplifier & Frequency Response: High-level section, ± 0.025 dB, 10 Hz to 40 kHz; ± 0.1 dB, 5 Hz to 75 kHz; ± 1 dB, 2 Hz to 2 MHz; Tone-control section, ± 0.025 dB, 10 Hz to 25 kHz; ± 0.1 dB, 5 Hz to 40 kHz; ± 1 dB, 2 Hz to 150 kHz; Phono-preamp section, ± 0.25 dB from RIAA curve, 20 Hz to 20 kHz. **THD**: 0.0075%, 20 Hz to 20 kHz, to rated output. **IM Distortion**: 0.005%, 60 Hz & 4 kHz mixed 4:1, to rated output. **Noise**: High-level section, 100 dB at rated output; Tone-control section, 96 dB at rated output; Phono-preamp section, 80 dB ref. to 10 mV, 1 kHz input. **Phono Input Impedance/ Capacitance**: 47 kohms, 50 pF. **Rated Output**: 2.5 V rms. **Dimensions**: 16⅝ in. W x 6 in. H x 9 in. D. **Price**: $399.00.

Model 200 Amplifier

Power Output: 100 watts rms per channel, 20 Hz to 20 kHz, both channels driven into 8 ohm loads. **Frequency Response**: ± 0.25 dB, 22 Hz to 41 kHz, 1 watt. ± 1 dB, 12 Hz to 133 kHz, 1 watt. **Harmonic and IM Distortion**: 0.1%, 20 Hz to 20 kHz, to rated output. **Hum & Noise**: 100 dB below rated output. **Damping Factor**: 100 at 20 Hz. **Input Impedance**: 47 kohms. **Sensitivity**: 1.5 V rms in for rated output. **Price**: $399.00.

The ESS preamp is constructed utilizing a large PC board containing all the circuitry except the power supply which is mounted on the shield. (See Fig. 1.) All the push button switches are direct wired to the PC board. The switch and potentiometers are hand wired (with wire) to the board. Notable here is the use of an Allen-Bradley pot for the volume control. The power switch is a rugged unit, capable of handling the in-rush of current from large solid-state power amps.

The construction of the power amp is also rugged and appropriate to an amplifier of this general power range. About the only construction point which might give trouble is the lack of support at the top of the two PC boards. Under rough handling, these boards could vibrate and possibly cause connecting wires to break loose. This should be no problem in the normal installation, however. The heat sinks are quite adequate for normal music use, although they did get very HOT during worse case testing conditions.

Circuit Descriptions

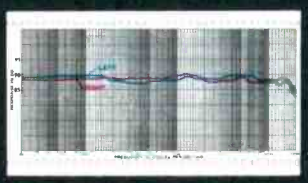
Functionally, the ESS preamp has four amplifier blocks per channel: a phono preamp-equalizer, an output amplifier, a tone-control amplifier, and a headphone amplifier. (See Fig. 5. During normal use, only the phono preamp and/or the output amp are in use. If the tone controls are switched in, that circuit is placed between the output amp and the main output on the back panel. The headphone amp is connected to the main output and is on-line all the time.

A time-delay relay circuit prevents turn-on thumps by opening the main outputs and shorting the internal output lines to ground during the delay period, which is about five seconds. On turn-off, the relay drops out very quickly, thus preventing turn-off surges from getting through to the power amp—many of which work for a short time when turned off.

When you feel like hearing your favorite symphony, feel like you're hearing it.

From the most brilliant highs of a piccolo to the sonorous lows of an organ, nothing matches the sound of Koss ESP-9 Stereophones. In fact, according to Stereo Review, "the Koss ESP-9's were outstanding enough in both sound and measurements to serve as a comparison standard for the others." And that's high praise indeed.

But then, for those who have heard the Koss ESP-9 Electrostatic Stereophone, praise like that isn't surprising. Because the



Koss ESP-9 and patented energizer offer a distortion-free, wide-range frequency response never before possible in headphones . . . flat ±2 db monitoring over the entire audible spectrum of ten octaves. And that's 4 full octaves beyond the range of conventional Stereophones.

The ESP-9's unique push-pull balanced acoustical circuitry also cancels out all second harmonic distortion. So what you hear is as breathtaking as a live performance. And perhaps it's even more breathtaking. Because the patented Koss fluid-filled ear cushions eliminate ambient noise and provide a truly private listening experience.

But you really have to hear the Koss ESP-9 to know why it's the world's finest Stereophone. So take a record or tape of your favorite symphony to your Audio Specialist for a live demonstration. And in the meantime, write for our full-color catalog, c/o Virginia Lamm. From $15.95 to $175, there's no sound equal to the Sound of Koss.

Koss ESP-9 Electrostatic Stereophones

KOSS stereophones

from the people who invented Stereophones.

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Koss Corporation, 4129 N. Port Washington Ave., Milwaukee, Wisconsin 53212 Koss S.r.l., Via dei Valtorta, 21 20127, Milan, Italy

The power supply consists of a full-wave rectifier bridge, a 500 μF filter capacitor, and a circuit which amounts to a high-gain emitter-follower with the base input fed from a voltage divider across the input filter capacitor. A 50 μF capacitor from the base to ground reduces input ripple by a factor of about 375:1. The output of this follower is further filtered by a two-section RC filter, which powers the preamp circuit with about +38 V d.c.

The basic circuit configuration used for the phono equalizer and output amp is shown in Fig. 6. As a basic circuit, it is not startlingly new, but ESS has worked out the parameters for very low distortion and wide bandwidth. The main difference between this circuit and the usual one of this configuration is the bootstrapped collector load of Q_2. The current gain of Q_3 is used to cause the junction of R_1 and R_2 to dynamically follow the voltage at Q_2's collector. If

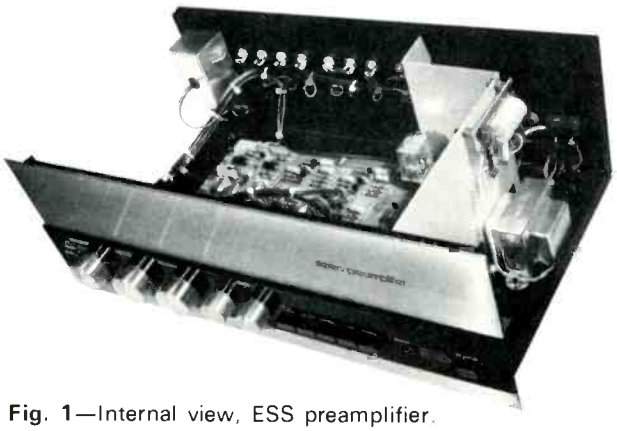

Fig. 1—Internal view, ESS preamplifier.

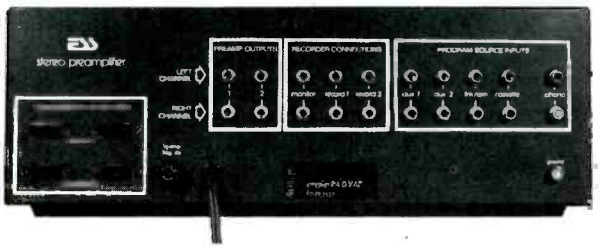

Fig. 2—Back panel view, ESS preamplifier.

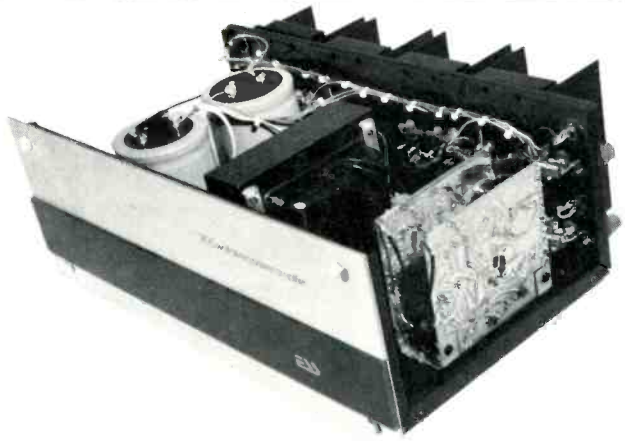

Fig. 3—Internal view, ESS Model 200 power amplifier.

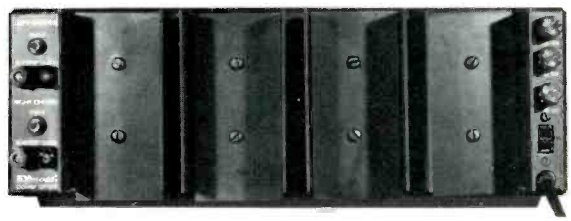

Fig. 4—Back panel view, ESS Model 200.

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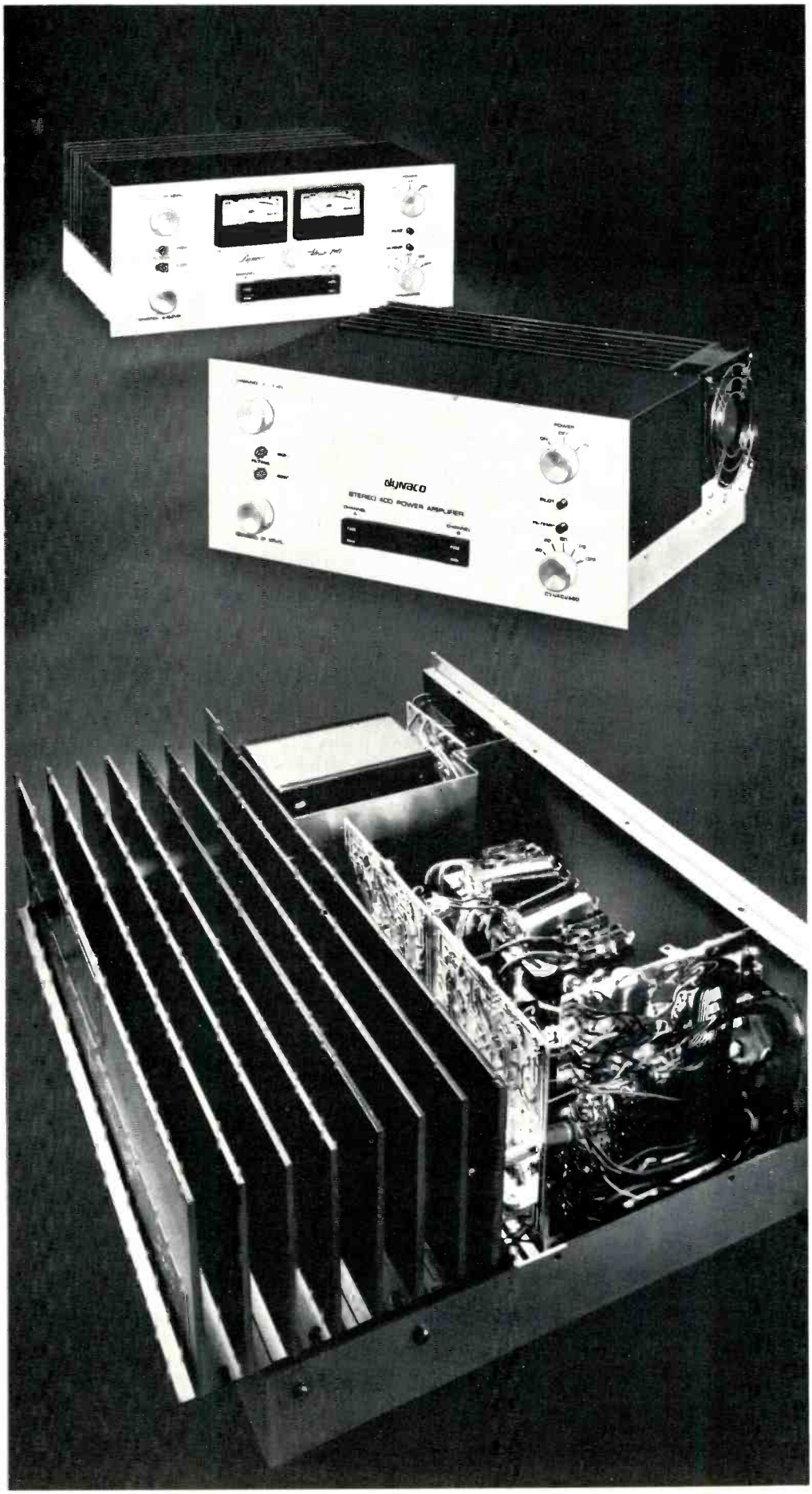

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It's all you've ever wanted in an amplifier. Power—400 watts at 8 ohms, 600 watts at 4 ohms; unsurpassed stability with any speaker; cooling capacity without equal; unmatched protection for both amplifier and speakers; and sound quality that draws raves from solid state and vacuum tube fanatics alike. A thousand square inches of heat sink—1.2 pounds of aluminum for each output transistor—plus space for an optional fan. Relay DC protection, plus exclusive DYNAGUARD™ speaker saver and a host of additional safeguards make the Stereo 400 the most reliable, as well as the best sounding amplifier extant. Optional illuminated meter kit—$75. Build it in 3 or 4 evenings with Dynaco's easy step-by-step instructions, and the simplicity of a single full color pictorial diagram. Still dubious? Send $2.50 for the detailed manual. $449 kit; $599 assembled.

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the junction a.c. voltage at R_1 and R_2 was equal to the a.c. voltage at Q_2's collector, R_2 would appear as an infinite collector load to Q_2, thus producing a very high voltage gain in Q_2. In practice, the voltage gain of Q_3 is never equal to one, and therefore R_2 does not get infinitely large, but it gets large enough to give a circuit like this open-loop gains in excess of 10,000. The tone-control amplifier is a simpler circuit, using Q_2 and Q_3 to form the high-gain inverting amplifier required for feedback tone-control response. The headphone amp is a complementary emitter-follower with input fed from the main output of the preamp.

The circuitry of the Model 200 amplifier is similar to other solid-state amps in that it uses an input differential pair direct-coupled to an inverting predriver. The predriver swings essentially the full power-supply voltage through a quasi-complementary gain of one output stage. Refinements are in evidence, however, as the differential pair collector that is used has a constant current load and is coupled to the predriver through an emitter-follower, giving much more open-loop gain than would be present without these two devices. The positive half-cycle output amplifier is a compound triple consisting of an NPN CE (common emitter) driving a PNP CE driver, which in turn drives two NPN output devices in parallel as CC (common collector or emitter-follower). The negative half-cycle output amplifier has a PNP CE driving a NPN CC driver, which drives two more NPN output transistors in parallel as CEs. The composite output amplifier is fed back to a gain of one by connecting the output back to the input emitters (output-amp input transistor emitters). The input coupling capacitor and feedback shunt decoupling capacitor are paralleled with back-biased diodes which may have an effect on overload characteristics or turn-on thump (very absent in this amp). The output protection circuit appears to be a volt-amp limiter type as inputs are from output current and voltage. The predriver transistor is current limited to prevent its failure under conditions of heavy negative half-cycle output VI limiting. The power supply is a bi-polar one, consisting of a good-sized transformer, full-wave rectifier bridge, and two 7800 μF/100 V filter capacitors. Supply voltage is $\pm$ 56 volts d.c. at idle.

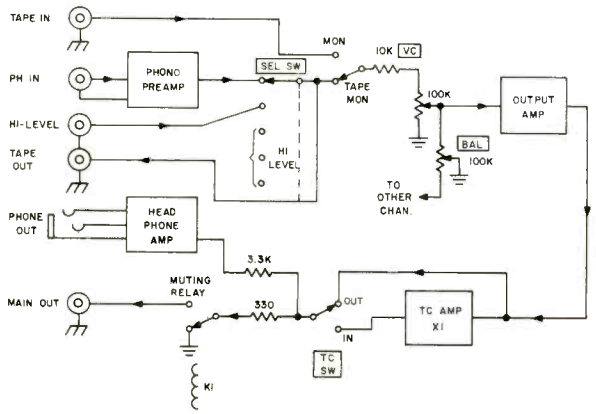

Fig. 5—Simplified block diagram of the ESS preamp.

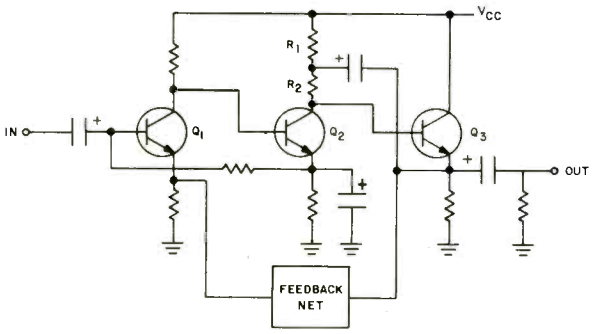

Fig. 6—Simplified circuit of the gain block used for the phono and output amps in the preamp.

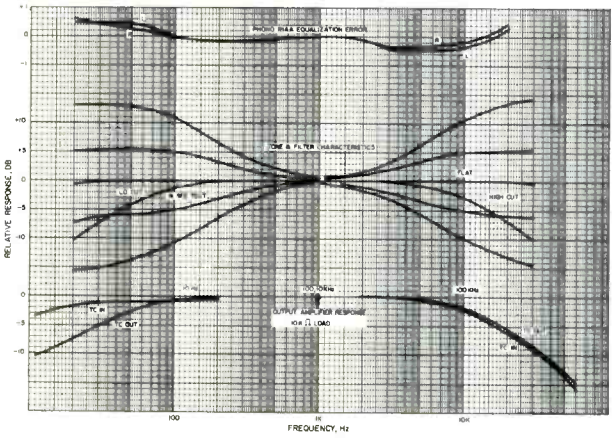

Fig. 7—Phono RIAA equalization error, tone and filter characteristics, and output amplifier response of the preamp. Note that two frequency scales are used.

Listening Tests

In order to be as objective as possible, listening tests are normally performed before the equipment is measured. This reviewer's normal record-playing set-up consists of a phono preamp with 40 dB of gain at 1 kHz, followed by a 25K dual volume control, with the output fed directly to a power amp or into a unity gain (at mid-band) active equalizer for the present speaker system. This is done since tone controls aren't desired most of the time, 40 dB gain is enough for most listening, and finally and most importantly, additional circuitry opens up the possibility of degrading the sound to some extent.

Accordingly, the listening tests on the ESS preamp were conducted as follows: the record-out jacks of the preamp were fed into the 25K dual volume control and into one input of the system equalizer. The main output was connected to another input of the equalizer. The preamp volume control and balance control were set-up with a CBS STR-130 test disc to give the same level at both inputs to the equalizer, which is acting as a switch box for the test. The capacitance of the cables from the 25K volume control to the equalizer form a low-pass filter with a minimum cutoff frequency in excess of 100 kHz. This set-up allows the basic phono preamp sound to be compared with the sound of the complete preamplifier. In some situations, the listening is done with electrostatic headphones (sans equalizer) to check for subtle differences, though generally what differences there are can be heard through the loudspeakers. Pickups tried with this preamp were B&O SP-12, Shure V-15 III, and Decca 4RC.

The phono preamp sound—or more accurately its lack of sound—was very good and was easily among the best heard from commercially available solid-state circuitry. Though its measurements are superb, the output amplifier, the ESS phono preamp was about as open and defined, though the high end was just a bit more edgy and distorted. Though its measurements are superb, the output amplifier, when switched in, brought a brighter sound with a small increase in distortion, as did the tone controls. When compared with other high-quality, solid-state preamps, the effect of the output and tone-control amplifiers is typical.

The Model 200 amplifier was compared to other power amps, which included among others a pair of Marantz 9s

Are we really number four?

A recent survey by a leading audio magazine found Sherwood in fourth place among all stereo receivers, in terms of the "brand bought most last year."

This report both pleased and confused us. Since we barely showed up in previous annual tallies, the evidence of sudden fame and popularity was certainly welcome.

Unfortunately, it didn't make any statistical sense. After all, we're the people who make this gear, and we ought to know how many units we put together in a year's time, and we promise you that the total doesn't even approach what the giants are doing.

Maybe there was another message in that score.

So we reviewed the survey a little more closely, and remembered that it was a *subscriber* survey, meaning that it automatically did not include the large general mass market for high fidelity equipment, where most of the big volume is.

In other words, the survey was biased, in favor of the sophisticated, expert, deeply involved audio enthusiast: the man who takes his listening seriously.

Among *this* specialized group, Sherwood registered a fourth place position.

Which would make sense statistically, since the numbers are smaller.

And on a performance-per-dollar basis as well, since the standards are higher.

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S7200

"Best Buy" (a leading consumer testing publication)

Amplifier output (RMS, 8 Ohms, both channels driven): 40 + 40 watts @ 1 KHz; 32 + 32 watts, 20-20 KHz

Distortion at rated output: less than 0.7%

Power bandwidth: 12-35 KHz

FM sensitivity (IHF): 1.8 μv

FM selectivity: 60 dB

FM distortion (mono): 0.25%

Capture ratio: 1.9 dB

Price: $359.95

Sherwood

The word is getting around.

and a Marantz 1120, and generally it performed quite well. The bass response was solid and tight, as we have come to expect from the best solid-state amps. The high end sound was very good and without the edgeness of other highly regarded solid-state amps.

Measurements

The gain of the phono preamp at 1 kHz measured 74.2X or 37.4 dB, which is close to the usual 40 dB of most phono preamps. Input noise over a 20 Hz to 20 kHz bandwidth with shorted inputs was 0.75 and 0.63 μV (82.5 & 84.5 dB) in left and right channels. An 80 dB S/N ratio referenced to a 10 mV signal input at 1 kHz would yield an input noise of 1 μV. RIAA equalization error in shown in Fig. 7, and distortion data is shown in Fig. 8.

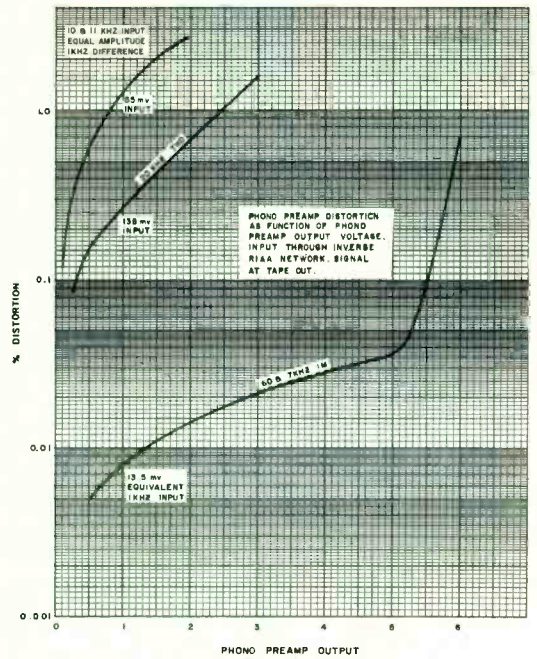


Fig. 8—Phono preamp output versus percentage distortion.

Distortion information of phono preamp stages is not usually specified for one reason or another. What this reviewer does is to feed the circuit under test with an inverse RIAA equalizer that has an insertion loss of 40 dB at 1 kHz and follows the RIAA curve from d.c. to 218 kHz. (Although the actual RIAA response is only specified from 30 Hz to 15 kHz, it can be logically extended beyond this bandwidth.) This pre-equalizer, in effect, becomes a perfect cartridge playing a perfect record. If the preamp under test is perfect, then it should reproduce what is fed into the pre-equalizer.

Results of the standard SMPTE 60 Hz and 7 kHz IM test of this phono preamp circuit are very good and better than most by a considerable margin. Since the input signal to a phono preamp is rising with increasing frequency for a flat recorded spectrum, it was decided to measure distortion effects due to high frequency inputs. The 20 kHz THD is typical of many circuits and is satisfactorily low at working levels.

The third curve in Fig. 8 shows the effect of high frequency signals—specifically 10 and 11 kHz—mixed at equal amplitude. The nonlinearity, usually second harmonic at a single frequency, causes a sum and difference to be generated at 1 and 21 kHz. The difference tone is measured here as it is by far the most dominant and would represent audible distortion and, in fact, is easily heard when listening to the output of the preamp under test with this test signal input. It is to be emphasized that although this kind of distortion data is rarely seen, the ESS preamp is quite good in this measurement as compared to other circuits that have been measured.

A word about output levels that phono preamps have to handle. This reviewer has seen an Ortofon S-15T drive a 40-dB phono stage to the equivalent of 2.5 V rms in the general frequency range of 1 to 5 kHz. Undoubtedly, it would not be hard to find a record that would demand even more in the way of output. This same pickup produced a musical transient input to a preamplifier of some 60 mV p-p at the equivalent of 50 kHz. If a phono preamp is in serious trouble at 10 and 11 kHz, it follows that it is often in worse trouble with higher frequency signals.

Square-wave response of the phono preamp is shown in Figs. 9 and 10. The bandwidth of the signals has been effectively limited to about 50 kHz by limiting the rise

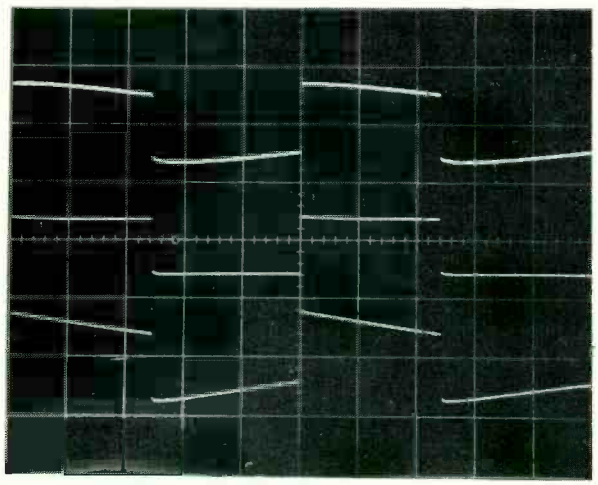


Fig. 9—40 Hz square-wave response of the phono preamp, 10k load, 25 mS/cm. Top trace is right output, 1 V/cm; middle trace is input to pre-equalizer, and bottom trace is left output, 1 V/cm.

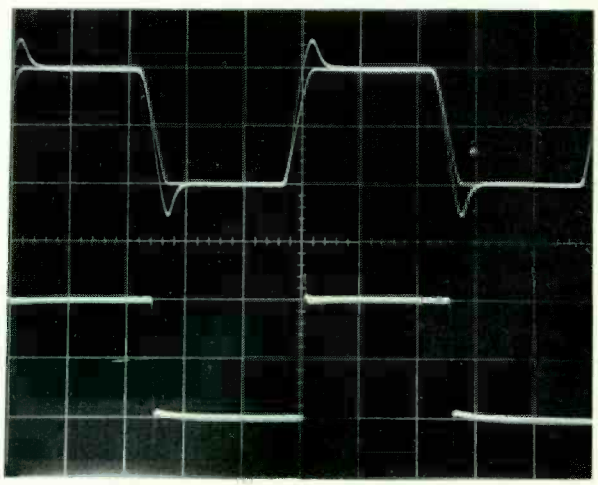
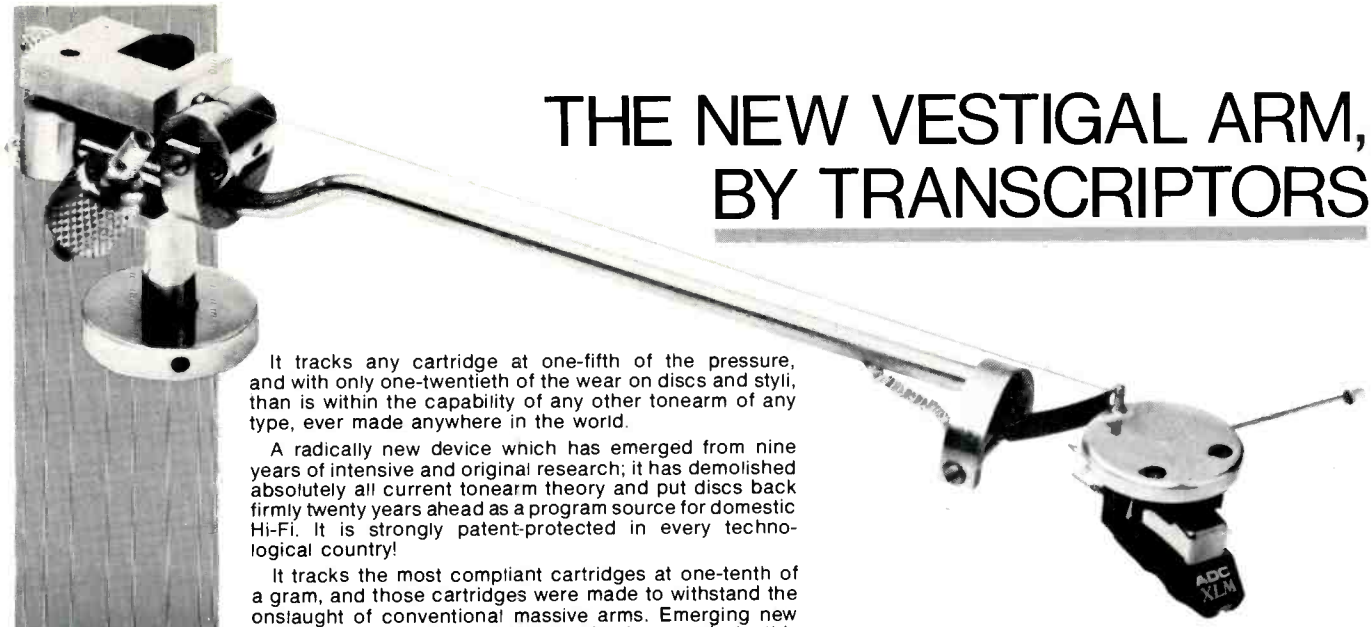


Fig. 10—Square-wave response with display adjusted so that input and output coincide. Top trace is 10 kHz, 200 mV/cm, 20 μS/cm; bottom is 1 kHz, 400 mV p-p, 200 μS/cm.

THE NEW VESTIGAL ARM, BY TRANSCRIPTORS



It tracks any cartridge at one-fifth of the pressure, and with only one-twentieth of the wear on discs and styli, than is within the capability of any other tonearm of any type, ever made anywhere in the world.

A radically new device which has emerged from nine years of intensive and original research; it has demolished absolutely all current tonearm theory and put discs back firmly twenty years ahead as a program source for domestic Hi-Fi. It is strongly patent-protected in every technological country!

It tracks the most compliant cartridges at one-tenth of a gram, and those cartridges were made to withstand the onslaught of conventional massive arms. Emerging new generation cartridges will do far, far better still in this arm.

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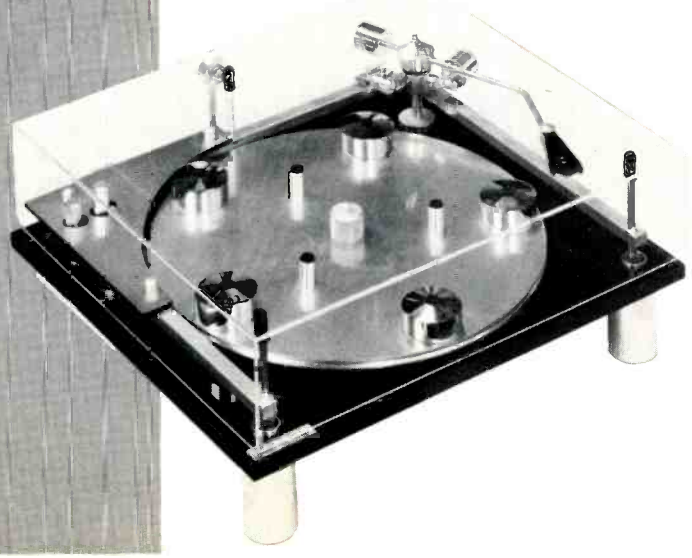
SPECIFICATION	Best low mass conventional arm or parallel tracking arm, with best cartridge	Vestigal arm, with best cartridge	Perfect arm
Actual Moving Mass	Best 180 grams in all planes	37.5 grams horizontal; 25 grams vertical	Zero Mass
Inertia (effective mass) with Cartridge	Best 11 grams in all planes (often twice this figure)	6 grams horizontal; 1 gram vertical	Zero Inertia
Tracking Pressure	Best 1¼ grams on selection of highly modulated discs	Best one-tenth of a gram on selection of highly modulated discs	Zero
System resonance	2-30 C.P.S., system resonance within large air moving frequencies resulting in distortion and feedback	Over 180 C.P.S., system resonance well outside air moving frequencies no distortion or feedback	Over 30,000 C.P.S.
Disc Wear	Severe degeneration of discs after 15 playings, no longer Hi-Fi after 35 playings	Degeneration of discs at least forty times less due to low inertia and tracking force	No Wear



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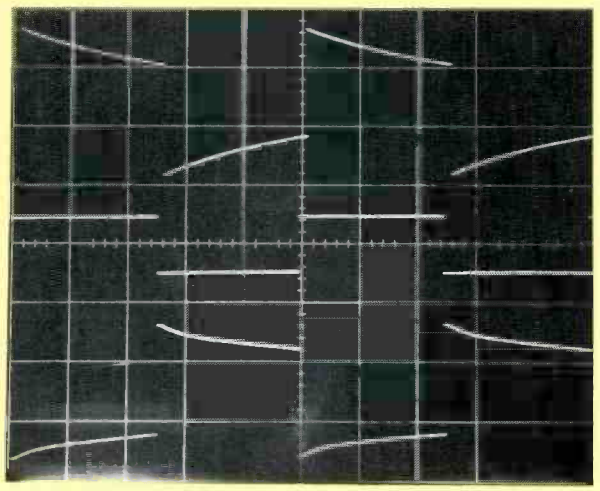


Fig. 11—Square-wave response at 20 Hz, 10 mS/cm. Top trace is with tone controls out, 1 V/cm; middle trace is input, and bottom trace is with tone controls in, 1 V/cm.

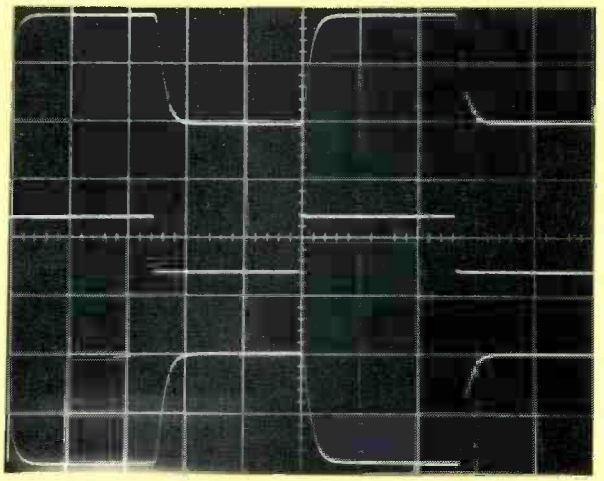


Fig. 12—Square-wave response at 20 kHz, 10 μS/cm. Top trace is with tone controls out, 1 V/cm; middle trace is input, and bottom trace is with tone controls in, 1 V/cm.

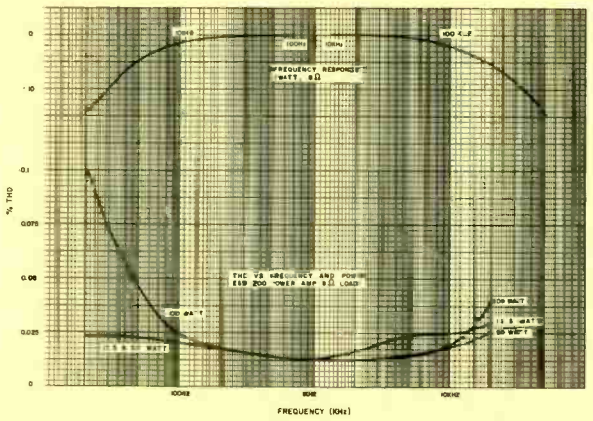


Fig. 13—One-watt frequency response and THD versus frequency and power output for the Model 200 power amp. Note that two different frequency scales are used.

time of the input signal to 7 μS. Note that Fig. 10 has the input and output waveforms overlayed for ease of comparison. The overshoot shown in these traces is the result of the designer's choice of letting the equalized response rise above 10 to 20 kHz and is fairly common.

There has been some discussion recently about the subjective effects of using different cartridges with different preamps. One test of this interface is to find out how different cartridge and cable capacities affect the RIAA equalization of the phono preamp. This is a separate effect from the response at the input to the preamp due to the second-order low-pass filter formed by the cartridge inductance and resistance, cable shunt capacity, and input resistance (hoped for!) of the preamp. This was investigated briefly for cartridges of low inductance and the more usual high inductance, and it was found that the ESS preamp didn't modify its response beyond that due to the high frequency rolloff caused by the input filter.

The phono input has a 100 pF capacitor wired across the phono input jacks, presumably to help with RF interference, a problem with wide bandwidth phono preamps. This unit still has a small problem with this interference, as it does produce a pop when auxiliary equipment is switched on or off, but it is not excessively loud and is certainly better in this regard than other equipment affected by RF.

Phono preamp crosstalk was measured on a pre-equalized basis and was down more than 50 dB between 100 Hz and 5 kHz, decreasing to 30 dB at 20 kHz and 33 dB at 20 Hz. Phono overload as a function of frequency is shown in Table 1.

Output Amplifier and Tone Controls

The voltage gain of the output amplifier with volume control at maximum and balance set for equal gains in

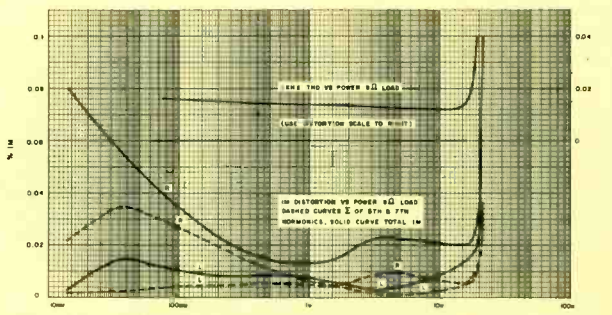


Fig. 14—THD at 1 kHz versus power and IM distortion versus power. Note that right channel IM distortion fell to levels achieved by the left channel with a small adjustment of the bias pot.

each channel was 6.9X or 16.8 dB, as compared with the more usual 10X or 20 dB. Frequency response, tone-control characteristics, and filter responses are shown in Fig. 7. Square waves at 20 Hz and 20 kHz for tone controls in and out are shown in Figs. 11 and 12. The low-cut (high-pass) filter cutoff frequency varies with volume control setting. The curve shown was with the volume control (VC) at half rotation and is representative of the behavior from this point down. At full rotation, the cutoff frequency was 180 Hz. The high-cut filter cutoff varies a much smaller amount with VC rotation, varying from 105 to 13 kHz at half and full rotation. This is fairly insignificant.

IM distortion, measured on a Crown IMA, was less than 0.01 per cent up to 3.5 V rms with a 10k or higher load with tone controls either in or out. Why 10k? At least two high-power solid-state amps have 10k input impedance. With tone controls out, THD was less than 0.01 per cent from 20 Hz to 20 kHz at rated output of 2.5 V with a high Z load. At 20 kHz with a 10k load at rated output, it was a mere 0.012 per cent. With tone controls in and a 10 k load, THD was 0.2 per cent at 20 Hz, 0.1 per cent at 50 Hz, and decreased to below 0.01 per cent from 400 Hz to 20 kHz. This level of harmonic distortion is difficult to measure, and a special in/out comparison bridge was constructed for the test, with results later verified on Radford equipment.

Crosstalk was measured by feeding a signal into a high level input and shorting the other channel input, with the VC at max, balance at equal gain for each channel, and tone controls out. From 100 to 400 Hz crosstalk was 61 dB down, while at 20 Hz it was 59 dB, and 36 dB at 20 kHz. Switching the tone controls and filters in and out didn't cause any unexpected changes in the measurements.

Output noise of the output and tone control amps was measured under several different conditions. It should be noted that the audibility of output noise varies with room characteristics, power amp gain, speaker efficiency, whether one is listening to a record or specifically for output noise, and a host of other factors. With the volume control at minimum and tone controls out, output noise measured 19.5 μV in the left channel and 19.0 μV in the right in the 20 Hz to 20 kHz band and was mostly composed of line harmonics. With the volume control at maximum, noise was 39.0 μV and 40.0 μV in the left and right channels respectively. Over the 400 Hz to 20 kHz band with tone controls out and volume control at minimum, noise measured 8.0 μV in the left channel and 7.6 μV in the right. Over the same band, again with tone controls out but with the volume control at maximum, output noise was 16.3 μV in the left and 16.2 μV in the right. Addition of the tone controls to the test caused higher output noise measurements, principally below 400 Hz. The measurements above 400 Hz are quite good and generally hiss of this magnitude is inaudible. The line harmonics could be heard if one stuck one's head in the speakers. (25 μV is 100 dB.—Ed.)

For the headphone amp, insertion loss was measured as a function of load and started at –4.2 dB for a hi-Z load, –5.2 dB for 620-ohm load, and was –12.8 dB for a 47-ohm load. IM distortion was measured for left and right channels as a function of output load and level. With the 47-ohm load, this was fairly high, with odd harmonics in particular, and it appears that phones with 600-ohm resistance (or higher) should be used for best results. Several different phones with impedances from 4-16 ohms to 2 kohms were tried. Using a Shure V-15 III pickup, the overall gain was adequate with the 2 kohm phones and the sound was good. With the low Z phones, the level was higher and the sound again was good. However, it is possible to put a preamp such as this into low-frequency oscillation using low Z phones at maximum gain, and therefore a power amp should be used to drive them.

Amplifier Measurements

Harmonic distortion versus frequency and one-watt frequency response are shown in Fig. 13, while IM distortion and 1 kHz THD are plotted against power output with 8-ohm loads in Fig. 14. The left and right channels' IM are shown along with a measurement of the unweighted sum of the 5th and 7th harmonics in the IM residue. This is measured using a special comb filter that permits measuring individual or sum of any combination of harmonics in the IM distortion residue up to the 7th. It is felt that the higher order odd distortion products are responsible to some extent for irritation and graininess in the sound of power amps. A slight touch-up adjustment of the right channel bias pot brought the right channel IM very close to the left in test behavior.

Square-wave response is shown in Fig. 15, where the middle trace shows the effect of a 2 μF capacitor in parallel with the 8-ohm load. The glitch at the zero crossing may be due to VI limiting, as it disappeared at lower levels. Damping factor was measured by injecting a known current into the output terminals of the amp. By measuring the resultant voltage across the internal impedance, this impedance was calculated. The damping factor, as deduced by this method, was greater than 100 from 20 Hz to 10 kHz. Hum and noise at idle was down 101 dB re 100 watts, 8 ohms, which works out to 252 μV output noise, and was mostly line harmonics. Clipping power at 1 kHz into 4 and 16 ohms was 215 and 81 watts respectively.

In conclusion, the ESS preamplifier and Model 200 power amplifier are excellent in their performance. No particular trouble was experienced with the equipment, and the experience of using and listening through it was quite enjoyable. Certainly, most audiophiles should be satisfied with the sonic performance of this equipment. *Bascom H. King*

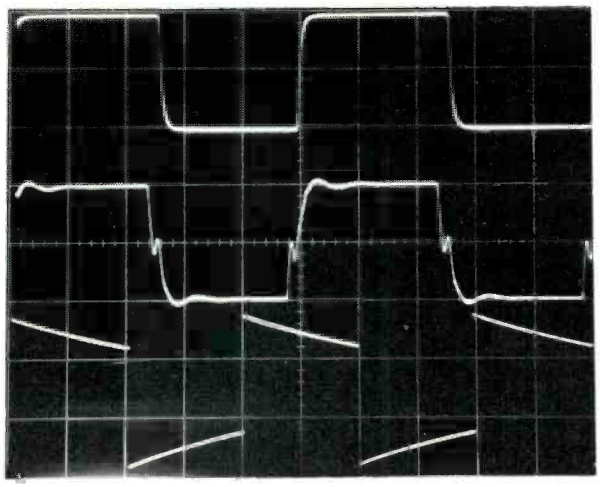
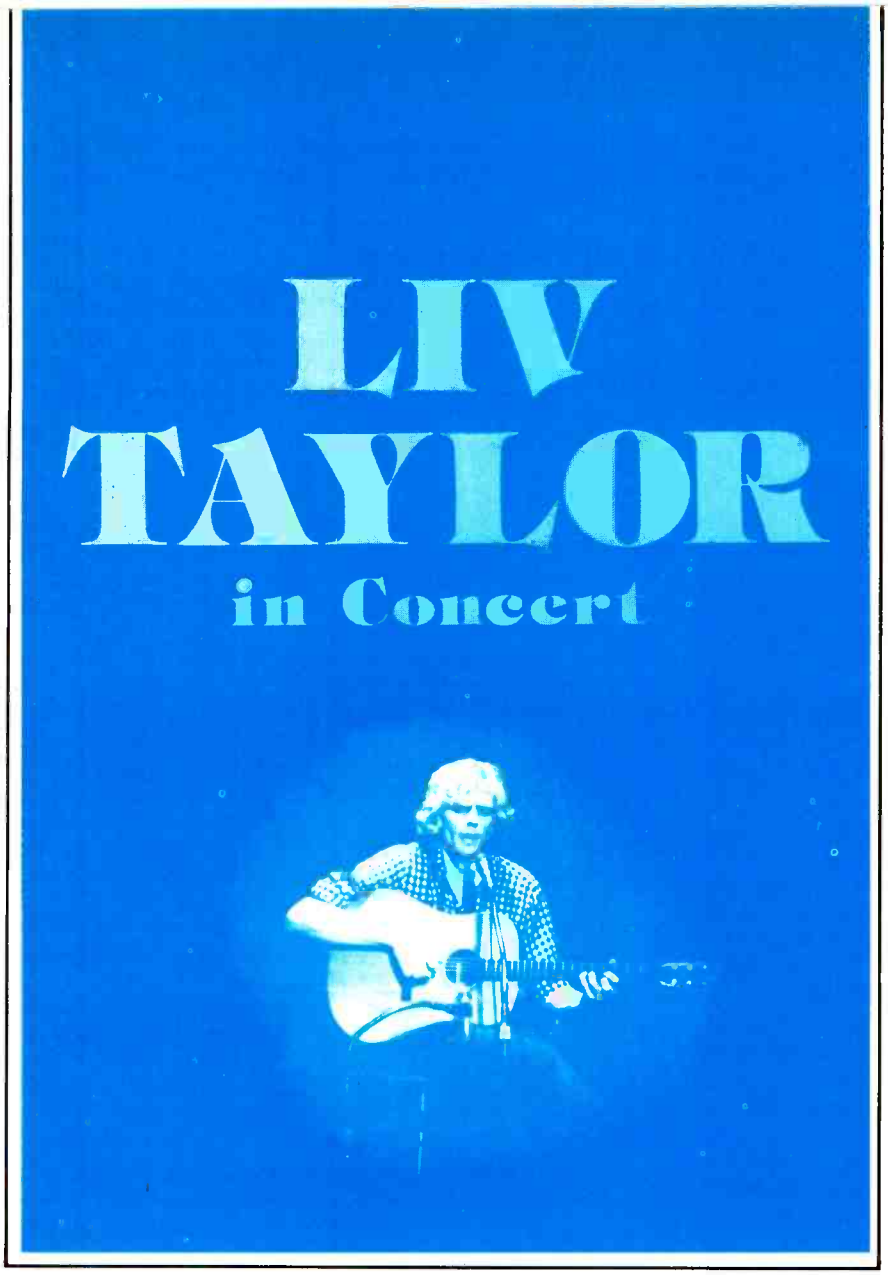


Fig. 15—50 Hz and 10 kHz square-wave response, Model 200 power amp. Top trace is 8-ohm load, 5 V/cm, 20 μS/cm; middle trace is the same except for addition of 2 μF in parallel with the 8-ohm load, and the bottom trace is 50 Hz, 8-ohm load, 5 V/cm, 10 mS/cm.



By Michael Nisc

LIVINGSTON TAYLOR is tall, lean, blonde, and doesn't like to be compared to his super-star brother, James. Perhaps it was just conjecture in the past to debate whether or not Liv, as he is called, has the notoriety because of his brother or has been overpowered, or limited, by his brother's massive shadow. It's not important anymore!

The Livingston Taylor Concert at the Main Point in Bryn Mawr, PA, outside of Philadelphia, was strictly the effort of a finely seasoned entertainer/musician/writer, in his own right, establishing his own massive shadow molded from humble enthusiasm, confidence, and talent.

On a miserably cold night, the house was full and the lines were already forming on Lancaster Avenue for the next show. . . .

The opening act was a frizzy-haired moppet from Los Angeles on her first national tour for Warner Brothers; a Bette Midler in miniature, you might say. Wendy Waldman's act was highly polished for a first go 'round. She offered romanticism, wit and a wide, gliding voice range which could easily suggest a Laura Nyro or a former Mother of Invention, Essra Mohawk. Within a single selection, her voice soared through numerous formats—progressive, pop, soul, MOR—suggesting a great future for this potentially fine young artist. Her easy, conversational style and humor reflected insight rarely found in someone so young. But with all her effort, the audience was only politely receptive. They had something or someone else on their minds—the reason they had spent their money for admission and braved the elements standing in line.

After a brief intermission, three musicians emerged from the basement dressing room. They walked through the predominantly female audience and catapulted onto the stage. To the left, Bill Eliot, a sensitive-looking, bearded musician approached his instrument with the delight of a cat approaching his prey; while on the right, Walter Robinson pulled his upright bass into position displaying the feeling that he wouldn't be happier anywhere else.

Center stage became the focus of attention as the casually dressed Livingston Taylor tuned his guitar to the pitch of the piano. He appeared to have trouble and Bill Eliot's expression told him that it was not quite perfect. "This doesn't happen to Eric Clapton," he quipped. But this wasn't Eric Clapton and the audience's anticipation grew greater with the delay.

It wasn't long before the trio opened with the upbeat and familiar Beatles tune, *With a Little Help From My Friends*. Liv immediately established a common thread of rapport and gratified the pent-up expectations of his audience. His uncontrollable smile, his body language, and his enthusiasm visually cued the audience and began taking them "higher and higher."

The picking and bowing bass lines provided by Robinson were pulsating, sensitive, clean and systematically supportive of the simple, tight and total rhythm section. Eliot's sophisticated piano style and vocal harmonization added yet another dimension. You had the impression the musicians were conscientious, musical perfectionists, but they were also visibly pleased with their efforts.

But it was Liv's guitar, banjo, flute and vocal leads which generated a total three-dimensional effect. He constantly interacted with his musicians bringing them into a single harmonious feeling with each other and with each song. The musical accompaniment combined with the unusually clean Main Point sound system gave the performance a record-like quality.

Liv's choice of material and its placement in the performance led me to believe that much thought and preparation was devoted to the concert, although it flowed with the naturalness and spontaneity of a "pick-up session."

The audience was taken on a musical roller coaster ride with the trio upping and slowing the pace with melodic, short and totally diversified tunes that painted lyrical pictures or made a

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"We would judge the effective lower limit of the AR-7 to be about 40 to 45 Hz—which is a very respectable figure for a speaker system of its size ...The tone-burst response was on a par with that of the other AR speakers we have tested—about as close to ideal as can be measured in a "live" environment ... it compares with many speakers selling for twice its price or even more—which clearly makes it one of the more outstanding under-$100 speaker systems, irrespective of size."
STEREO REVIEW

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"We predict that the AR-7 will become the standard for other speakers in the under-$100 class and supplanting some speakers of even greater cost!"
AUDIO

"The AR-7 is quite flat in frequency response and most notably free of excessive peaks or dips ... a smooth musical balance that is not significantly bettered by any speaker at any price ... only slight rolloff evident well above 15 kHz, but there appears to be strong response far beyond 20 kHz. The woofer solidly strong to about 50 Hz ... with strong usable response just extending to 40 Hz. In short, the AR-7 is a remarkable speaker, and an even more remarkable value."
STEREO & HI-FI TIMES

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humorous commentary on life. Originals and standards, tempo changes, audience participation and varied musical styles hallmarked the concert. Liv's timing kept the concert moving and each selection was short enough to prevent that disastrous cloud of boredom from setting in.

Liv is positive and filled with good humor and warmth. Musically, he combined these qualities into a "sophisticated" country expression. He did not stereotype himself by prefacing each song with "This is a song written by . . . and it's called . . . and it's in my new album called . . . and you can get it at your local record store." Because of this, titles became unimportant, and yet the audience knew, recognized, and spontaneously appreciated tunes like *Carolina Day* and *Six Days on the Road.*

I was tremendously impressed with the composition *Falling in Love with You.* As a matter of fact, it could have been one of the nicest tunes I've ever heard. *Get Up, Get Out of Bed* could be a strong contender for a Livingston Taylor hit single (hear that, Capricorn!) with its strong "hook," that crucial part of any hit song that people will remember after hearing it on the first pass.

Instrumentally, the combination of Robinson and Eliot cultivated a jazz base while Taylor stayed close to home on the guitar and banjo (and what pickin'!!) with folk/country overtones on (Here comes another tornado, Dorothy!) *Somewhere Over the Rainbow.* The group's rendition at the conclusion of their set was tender, updated, beautiful and sensitive. It was also a surprising mind blower!

As the performers were making it back to the safety of the dressing room, the traditional Main Point footstomping and rhythmic handclapping signified the audience's overwhelming, genuine approval and their demand for more. Many stood and gave Liv an ovation. This must be a common experience for him. He seemed to know it would happen. "We're getting spoiled, you guys," he shyly but proudly noted as he reached for his flute which just *happened* to be on stage!

Bill and Liv began the intro and Walter bowed the bass into a sad, poetic melody creating simultaneous images of pathos and tranquility. Then suddenly—*voilá*—a rapid change in tempo . . . *Joshua Fit the Battle of Jericho.* Unreal! That Taylor really does numbers on my head.

"I come to Philly and get crazy," he said.

No, Liv! You come and *Philly* goes crazy!!

Sherwood's Forest

Sherwood L. Weingarten

JAMES MONTGOMERY BAND

FOREVER, the sages advise us, is a long, long time. Still, it seems *that* long since I've come across a really good album, one to actually rave about, a disc that once put on a turntable compelled the listener to pay full attention, enjoy, and then put it on again.

Perhaps, thought I, it was just that old jaded feeling; maybe I was being too harsh on the artists, the manufacturers. Could it be that what *I* thought was mediocre was really superior? After all, a good deal of what I panned eventually showed up on the charts. No, I soothed myself, even if being on the charts *were* the accurate measuring rod, it might only indicate that the lowest common denominator again was being served, that *something* had to make the charts (even if it was putrid).

But I doubted. And that doubt led to necessity, which those same sages insist is the mama of invention. Ergo, the one-shot experiment that follows: sort of a consensus. Or disagreement. Or what have you.

At any rate, this column is a composite of thoughts, reactions, opinions, musical tastes. Mine first. Then those of my wife, daughter, and son. And so you can understand the level of their musical abilities and expertise, let me introduce them, youngest first.

Mark, eight, has been pickin' guitars a bit more than a year; he might as well have been pickin' his teeth for all the progress he's made. Thump, thump, thump—like Ricky Nelson. His tendency is to dig anything with a heavy beat, although when asked to name a couple of musical favorites, he listed the Beatles together with Eugene Ormandy and the Philadelphia Orchestra.

Jan, 10, wants music she can dance to, or at least something with which her developing body can gyrate. A couple of years ago she wanted and tried to be a drummer. She might have made it if she weren't half a beat behind all the time. Now she's switched to playing the organ. All she has to do is change the style of her instrument and add a monkey for ensured success. Jan's singing, not incidentally, tends to be flat, but she ignores that, perhaps figuring that if Bette Midler can make it, so can she. Her favorites? Donny Osmond, Sonny & Cher, the Carpenters, she says.

Though I wouldn't swear to it, I believe both kids to be tone deaf. Their music teachers, who greedily snap up my money, claim otherwise. Heck, maybe one of 'em will turn out to be as good as Fabian.

Lucy, 32, abhors hard rock. She may, in fact, hate everything that comes from amplifiers. Radio, television, stereo, tape recorders—every chance she gets, she turns them lower (lower, I'd testify, than is audible to the human ear). She plays no musical instruments, but is a whiz at engineering when we want to record anything. Mark-Almond, Chicago, and Neil Diamond are numbered among those she more than tolerates.

She's not tone deaf but swears I am.

Now, to set the scene: the Weingarten living room, after a luxuriant

evening meal prepared by mama bear, with four on the couch (two willingly, two retained only by virtue of monetary bribes).

Record No. 1 **FIRST TIME OUT** (Capricorn, CP 0120) with a six-man group, the ***James Montgomery Band,*** offering nine cuts of blues-rock.

For me, the band, composed of guys in their early to mid-20s, is good but not really outstanding. There's too much sameness in their music for them to rise above the hundreds of other competent new groups around. Still, there are some bright spots on the LP, which is distributed by Warner Brothers. *I'm Funky But I'm Clean* is just that, a funky sound with lyrics that are cleanly understandable (though banal). *Ready Teddy* is an old-fashioned rock 'n' roll zinger that moves, moves, moves. *Going Down,* another funky outing, seems to do something to your ability to stay still. And *Train* is a drivin', steady piece with narration-singing that doesn't interfere with the straight-ahead strength of the instrumental work.

Said Mark, who started shaking his whole body, it seemed, when *Ready Teddy* was on: "I like it. That's all." And that's to the point, my boy, to the point.

Said Jan, with her not-unusual double-edged sword technique: "Real cool, man, real cool. But I liked it better at the beginning; toward the end, it gets boring." I thought "real cool" went out before she was born.

Said Lucy, who midway through the disc escaped to the kitchen for a drink: "I'd prefer that **FIRST TIME OUT** is the group's last time out. If the goal of recording artists is to reach the top, this group's got a lonnnnng way to go."

Record No. 2: **BACHMAN-TURNER OVERDRIVE II** (Mercury, SRM-1-696), with the four-man outfit doing eight electric items that broke no new ground in the rock arena. In my judgment, the best tune is *Welcome Home,* a folk-rock entry with some hard, hard sounds played as a sort of counterpoint to the softer totality.

Commented Jan, who somehow found humor where none of the rest of us did in *Blown,* the hard-rock lead piece: "Considering I like fast music, this is *very* good; I especially loved *Tramp.*"

Commented Lucy, whose face frequently resembled a prune during the playing of the LP, so put off was she by the loudness: "The electric sound is decent enough, but the vocals are inadequate. *Tramp,* in particular, was bad; its music was repetitious, and the lyrics are absurd. When *I Don't*

Have To Hide played, I felt just the opposite, wanting to hide and not listen. Ugh!"

Commented Mark: "I like the whole album—although almost all the songs sounded the same to me." Et tu, Mark?

Record No. 3: **THE ADVENTURES OF PANAMA RED** (Columbia Quadraphonic, CQ 32450), with the ***New Riders of the Purple Sage*** doing 11 country-rock tunes that ranged from pleasant to bland. I was particularly interested in finding out if the kids picked up the drug-oriented items (the title tune, a double-entendre ditty about grass: *Important Exportin' Man*, a bit about dealing dope, and *Lonesome Cowboy*, more overt in that it includes lyrics that proclaim: "I been smokin' dope—snortin' coke/Tryin' to write a song/Forgettin' everything I knew/Till the next line comes along." Neither child noticed any of it, concentrating instead on the music.

Said Mark: "I liked it because of the music."

Said Jan: "I like the whole thing very much. I wasn't paying too much attention to the words, though; they're not necessary to enjoy the songs."

Said Lucy: "For a country-rock group, they're great. But because my tastes don't lie in that direction, I got bored with it. I think the music is very repetitious; it could be one 40-minute song with slight variations. I like the sound but would prefer it in small doses. I object, by the way, to the glorification of the drug scene." I agree.

Record No. 4: **A LEGENDARY PERFORMER—ELVIS, VOL. 1** (RCA, CPL1-0341), with a dozen musical cuts plus two excerpts from a 1958 interview. Most tracks, I feel, aren't worth hearing almost 20 years later except in a historical perspective. The album includes two tunes originally recorded on the Sun label, *That's All Right*, Sun's first commercially-released single from 1954, and *I Love You Because*, previously unreleased. Also included is Elvis' first recording for RCA, *Heartbreak Hotel*, done Jan. 10, 1956, and his biggest-selling single, *Don't Be Cruel*, also recorded that year.

Love Me, an unreleased live version, is marred by poor sound quality, as are *Trying To Get To You* and two more cuts on which the audience intrudes with outdated but familiar squeals. *Tonight's All Right For Love* previously was unreleased in the U.S. and other English-speaking countries (with good reason, I'd say; it's saccharine and just plain lousy), despite it being heard by millions who saw the "G.I. Blues" flick.

This album, unlike all those that went before in the test, drew unsolicited comments and actions from the family as it was played. First to talk was Jan, who interrupted *I Love You Because* with "I hate it. It's too slow and mushy."

Both kids started jumping, dancing and otherwise going bananas when *Don't Be Cruel* started, an honest indication that the tune stands up as a classic rocker.

As *Love Me Tender* unfolded, Lucy said, "I used to love this, but I don't think I particularly care for him anymore." Ahh, the ravages of age and lost love.

When the disc stopped revolving, the comments continued. Said Mark, "I love the record 'cause I like the way he sings the songs."

Said Jan, "I think this is a crazy record. One minute they're doing old-fashioned slow songs, and the next they're doing stuff that's just like you hear today."

Said Lucy, "With a few exceptions, such as Frank Sinatra, I don't feel you can take an artist from another era and bring him up to date. The songs, the styles are outmoded. Somehow,

Presley just doesn't make it anymore; he doesn't cut it." Tough broad, that wife of mine, callin' 'em as she sees 'em.

Record No. 5: **LOOKIN' FOR A LOVE AGAIN** (United Artists, UA-LA199-G), featuring the country-soul sound of ***Bobby Womack.*** My view was that all 10 cuts, half of which were penned by Womack, were extraordinary in their ordinaryness. If you wanted to dig through the junk to find some snatches of tolerable listening, you could, in desperation, latch into *Doing It My Way,* a slow thing, or *Let It Hang Out,* a rocker.

Said Mark, who is often articulate only when he wants me to buy him a $49.95 toy, "The slow songs were bad but the fast songs were good—he sounded right for them."

Said Jan, "I liked the faster numbers, but I don't think he should make any more records until he practices some more." Touché.

And said Lucy, "He should stay away from slow vocals and stick to up-beat material. He's mediocre on an overall basis, I found myself trying too hard to discern what the words were; it was so disconcerting, I stopped listening."

Record No. 6: **FOR MY LOVE . . . MOTHER MUSIC** (RCA, APL 1-0266), with ***Jose Feliciano*** doing 10 cuts, three of them self-penned. His middle-of-the-road soul-rock sound, in my opinion, has become plastic. Arrangements, by Feliciano and Steve Croupper, do nothing to make your blood run faster or your heart beat louder. Although the singer-guitarist makes one think back to *Rain* with *The Gypsy,* nothing else on the album brings anything to mind, either past or present. Certainly not future. Another promising artist down the tubes of ho-hummables.

For once, a consensus. Noted Jan, "It's all right, but nothing special." Said Mark, succinctly, "It's so-so." And continued Lucy, "He used to be much better; this one doesn't excite me very much."

Record No. 7: **TABERNAKEL** (Atco, SD 7032), with ***Jan Akkerman*** providing 10 interesting cuts, including the 14:06 *Lammy,* itself segmented. Akkerman, who wrote two songs on the LP and arranged and/or adapted the rest, utilizes heavily classical motifs. Though he is extraordinary on lute, he also tinkers with acoustic and electric guitars, bass guitar, and organ. He is backed on a couple of numbers by Tim Bogert and Carmine Appice, whose names might indicate—falsely—that the LP is a contemporary rock thing. That mistaken impression is aided by a cover photo of Akkerman which makes him look like a juiced-up musician or a modern version of Christ. In truth, however, the music is intricate, soft and gentle, pleasant and cerebral. Damned good, in fact, until we get to the flip side's *Lammy,* which is an overlong, religious-oriented experiment, replete with chorus and full orchestration, that rises to up-tempo insufficiently often. *House Of The King,* not incidentally, also starts to rock away from its nice melodic line but then gets immersed in strings and overproduction.

Said Mark, getting a wee bit tired of the whole thing and voicing regret that he sold out too cheaply, "It's terrible. I hate it. The last song's too long, and the others are too slow."

Said Lucy, "It's refreshing, relaxing, thoroughly enjoyable—except for *Lammy,* which I couldn't relate to or get into."

Said Jan, who midway through the album slid downward onto the couch, "Zzzzzzzzzzz."

Canby's Capsules

Edward Tatnall Canby

Boulez Plays Bartók—Concerto for Orchestra. N.Y. Philharmonic. **Columbia MQ 32132,** SQ quadraphonic, $6.98 *(also stereo).*

This is a re-check, with newest SQ logic decode. Yep, it does surround you as advertised—but the huge hall reverb (Manhattan Center) would confuse even live directionality, let alone SQ! Columbia's fancy diagrams of placement are unwise —forget them and just listen. Minus diagrams, the surround sound is just fine.

Robert Thompson at the Positiv Organ, St. Olaf College. **Ethos Records** (Box 287, Northfield, Minn. 55057). The organ: C. Hendrickson, 1403 N. 5th, St. Peter, Minn. 56082.

Wow—a tiny 1-manual, 3-stop portable tracker "air" organ, console-sized on casters—it was wheeled into a convent chapel here, and sounds astonishingly big. Excellent playing, too—old music (Dandrieu, Frescobaldi, Stanley) and new (Distler, Pinkham, Koetsier). The mic is a bit *too* close for the big 5-second reverb.

Brahms: Two Sonatas for Clarinet and Piano, Op. 120. Mitchell and Leona Lurie. **Crystal S 301,** stereo, $5.98.

An all-American performance out of California—strange how far that is from Europe! Curiously deadpan playing, outwardly dynamic but not warm in phrasing and melody. The husband-wife team have fine rep out there, though. Recording is amateurish—the fault is in the hard, small room sound, not the equipment.

Greece in Music and Song. Argo ZFB 70, mono, $5.95.

Field recordings via Nagra II, 1961-62, in the Greek mountain back country. It's gypsy music, Greek style. Assorted raucous winds, oriental-sounding vocals, weird ensembles, some on the inept side (but who are we to judge?). As so often in Ethnic recordings (except Nonesuch), too many samplings, cut off too soon. Exasperating for the listener. Better fewer, and at satisfying length.

Perahia. Schumann: Davidsbündlertänze, Op. 6; Fantasiestücke, Op. 12. Murray Perahia, piano. **Columbia M 32299,** stereo, $5.98.

Columbia goes to town with its latest piano acquisition, and rightly. Young Perahia is a thoughtful as well as powerful pianist, here tackling a tough assignment (for the mind as well as the fingers). He plays the difficult Schumann beautifully, hitting that perilous balance between too much and too little expression. Impetuous and youthful (compared to elderly Claudio Arrau, for instance) but genuine. Warm, hard Columbia piano tone.

The Trinity College Chapel Organ (Hartford, Conn.) **Austin SM 225,** stereo, $4.98.

The organ companies put out LPs to celebrate their new products. This vast new play-anything Austin puts emphasis on the French 19th c. Cavaillé-Coll, yet with plenty of Baroque etc. Veteran Clarence Watters pulls out the stops, expertly and musically, for an old fashioned organ program: Baroque, both French and German, recent French (Dupré, Widor)—and Watters (shattering roars and groans—phew). Good display.

Grieg: Violin Sonata Op. 8 and 45. Mischa Elman; Jos. Seiger, pf. **Everest 3333,** sim. stereo, $4.98.

Elman was a grand old-style violinist whose last discs, at an advanced age, were surprisingly well played. Here you have some unusual Grieg (particularly the earlier Sonata) in beautifully natural, of-the-period performances. Fair sound from mono tape, the fiddle ultra-close (and on edge of scratchiness—use filter), the piano modestly enveloping. A worthwhile reissue.

Tchaikovsky: Symphony No. 3 ("Polish"). N.Y. Philharmonic, Bernstein. **Columbia M 31727,** stereo, $5.98.

Is it "new"? Who knows—it's on the prime Columbia label and that's enough. Typical Bernstein/N.Y. Philharmonic, broad, mellow, not very taut, the details tending towards inaccuracy but with a fine warm feeling. T.'s most Schumannesque symphony, also Rachmaninoffesque, if you ask me, before the fact. Those big melodies to swoon over.

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Canby's Capsules

Edward Tatnall Canby

Baroque Lute Recital. Toyohiko Satoh. **Klavier 514,** stereo, $5.98.

A young Japanese, living and studying in Europe, turns out excellent very-late lute music by Bach and two lesser lights, French and Polish—Visée and Weiss. He has a fine ear for the music and a good sense for style and ornament. Fine record.

Leonard Bernstein Conducts His Music for the Theatre. N.Y. Philharmonic, **Columbia MG 32174** (2 discs), stereo, $14.96.
Bernstein's Greatest Hits. RCA ARL1 0108, stereo, $5.98.

Here they go again—RCA and Columbia. Columbia has the Maestro in person—and charges extra. RCA's more modest single includes English performances. Times, places, credits are played down in both—it's just Bernstein for Listening. Both include excerpts from the recent *Mass* as well as ballets and musicals already familiar.

Edna Karr Junior High School Concert Band 1972. (H. & G. Recording Service, P.O. Box 161, Chalmette, La. Pressed by Recorded Publications, Camden, N.J.)

Another of those special jobs, locally recorded, custom pressed. (They'll be suffering from vinyl shortage.) A characteristic school music project this. Remarkably difficult music, ploughed through with astonishing expertise (but not much understanding) by the kids involved. So much fuss over technique, so little regard for musical value! That's us. Good stereo balance but totally dead sound. (They wouldn't add reverb—might cover up the details of players' performance. Gotta grade 'em, I suppose.)

Greatest Hits of the '70s. Boston Pops, Fiedler. **RCA ARD1 0035 CD-4,** quadraphonic, $5.98.

Hey guys—*keep it coming!* This is already ancient (last spring)—*we need more CD-4!* Fine system but such a dearth of listening. Yep, this one, presumably brand new, immediately gives that extra CD-4 ambience. Also the expected lower level, and tiny edge of distortion. But what we need is stuff with listening guts. You can have the hits, if they'll keep your CD-4 morale up until more arrives. They won't keep mine up.

Chavez: The Four Suns; Selections from Piramide (Acts III, IV). Ambrosian Singers, London Symph. Orch., Chavez. **Columbia MQ 32685,** SQ quadraphonic, $6.98.

The old man of Mexican modernism, irrepressible as ever, brings on his reconstituted full-orchestra Aztecs again—two extraordinary ballet suites. *Suns* is 1925 and sounds it, a lively antique shocker; *Piramide,* undated, is clearly much later and atonal, a highly professional *tour de force* of sound. Both use totally pro-choral effects—a whole movement of rhythmic speech-chant (Act IV) in "P.", in some unidentifiable folk-language, marvelously projected by these unlikely Britishers. Highly worthwhile stuff, if maybe not quite Beethoven or Bach.

Schumann: Humoreske, Op. 20; Piano Sonata in F Minor, Op. 14. Jerome Rose. **Vox Turnabout TV-S 34533,** stereo, $2.98.

A pleasure these days to find Schumann so revivified; he was rarely understood by our earlier hardboiled-type modern pianists. The American plays right in the true tradition, sympathetic, musical, with plenty of power and lots of romance. Nicely recorded, too, and *not* a reissue.

Leonard Bernstein Conducts Haydn—Symphonies 93 and 94 ("Surprise"). N.Y. Philharmonic. **Columbia MQ 32101,** SQ quadraphonic, $6.98.

How to describe predictable Bernstein? I jotted on this disc cover "mushy around the edges." It's nicely musical Haydn but old-fashioned in styling, too big, slowish, and lacking in crispness. (Try old Beecham's even older-style Haydn, razor-sharp to the last note.) As so often, an honest, slightly sentimental rendering in a Romantic fashion, and lots will like it. Me too.

The Yellow River Concerto. (Also *San Pei March, Stars and Stripes, Pines of Rome.*) Daniel Epstein, pf., Phila. Orch., Ormandy. **RCA ARL1 0405,** stereo, $5.98.

Out of the "triumphant 1973 China tour," this is billed as a "first cousin of the *Warsaw Concerto*" with considerable honesty. Much less pretentious in sound than the *Warsaw,* it is far more drivelish, if pleasing. How can so many waste so much on this kind of nothing-music?? Also a Chinese and a U.S. March, and the usual *Pines,* one of Ormandy's standby standards. Had to put something on side 2.

Tape & Turntable

Bert Whyte

Rick Wakeman: *The Six Wives of Henry VIII*

A&M QU54361, SQ, $6.95.

Every once in a while a recording comes along that astonishes me with its sheer sonic impact and which evokes considerable emotional and musical response as well. This A&M SQ disc is in that rarefied category.

The recording turns out to be a sort of "suite" in which each of Henry's wives is the subject of a musical portrait, purportedly indicative of her character. So it is a gimmick . . . who cares? The important thing is that producer/arranger/keyboard artist *Rick Wakeman* is a multi-talented young man who has given us six highly imaginative and exciting "mini-tone poems," in a successful fusion of rock and classical musical elements.

The instrumentation Rick uses is loaded with Moog and ARP synthesizers, Mellotrons, an RMI electric piano, a Steinway grand, special Hammond organ, the organ of St. Giles church in Cripplegate, England, along with bass, guitar, drums, special percussion, electric banjo and five vocalists. The album was recorded in England, but the 4-channel mix was done at the A&M studios in Hollywood by Marv Bornstein.

Mr. Bornstein is to be congratulated on probably the best surround-type quadraphonic mix I have yet heard. Every musical element seems to come from a logical position, with much complementary localization. Even though there is a great deal of free-wheeling sound, the quad has an "organized," coherent feeling. The music is virtually tailor-made for quadraphonics, complexly structured, but nonetheless, musically entertaining.

The sound, as noted, is sensational. Every element is as clean as the proverbial hound's tooth (except, of course, for the fuzz boxes, which I still can't stand). The St. Giles organ is used to stunning effect in the "Jane Seymour" section, and beautifully integrated into the pop musical milieu. My Lafayette SQ-W decoder did a great job in creating a four-channel sound that appeared to be as close to discrete as I have ever heard from an SQ production. If you don't like this recording, you may as well give up on 4-channel!

The Best of Judy Collins

Stereotape/Elektra ESTQ5030QF, quadraphonic open-reel, 7½ ips, $11.95.

The Best of Bread

Stereotape/Elektra ESTQ5056QF, quadraphonic open-reel, 7½ ips, $11.95.

It is always a pleasure to welcome a new tape company, and especially one so solidly behind open-reel quadraphonic music. Such is Stereotape, a division of Magtec, located at 8125 Lankershim Blvd. N. Hollywood, California 91605. Stereotape has accomplished the remarkable feat of becoming the licensee for quadraphonic tapes from such companies as Warner Bros., Reprise, Elektra, Audio Spectrum, Nonesuch and most astonishing of all . . . RCA! They have a catalog sheet listing an initial 23 quadraphonic tapes featuring such groups as Seals and Crofts, The Doobie Bros., Carly Simon, Bread and none other than Frank Sinatra. I'm really looking forward to hearing ol' Frankie in quad! In a new release which should be available by the time you read this, there are fine classical items from Nonesuch and RCA. Actually most of the quadraphonic tapes are of material available on CD-4 Quadra-discs, so if you happen to have both open-reel quadraphonic and CD-4 playback facilities you can have the unique opportunity of comparing disc and tape. I did just that with both the ***Judy Collins*** and the ***Bread*** tapes listed above. For example, on the CD-4 recording of Bread, I detected some slight distortion in the voices in several cuts, and a number of people attributed this to a flaw in the CD-4 process. On this tape, careful listening reveals some of the same thing, albeit at an even lower level. Thus one has to conclude this was on the master, or the dubbing master. Aside from this very minute problem, Bread is excellently recorded with tasteful use of surround quadraphonic effects. Particularly effective in 4-channel is the Bread's famous ballad, *Make It With You.* I confess I'm not much of a Judy Collins fan, but those who are should enjoy this tape. It is a very clean recording, with

good, though somewhat understated quadraphonic effects which, from the nature of the music, is probably the correct approach. Stereotapes has done a fine processing job on these tapes with commendably low tape hiss. I should mention that the RCA release will also feature pop material including some of the well-known Mancini and Montenegro productions. Stereotape is off to an auspicious start in its quadraphonic tape program, so best wishes, and may they flourish!

Carly Simon: *No Secrets*

Elektra EQ5049, Quadradisc, $6.95.

Carly Simon is an attractive young woman with extraordinary talent. She plays the acoustic guitar and piano, composes, and writes the lyrics for much of her music, and sings in a very engaging, pleasantly "folkish" kind of voice, free of the nasality with which most of the current crop of folk singers seems to be afflicted. If Carly Simon has already achieved a certain fame, it is sure to grow because of this CD-4 recording. That is because this disc is widely used to demonstrate just how good the CD-4 process can be. The recorded level appears to be equal to a normal stereo disc. The bass is positively massive and the drums are very solid with great impact. The recording is bright and clean with much forward projection. The quadraphonic aspects are just fine, with precise localization of the various musical elements, yet the front/rear balances are sensible and you are immersed in a most pleasing sound field. Top everything with the fact that the music is consistently interesting, with excellent arrangements and some amusing lyrics.

This superb recording was made in London, remixed in Los Angeles and London, and I note that the very high quality disc cutting was done by Doug Sax of the Mastering Lab in Los Angeles, who did the remarkable direct-to-lathe Sheffield recordings. All in all, this is a premier recording which adds considerable lustre to the CD-4 process.

Handel: *Royal Fireworks Music* (original scoring); *The Water Music*. Johannes Somary conducting the English Chamber Orch.

Vanguard VSQ30020, SQ, $6.98.

Original scoring in the case of the *Royal Fireworks Music* means such items as 24 oboes, 12 bassoons, 2 contrabassoons, 2 serpents, 9 trumpets, 9 horns, 3 tympani and 2 side-drums. As you might expect, such an array can produce a fulsome sound indeed! For

all of it, and as interesting as much of it is, I still prefer the more familiar *Water Music*. Johannes Somary is well-known for his splendid Handelian interpretations, and here he is in his element. Those sections which call for the "stately tread," receive their due, and on the other hand his "Hornpipe" is properly ebullient. The sound is quite lovely . . . excellent instrumental balances in a spacious acoustic perspective, heightened by the rear-channel ambience pleasingly presented by the SQ recording.

Ronnie Aldrich: *Come to Where the Love Is*. Two pianos with the London Festival Orch. and chorus.

Ampex/London J17190, quadraphonic open-reel, 7½ ips, $12.95.

To indulge yourself in this recording you must have a quadraphonic open-reel tape deck, and ancillary equipment, and a fondness for the piano artistry of *Ronnie Aldrich*. Given such, you can literally drown yourself in a sea of four-channel discrete sound. My word! Talk about Ronnie's antics with his pianos and engineer cohorts in stereo . . . wait till you hear them in 4-channel. Overblown it may be, but the sound quality is exemplary, and even tape hiss is fairly low. Ronnie tickles his way through some typical ballads, and say what you will, the chap can really play quite well. Nothing earthshaking here, but a welcome addition to the quadraphonic open-reel library.

The World's Greatest Jazzband of Yank Lawson and Bob Haggart

Project Three PR4C-5033, quadraphonic open-reel, 7½ ips, $11.95.

For quad open-reel devotees, ***Enoch Light*** has been foremost in keeping faith with this medium. He continues to produce exciting high quality quad recordings at regular intervals. This recording of the World's Greatest Jazzband is a resounding success. The band is an ebullient, free-swinging group that plays with the zest and verve expected of such polished professionals. There is a Dixie accent given to such tuneful standards as *Limehouse Blues, Sunny, Bugle Call Rag* and *Baby, Won't You Please Come Home,* as well as a more contemporary treatment of such as *Ode To Billy Joe, Up, Up, and Away,* and *Mrs. Robinson*. The surround-style recording is big, bright, super-clean, brazenly brassy as a group like this should be. As usual, Enoch handles the dynamics of quad with his deft touch in instrumental positioning and logical front/rear and corner-to-corner balances. As a bonus, tape hiss is quite low, even at loud playback levels.

Jazz & Blues

Martha Sanders Gilmore

JUNIOR MANCE: The Junior Mance Touch

Musicians: Junior Mance, piano; Martin Rivera, bass; Richard Pratt, drums.

Songs: *Zabuda; Let's Stay Together; Tin Tin Deo; Midnight Special; I Can See Clearly Now; Where I Come From; Something.*

Polydor, PD 5051, stereo, $4.98.

This recording sets out to bear out the fact that Junior Mance is a very special pianist—and does so. His style is at once given to percussiveness and gentility. He can come on as strong as a thunder bolt, then can play soft tinkling passages that sound like gently falling raindrops.

But Mance has come a long way in forming his present trio, having played with some of the giants of all jazz time. After having studied privately for a few years, Junior Mance took a major in music at Roosevelt College in his own native Chicago. Mance accounts among his early influences Art Tatum and the boogie-woogie pianists and later Bud Powell and Ahmad Jamal. (Indeed, there is a good deal of the latter in Mance's approach.)

Mance joined the Gene Ammons group in 1947, working with "Jug" for two years. He then spent a year with Lester Young and afterwards rejoined the Ammons organization. After a two-year stint in the Army where he formed a friendship with Julian "Cannonball" Adderley, Mance returned to Chicago where he joined the rhythm section of the Bee Hive Lounge, backing up such jazz greats as Charlie Parker, Lester Young, and Coleman Hawkins.

Mance joined vocalist Dinah Washington in 1954 as her accompanist, then held tenure with the Cannonball Adderley Quintet which further broadened his range of musical expression. But the "turning point" in his career came in 1958 when Mance joined the Dizzy Gillespie Band, which toured Europe and the United States to widespread acclaim. He backed up singer Joe Williams for two years, then in 1961 formed his own trio which he has had until this very day.

Junior Mance is an accomplished composer as well as performer, his most popular compositions being *Jubilation, The Uptown, Happytime, That Mellow Feeling, Harlem Lullaby,* and *Where I Come From* which is included here. It is basically a stop-and-go blues in which Mance demonstrates his excellent ability to create excitement. He builds into quite a tumult alongside his long-time bassist Marty Rivera, who does yeoman's duty here. The two together truly swing and it's good down to its last note.

Mance's strident, percussive technique is well borne out in *Zabuda* which is, incidentally, written by his accomplished bassist Martin Rivera. It is a bluesy Africanese tune full of tremelos and one that is indicative of Mance's ability to build dynamic peaks.

Let's Stay Together is quite the contrast, a ballad with Mance and strings—arranged and conducted by Bill Fischer—that are in good taste and do not intrude, being merely thrown in as an extra adornment. Mance is a pianist of few and highly selected notes, a pianist who brings all his tunes around full circle.

Mance punctuates *Tin Tin Deo* chord-wise and notewise, providing lots of pauses that refresh, cooking along naturally. He is above all a very natural pianist. There are no superfluous hi-jinks to his art. The music fairly flows out of him as he ends *Tin Tin Deo* with a crash, bang, and glissando to the lower keyboard.

Leadbelly's *Midnight Special* is a perfect vehicle for Mance, a slow, sideling, exceedingly bluesy blues. However, one finds oneself listening to Mance's unfortunately unidentified backdrop here which includes a harmonica player and guitarist instead of Mance.

Mance's treatment of George Harrison's *Something* is a pensive, jewel-like statement of this popular favorite which is apt to lull you to sleep. But he builds quite a momentum in *I Can See Clearly Now*, a gospel tune with a *Bridge Over Troubled Water* feeling to it which features Richard Pratt's very adept use of sock cymbal with a little bit of militant snare thrown in.

The audio throughout this recording is absolutely excellent, clear and well separated.

I must agree with the critic who so well described Junior Mance as "a piano precisionist whose fingers move from whispered poetry to utterances of the highest vivacity."

Performance: B+ Sound: A

RUBY BRAFF & ELLIS LARKINS: The Grand Reunion

Musicians: Ruby Braff, trumpet; Ellis Larkins, piano.

Songs: *Fine and Dandy; I Want a Little Girl; Skylark; The Very Thought of You; If Dreams Come True; Liza; Easy Living; Love Walked In; Things Ain't What They Used To Be; Ain't Misbehavin'.*

Chiaroscuro CR 117, stereo, $5.98.

Trumpet man Ruby Braff and pianist Ellis Larkins have come up with an exceedingly thoughtful and mellifluous collaboration on Chiaroscuro for which we bless them both. It is all accomplished without the assistance of bass and drums and is all the more pure for it if not all the more difficult to make succeed. But these two well-seasoned jazz veterans do succeed and the thought of supplementing their sincere artistry with those rhythmic backdrops of bass and drums simply and, strangely enough, does not even enter one's mind.

Braff's musical credentials are many although he is a striking example of a jazz musician who has received critical acclaim without it necessarily resulting in work for him. For in 1960 Braff reported that he had been out of work almost continuously for the past five years. Truly an enigma—it boggles the mind—when one considers that Braff has played with jazz men such as Bud Freeman, Urbie Green, Pee Wee Russell, Gene Ramey, George Wettling, Joe Sullivan, and Edmond Hall. And it is also curious to note that one Reuben Braff had an acting role in Rogers and Hammerstein's musical "Pipe Dream," vintage 1955-56. But Braff made a comeback this past summer at Newport in a stunning performance with guitarist George Barnes at a full-to-overflowing concert in Carnegie Hall.

One must also give pianist Ellis Larkins credit where credit is due. Larkins is a classically trained musician, having studied at the Peabody Conservatory of Music and at Juilliard. What better credentials could one ask for? Larkins went on from there to make his debut at the Cafe Society-Uptown with the Billy Moore Trio, then formed his own trio. Larkins, as we witnessed this past summer at Newport when he accompanied songstress Ella Fitzgerald, is also most successful as an accompanist for various singers. He lends just the exact amount of shading to their voices and is attentive to every nuance and watchful of the sheerest details which certainly comes through on this LP as well.

This is as fine a collection of evergreens and old standards as you will ever run across including tunes by Hoagy Carmichael, Ray Noble, George Gershwin, Duke Ellington, and Fats Waller, only to name a few. Braff's rendition of *Fine and Dandy* contains his usual fine and mellow embellishments with Larkins right beside him playing with a smooth, graceful flow. That Larkins is an exceedingly even

pianist is further demonstrated in his *I Want a Little Girl* which is a real tear jerker with Larkins in a real bluesy bag. There is a tremendous side-wise movement to his piano style.

Ruby Braff begins Ray Noble's *The Very Thought of You* in an interesting way—at the end of a phrase, bending notes and showing off his sky-wide range. One of the shortest tunes here and one of the best, it has Braff swinging richly.

If Dreams Come True has a lazy, unhurried tone about it—as does the entire album. Larkins' pianistic lines are meticulously pruned of all excesses as he delays precisely the right amount of time after every note. Braff uses his mute here to his best advantage, putting a spirited ending on it.

The Gershwinesque quality about Larkins' style is borne out in Gershwin's *Liza* which is beautifully executed by the pianist. Braff holds a high note for an inordinate length of time and it is interesting to hear what they do with this old-timer. Braff's sureness and steadiness as a musician comes across in *Easy Livin'* in which he plays very tenderly. And in spite of Larkins' steady left hand his delivery is always unpredictable and provocative.

The two musicians demonstrate their compatibility in *Things Ain't What They Used To Be* which includes some out of character, strident, muscular chords by Larkins with his creeping, walking up bass left hand. The two swing together hotly on this one, really communicating as Braff makes his horn talk to us, literally speaking through it. And in Waller's *Ain't Misbehavin'* Braff quotes from *Slaughter on 10th Avenue* and *Let's Fall in Love* as he slips back and forth easily from octave to octave. Larkins' playing simulates a rippling brook in *Skylark*, his notes cascading forward, falling one upon the other. The pianist tacks on a beautiful ending.

Each piece here is unrushed and well developed. But if I have any reservations about this LP it is that there is perhaps not enough variety here and there is a bit of fuzziness about the sound reproduction.

But this recording is truly a "grand reunion" and it is one of which you will never tire. It will put you in a mellow mood, guaranteed!

Performance A– Sound B–

HORACE SILVER: In Pursuit of the 27th Man

Musicians: Horace Silver, piano; Randy Brecker, trumpet; Mike Brecker, tenor sax; Bob Cranshaw, bass; Mickey Roker, drums; Dave Friedman, vibes.

Songs: *Liberated Brother; Kathy; Gregory is Here; Summer in Central Park; Nothing Can Stop Me Now; In Pursuit of the 27th Man; Strange Vibes.*

Blue Note, $5.98.

The first side of this album is dynamite. *Summer in Central Park* is one of the lightest and liveliest jazz waltzes I've heard. It truly evokes the bright, airy feeling one has walking through the park on a lovely summer day. *Kathy* is another light composition. It has a Latin feel in 5/4. There are inspired solos by Dave Friedman on both cuts. Rhythmically speaking, *Liberated Brother* and *Gregory is Here* have Latin-rock type feels—the former being a cha-cha and the latter a slow mambo. *Gregory is Here* has the nicest chord changes of any of Horace's compostions. Mike Brecker's solo is his best on the date here. He demonstrates his growing reputation as one of the finest young tenor players around. Brother Randy follows with a solo, showcasing his finesse on trumpet. Like the solos on *Gregory is Here*, on all four cuts the musicians say what they must in just a few choruses each. All solos on the side are exactly the optimum length.

The rhythm section lends ideal support to the group. Cranshaw and Roker have been doing studio dates in New York for some time together. They are familiar enough with each other's playing to add another dimension to the rhythm section which couldn't be had using a bassist and drummer who don't work together as often as these two do. Cranshaw excutes good time and throws in some nice licks as well. Without overplaying, Roker reinforces the time and punctuates it with good taste. Horace's big block chords bind the section together.

The quality of the recording is excellent. The cover is an attractive book type with two pictures of Horace in gym shorts and jerseys with different numbers. The numbers have meaning to Hoarce and could be explored further if this were a horoscope. This is a positive review and I don't want to ruin anyone's impressions by saying that side two is repetitious, and not as refreshing and enticing to come back to as side one. So, forget that I said that. The group is on the road now. I recently saw them in Philly. They are an exciting quintet with Randy Brecker. Get out and see them. If you don't have the album, you'll want it. And, you'll realize the album is well worth the price—even if only for side one. *E.N.*

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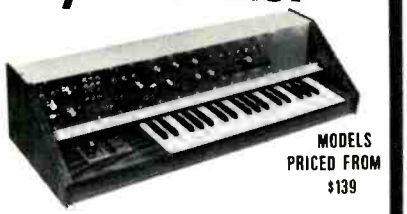

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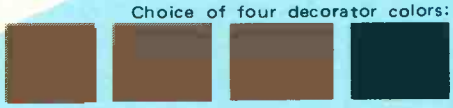

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I bought a Marantz 4 channel receiver because I refuse to be stuck with an electronic antique.

Not one to tolerate obsolescence (planned or unplanned), I considered the stereo vs. 4-channel question carefully, then purchased a Marantz receiver for three compelling reasons.

One. Marantz has Dual Power. This means you get full power of four discrete amplifiers working all the time. When you're listening to regular 2-channel tapes and records you can combine the power of all four channels into the front speakers. This means even if you're not ready to commit yourself to a complete 4-channel system, you can buy Marantz now and when you get the other two speakers just flip a switch. You have 4-channel. Meanwhile, you're not compromising 2-channel because you're getting more than twice the power for super stereo.

Reason number two. Marantz receivers feature the exclusive snap-in snap-out adaptability to any 4-channel matrix decoder. This means that your Marantz stereo will never be made obsolete by any future 4-channel technology because the Marantz snap-in SQ* module is designed to keep up with the changing state of the art. What's more, Marantz receivers have Vari-Matrix—a built-in circuit that will synthesize 4-channel sound from any stereo source (including your stereo records and tapes) and will also decode any matrix encoded 4-channel disc or FM broadcast.

Reason number three. Marantz receivers, from the Model 4230 up, feature built-in Dolby** noise reduction to bring you the quietest FM reception ever. And you can switch the built-in Dolby into your tape deck for noise-free, no-hiss recording from any source. A real Marantz exclusive.

I chose the Marantz Model 4270 because it suits my needs perfectly. It delivers 140 watts continuous power with under 0.3% distortion. And it's literally loaded with features. However, your requirements may be more modest than mine. In which case you can own the Marantz Model 4220 which delivers 40 watts with Dual Power. Or you can go all the way and get the Marantz Model 4300 with 200 watts. It is the very best. Choose from five Marantz 4-channel receivers from $299 to $899.95.

The point to remember is this—whichever model Marantz 4-channel receiver you do buy, you can buy it today without worrying about its being obsolete tomorrow. Look over the Marantz line of superb quality receivers, components and speaker systems at your Marantz dealer. You'll find him listed in the Yellow Pages. Think forward. Think Marantz.

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*SQ is a trademark of Columbia Broadcasting System, Inc.
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