AUDIO

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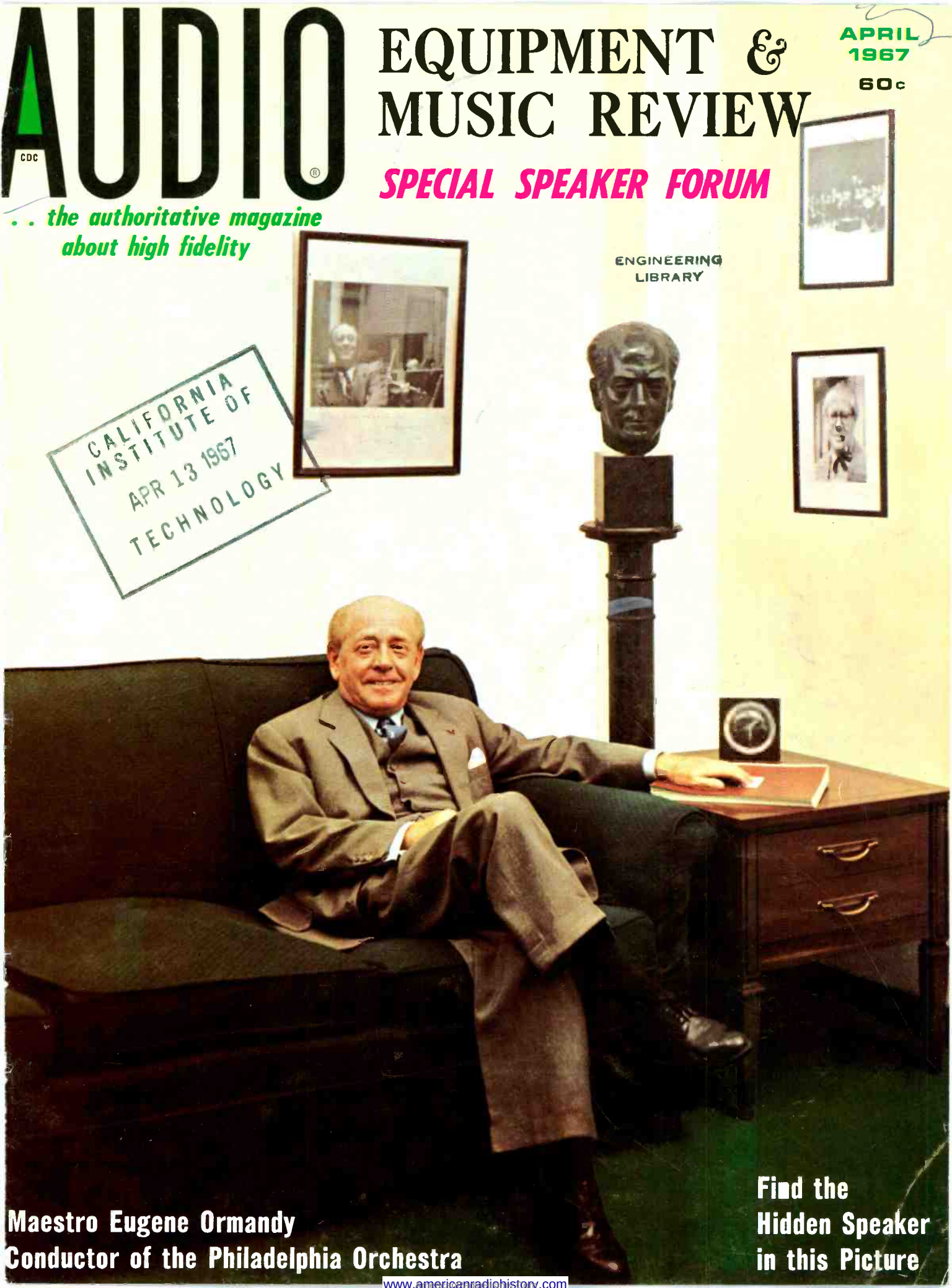
EQUIPMENT & MUSIC REVIEW

APRIL 1967
60c

SPECIAL SPEAKER FORUM



Maestro Eugene Ormandy
Conductor of the Philadelphia Orchestra

Find the Hidden Speaker in this Picture

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You bring the wheels . . . Scott's got the speakers! Scott's all-new S-11 speakers are absolutely unparalleled in performance. To prove it to you, Scott wants you to listen to a pair at leisure, in your home, with your own equipment, at no cost or obligation. Test these speakers with your favorite records, with FM stereo . . . even with AM. Compare them with your present speakers . . . regardless of cost. Once you've enjoyed Scott's new S-11 speakers in your home, you'll never again be satisfied with any other speaker.

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AUDIO

April, 1967 Vol. 51, No 4

Successor to RADIO, Est. 1917

AUDIO Articles

AUDIO Reviews

AUDIO Profiles

AUDIO in General

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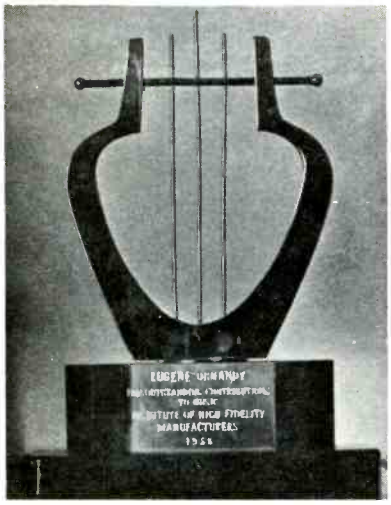
Coming Articles

Next month AUDIO celebrates its twentieth anniversary. This will be a gala affair so do not miss it. Be sure to be with us in May. There will be all the regular features and columnists, expanded record reviews, and the Equipment Profiles — plus a host of surprises from out of the past.

On the Newsstands, at your favorite audio dealer's, or in your own mailbox.

About the Cover



Maestro Eugene Ormandy relaxes in his Academy of Music dressing room after a rehearsal session with the Philadelphia Orchestra. Our hidden speaker system is in the end table on which his hand rests. A complete construction article is on page 19. Maestro Ormandy kindly consented to pose with the speaker in order to tie in our cover with the subject of this feature article, although he does not own such a speaker. The IHF lyre pictured above testifies, however, to the invaluable contributions that Maestro Ormandy has made to the cause of recorded music. We can only echo the statement of the inscription, "For Outstanding Contributions to Music." Photo by Mano Mehanian of Philadelphia.

AUDIO CLINIC

Joseph Giovanelli

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.

Potentiometers

Q. I have problems on which I would appreciate your advice.

1. I am confused as to the type of potentiometer to use with audio circuits. I have heard of linear-taper pots and audio pots. What is the difference between the two types?

2. The volume control in question is a 0.5-megohm pot. The amplifier involved here is quite a powerful one. So great is the amplification that I do not have control over the output. With the present control it is barely sufficient to open the pot to reach a very loud output. I would like to know if I should increase or decrease the resistance of this pot to give me more latitude of control over this amplifier.

3. I am building an integrated control console for my audio system. I wish to remove the volume control from both of my amplifiers and move the controls to my control panel, using low-loss mike cable to and from the pots. How far may I safely locate the remote volume control from the power amplifier without loss of frequency response and/or hum pick-up? Joseph H. Lanford, Woodruff, S. C.

A. 1. For use in audio amplifiers, a potentiometer should have an audio taper rather than a linear taper. A linear taper potentiometer changes resistance uniformly with uniform rate of shaft rotation. To state this another way, if three degrees of shaft rotation produces *X* change in resistance, another three degrees of shaft rotation will produce *X* change in resistance. The log or audio taper pot works as its name implies. The resistance of the potentiometer changes at a logarithmic rate when the shaft is turned. At one end of the rotation a three-degree shaft rotation will produce a small change in resistance. At the other end of the pot shaft's rotational arc, the same amount of shaft rotation will produce a considerable change in resistance of the pot. The log pot is preferred because the ear does not respond uniformly to changes in volume. By using a pot having an audio or log taper the characteristics of the pot will match those of the ear. Thus, a given amount of shaft rotation of the pot will produce a certain change in loudness as heard by the ear. A similar rotation further along the course of the shaft's rotational arc will produce a similar change in loudness.

2. Changing the impedance of the potentiometer will not reduce the sensitivity of the amplifier or allow for easier control over the volume. Lowering the pot's impedance may reduce bass response because of voltage-division action between the resistance of the pot and the reactance of the coupling capacitor feeding it. If you wish to reduce the effect of a potentiometer, place a resistor in series with the "hot," or ungrounded, end of the pot. If the value of the resistor is equal to the resistance of the pot, the attenuation offered by this arrangement will be six dB. The potentiometer will exercise somewhat greater control over the amplifier volume. In other words, it will take a greater amount of shaft rotation to achieve a change in level than is at present possible. If you still do not have a sufficient amount of control, make this resistor still larger in value.

3. You must keep the leads from the potentiometer as short as possible so as not to lose highs. Use RG63U cable as interconnecting lead for the pot. The lead which is the most critical is the one between the arm of the pot and the grid of the tube in the amplifier. I do not think you should exceed three or four feet of cable length for this grid line.

To make a remote volume control operate with the least possible loss of highs, isolate the pot wtih cathode followers. Build them into your control unit. If the lead between the high side of the potentiometer and its feedpoint is not long, no cathode follower need be used here. Further, if the impedance of the feed point is low, then once again I can safely say that no cathode follower need be used there. However, you must use such a circuit between the arm and the grid to which it is connected if losses of highs are to be avoided. The cathode follower will not introduce any significant distortion.

This arrangement will allow you to run a virtually unlimited length of cable, at least insofar as most practical installations are concerned.

Piano Recordings

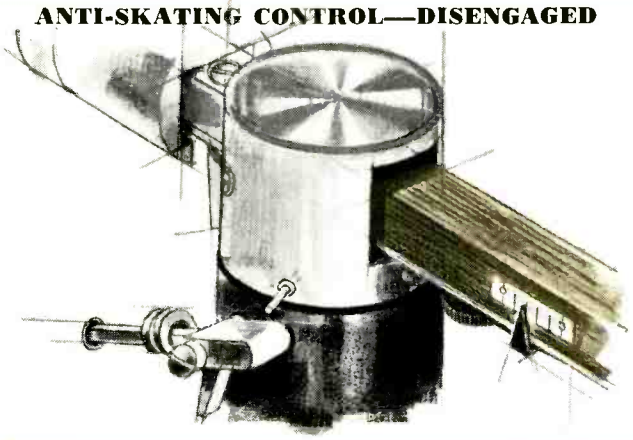
My queries all have to do with recording a grand piano in a small living room. Other than taping favorite works from FM, this is my principal use for

GARRARD'S LAB 80 MK II...

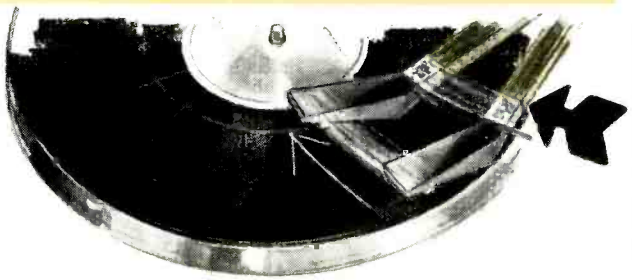
HOW THE PATENTED ANTI-SKATING CONTROL ELIMINATES A CAUSE OF DISTORTION AND PROLONGS RECORD AND STYLUS LIFE

Due to the offset angle of any cartridge, and the rotation of the record, all tone arms have an inherent tendency to move inward toward the center of the record. This "skating force," a definite side pressure against the inner wall of the groove, is a major cause of poor tracking, right channel distortion and uneven record wear. The Garrard Lab 80 MK II is fitted with a patented, adjustable anti-skating control consisting of a simple arm with a sliding counterweight which is set along a calibrated scale. To obtain the correct anti-skating compensation, the counterweight is moved to a position along the scale corresponding to the stylus pressure reading on the tone arm. The anti-skating device then accurately cancels out the tone arm side pressure. This insures flawless reproduction through perfect tracking of the most advanced cartridges... those with the highest compliance and frequently the most critical stylus assemblies. Since the Garrard anti-skating control uses no springs or other delicate balancing devices, it remains accurate permanently. These illustrations explain how the anti-skating feature operates on the Lab 80 MK II...$99.50, less base and cartridge. Anti-skating controls are also built into Garrard's 70 MK II and 60 MK II. For descriptions of all five Garrard models, write for complimentary Comparator Guide to Garrard, Dept. AD-1, Westbury, N.Y. 11590.

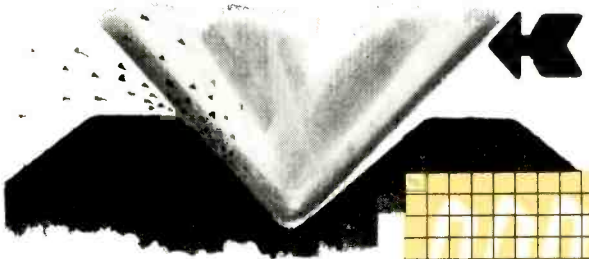
ANTI-SKATING CONTROL—DISENGAGED



The anti-skating arm can be turned over and out of operation. This permits the tone arm to track as if there were no anti-skating control. Now, when the Lab 80 is started there will be the normal tendency, present in all tone arms, for the stylus to exert a side pressure (skating force) toward the inner wall of the groove... causing distortion and uneven wear on record and stylus. The inner wall may be prematurely worn, while the stylus pulls away from the outer wall.

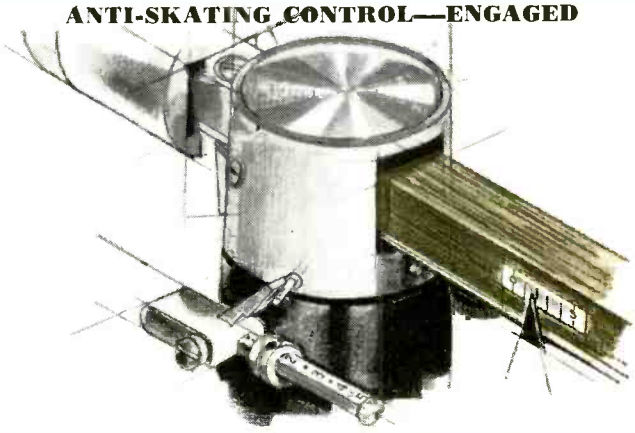


If this record surface were flat (without grooves) the arm would literally skate across to the center, as you see in this illustration. Garrard dealers are supplied with grooveless records and can demonstrate the action for you.

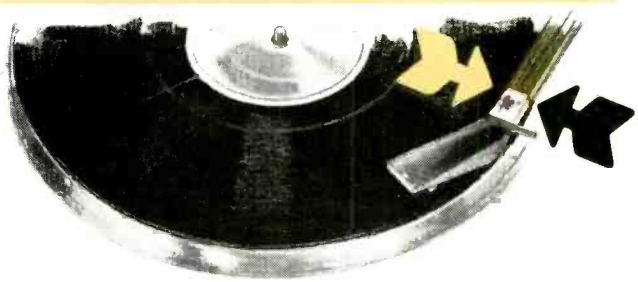


On the oscilloscope—tracking without anti-skating control, sine wave form shows considerable distortion.

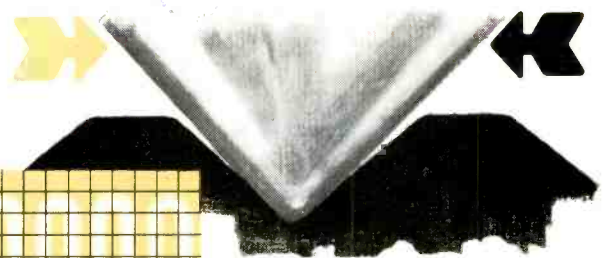
ANTI-SKATING CONTROL—ENGAGED



With the anti-skating control in position (as it is kept, once the correct pressure is set) the tone arm tracks perfectly. The side pressure (skating force) toward the inner wall of the groove is neutralized by an equal side pressure toward the outer wall exerted by the anti-skating weight. Favoring neither side, the stylus tracks with a minimum of wear to itself or to the delicate record groove wall. Free of this distortion-causing factor, the sound emerges cleaner.



Playing a grooveless record (as in the illustration), the arm remains in one position as if tracking a groove(!)...a dramatic demonstration of the perfect performance of the Lab 80, which your Garrard dealer will be happy to show you.



Tracking with anti-skating control, the sine wave form becomes a clean picture of the output of the cartridge.

THESE OSCILLOSCOPE READINGS BASED UPON 1,000 CYCLE, 30 CM PER SEC. TEST RECORD AS SIGNAL SOURCE.

Check No. 103 on Reader Service Card.

my tape recorder. The following are the fixed parameters:

1. Tape recorder.

2. Room size, 14 feet x 16 feet x 8-foot ceiling. The ceiling is made up of a number of squares and rectangles of acoustic tile, 70 per cent absorbent.

3. The furniture is all "hard."

4. Walls are plastered stone; the floor is oak parquet without a rug.

My problem is: What might I try which might improve recording acoustics? The recordings that I make all have that tinny, "home-recorded" quality. So far I have only experimented with different types of microphones and their placement. The best results I have had were with a dynamic or an ancient velocity mike. The best placement seems to be suspended from the ceiling just outside the opening of the piano. I know you cannot recommend specific makes, but, can you suggest the most suitable generic type?

What about the room acoustics? Would a rug help appreciably? How about a drapery behind the piano? W. W. Moyer, Creamery, Pa.

A. For a long time I was faced with your very same problem. I cured it in a couple of ways. First of all, I used good acoustic tile, completely covering the ceiling. Further, there is a thick rug on the floor. Fortunately, too, there are some rather large, over-stuffed pieces of furniture in my living room. In short, when the room is too small for the recording job, about all you can do is to deaden the acoustics and rely on the direct sound from the piano to do a proper job of recording. If the sound produced is too "dead," you can often help the situation through the use of some kind of artificial reverberation. I have found that velocity microphones do a good job. However, I also have had success with an omnidirectional capacitor. Both of these mikes were suspended just to the right of the treble section of the piano and about two feet above it. In my particular room the mike must be placed almost dead in line with the treble end of the keyboard, but this position probably will vary somewhat from room to room.

There is a variable which must be taken into account. The piano may be to blame for your poor recordings. You should really listen to the piano you are using. See if the recordings that you make are, indeed, all too similar to the poor sound made by your instrument.

I have an old Steinway here, dating back to 1885 or thereabouts. The piano is old enough so that it was made with only 85 keys rather than the usual 88 keys. It replaced a "clunker" I had here which never sounded right when recorded. I finally listened to the instrument very carefully and discovered that my recordings were all too faithful.

If you have too brittle a quality from your piano, it may well be that your piano action needs to be voiced down a bit. This is done by first filing the hammers smooth, removing the convolutions placed on their surfaces by their impacting the strings. Next, they are "needled" with a special tool made for this purpose. The results of this needling are to fluff up the felts on the hammers, making them softer. If the amount of filing has been great, it might then be necessary to change the let-off somewhat so that the stroke is correct. Failure to do this might leave the hammers too short of the strings upon their release by the escapement mechanism in the action.

At times, better over-all sound can be obtained when the recordings are made in stereo. The added perspective often makes up for other deficiencies which your recordings may have. Æ

Industry Notes

In the latter part of April, the Philadelphia Daily News will publish what is the second of four pull-out sections in 1967 promoting the Hi-Fidelity/Stereo industry.

Last year marked the first year that the News departed from the usual procedure of running supplements only when there was a Hi-Fidelity Show in Philadelphia. Local dealers decided that once every two years was too long a period to wait for a promotion . . . after all, they were open for business every day of the year.

So, in 1966, due to close cooperation between the Daily News and local dealers, reps, and manufacturers, four supplements were published. Each supplement, published in February, April, September, and November, featured a color opener and editorial write-ups on local dealers. In on-the-spot interviews, dealers discussed their feelings about innovations and improvements in the industry and the prospects for the future. Featured also was up-to-the-minute information on the latest developments in Hi-Fidelity and Stereo equipment. Because of the support of these dealers, their reps and manufacturers, the News was able to publish a total of 72 pages of editorial and advertising on Hi-Fidelity and Stereo equipment. No other newspaper in the City of Philadelphia has been able to gather such support.

In this section, there will be 24-plus pages introduced by a full-color cover, localized editorial comment, and photo coverage. Finally, the supplements will be distributed to the readership of the Daily News. In addition, copies will be furnished by the News to local colleges, universities, and to participating dealers for in-store merchandising.

It is our impression that this is the largest, most comprehensive promotion of the Hi-Fidelity/Stereo industry in newspaper history. Æ

The man with the golden ear

17½ cubic feet of sound in your living room requires two basic essentials. The first is a Golden Ear to catch every nuance. The second, rather obviously, is a permissive wife. Some men have both (unbelievably) and have installed the actual Altec A7 "Voice of the Theatre"® in their living rooms. This is the same system that has become standard for recording studios, concert halls and theatres. However, if your wife is something less than permissive, Altec has the answer. ▪ We have taken all A7 speaker components and put them in a single package. *Half the size.* The same high-frequency driver. The same cast aluminum sectoral horn. The same 15" low frequency speaker. The same crossover network. ▪ Frequency response is unbelievably wide (beyond the range of human hearing, if that's of any interest). The midranges are "in person" and that's where 90% of the sound is. Basses don't growl and groan. Trebles don't squeal. ▪ Styling? The hand-rubbed walnut Valencia has a delicately curved wood fretwork grille. The oak Flamenco is pure Spanish. Send for your '67 Altec catalog or pick one up from your dealer. Compare. Buy. If the wife complains, tell her about your Golden Ear.

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Check No. 106 on Reader Service Card.

Fundamental AUDIO

MARTIN LEYNARD

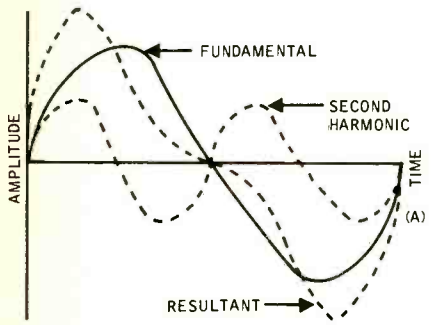
The Shape of Waves

LAST MONTH WE DISCUSSED the harmonic content of musical sounds, and saw that, while a tone's fundamental frequency determines its pitch, its harmonic content determines its character; this is why "E" sounds different on a violin than on a piano.

Every musical waveform can, therefore, be considered as a mixture of different waves, each with its own frequency and amplitude, and each with its own peaks and troughs occurring at different times and places. But if we consider each peak as a positive voltage, and each trough as a negative one (as is the case when sound-waves become electrical signals), then it becomes obvious that we cannot have both positive and negative voltages occurring simultaneously in the same signal. Instead, the voltage at any instant is the sum of all the individual peaks and dips occurring at that instant. Where the peaks of two equal and identical waves coincide they add to form a wave of identical frequency but with twice the amplitude of either alone. Where each peak of a wave meets the trough of a wave of the same frequency and amplitude, they cancel.

But where waves of different frequencies and amplitudes meet—as in the mixture of fundamentals and harmonics of a musical tone—they cancel in some places and reinforce in others, producing a complex wave form (*Fig.* 1).

Because each musical instrument produces a different mixture of overtones, each has a distinctive waveform. *Figure* 2 shows several such musical waveforms. The same instrument will also produce different waveforms when making different sounds: *Figure* 3A is the waveshape of the author's voice, with the author saying "eeee"; 3B is the author again, saying "aaahh," with exactly the same pitch and just about the same volume.



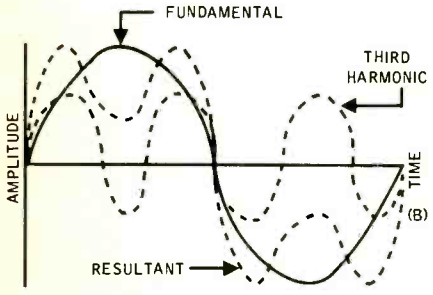


Fig. 1. How a complex wave is built up from a fundamental and an overtone.

The Life Cycle of a Wave

Each of the photographs in *Figs.* 1 and 2 show a brief moment (1/25th second) in the middle life of a tone, after the tone's beginning, but before it showed any appreciable decay. If you examined the entire life of a tone, you would find that this life could be divided into two, and sometimes three periods. These periods are: attack (from the moment energy is first applied to the tone-producing object to the time the tone reaches its full amplitude), steady state (the period during which the note is sustained) and decay (the period during which energy is removed from the tone-generating system). Some instruments, such as the piano are "lightly damped," and the tone will sustain itself for quite a while until the key is released. Releasing the key allows a damper to fall against the string and absorb its remaining energy, whereupon a rather rapid decay sets in. Other instruments, such as the guitar, are so heavily damped that the decay and steady-state periods coincide. (Of course, if the piano key were held indefinitely, its tone would eventually fade out, producing a graph more like that of the guitar, but ending far further to the right; and the guitar tone could be cut off by damping the string with a finger, resulting in a shorter version of the piano graph.) However, the human voice is a rather different story. For in speech (and in wind instruments),

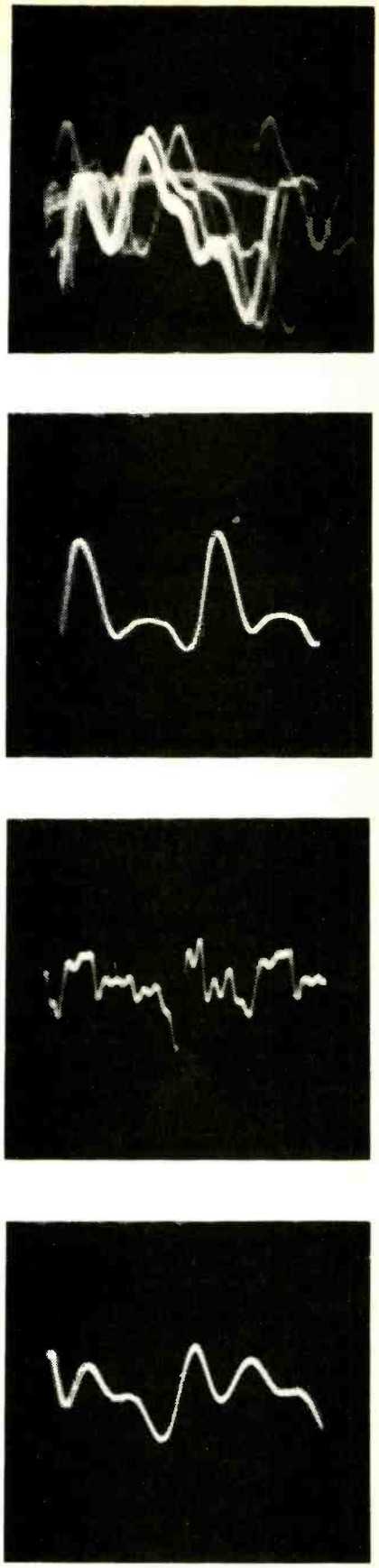


Fig. 2. Musical waveforms illustrated top to bottom: piano; electric bass; pitch pipe; flute.

If you think Gotham Audio sells only one product

You're too close to the mike

We're famous as the sole U.S distributor of the world's finest microphone.

Maybe too famous.

Sometimes our unwary friends are so dazzled by Gotham's association with Neumann, that they overlook our other products and services.

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Audio Specialist Symposium Scheduled for Spain

The newly formed International Society of Audio Specialists has announced its first symposium—open to dealers, distributors, audio specialists, and anyone interested in audio, both here and abroad—to be held in Torremolinos and Madrid, Spain. Leaving New York on Sunday, May 21, the group will proceed to Torremolinos, on the Mediterranean, traveling by PAA jet. Three seminars will be held there in the mornings, with the afternoons free. On Saturday, May 27, the group moves to Madrid for the remaining two morning seminars, and returns to New York on May 31.

Seminar speakers include Donald Aldous, technical editor of the British *Audio/Record Review;* Herb Horowitz, of Empire Scientific; Jack Trux, of Ampex Corporation; Tjard G. A. Schmidt, of ELAC; Richard J. Katz, of Katz, Jacobs & Co. Advertising; C. G. McProud, AUDIO's editor, is program chairman. Full details about this symposium, including costs of the all-expense,paid trip, eligibility, and the many side benefits, may be obtained from the International Society of Audio Specialists, 162 E. 64th St., New York, N. Y. 10021.

NOTE: Although the editor of AUDIO is serving as Seminar Moderator, it should not be construed that AUDIO is in any way co-sponsoring the event.

the tone-generating system is excited continuously, not just plucked or tapped once and allowed to resonate until decay sets in. Thus the tone is more evenly sustained, and can in fact be held as long as the speaker's (or instrumentalist's) breath holds out—forever, in an electrically-blown organ.

Wave shapes do influence our recognition of tones, not only in speech but

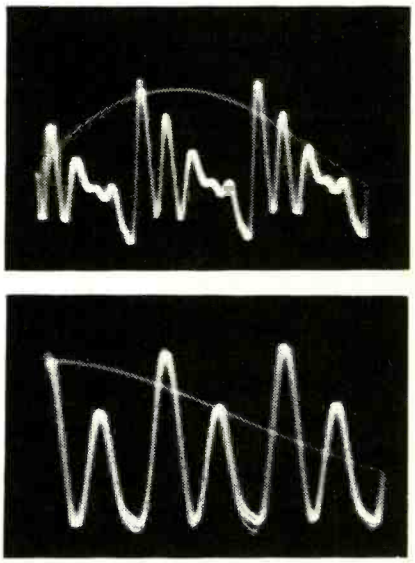


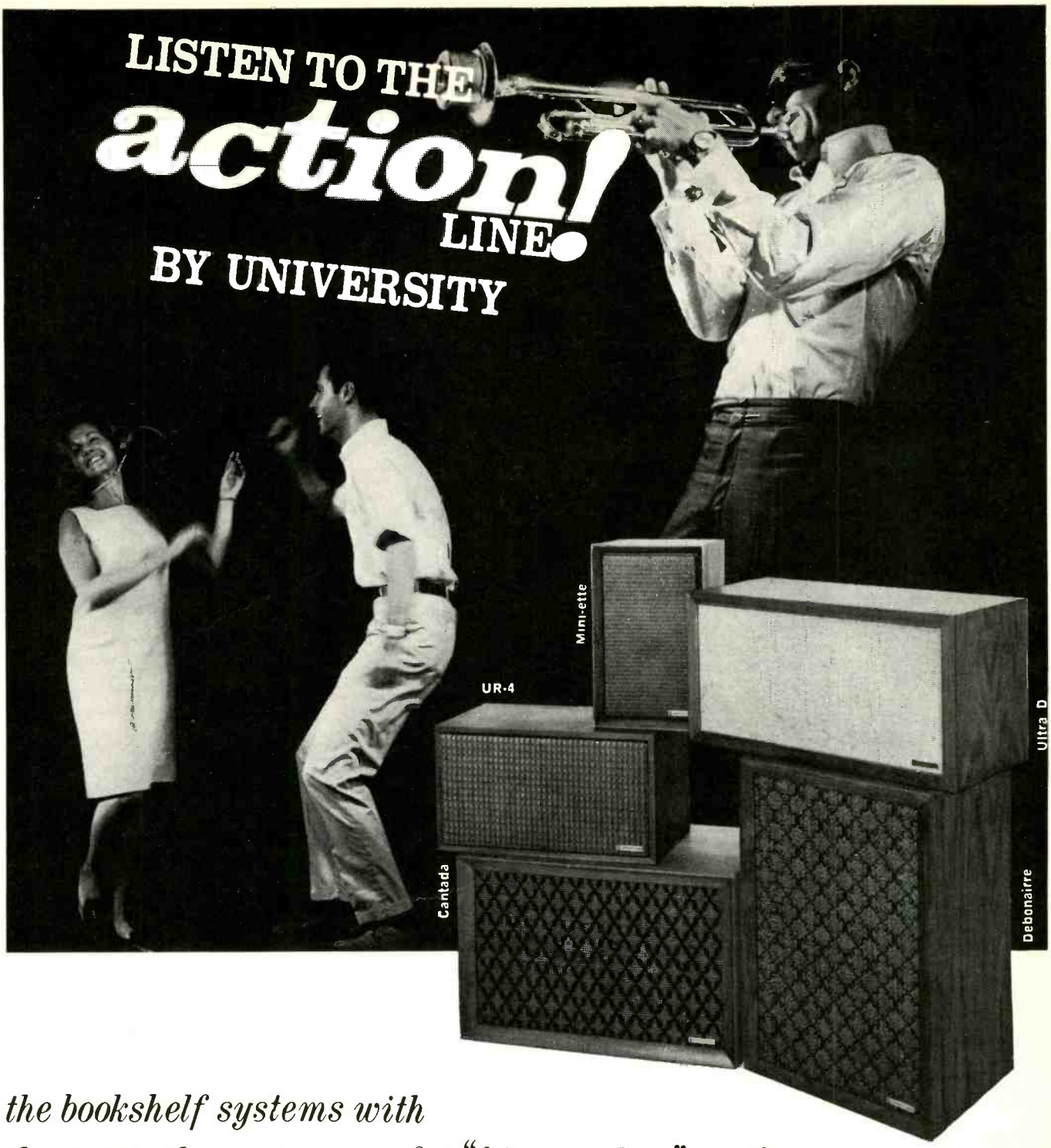
Fig. 3. Vocal sounds: top, aaaah; bottom, eeee.

in music. Piano music, for example, sounds like the music of a small organ or accordion when played backwards. (You can try this for yourself if you have a full-track monophonic or 2-track stereophonic tape recorder—or listen to the Beatles' recording of *Tomorrow Never Knows,* whose background was largely recorded backwards and speeded up.)

Transients

The sound of an instrument's attack is often rather different from that of its steady state. This stems largely from vibrations associated with the energy source that first excited the tone source (string, air column, and so on). into resonance and the source's recovery from the shock of receiving this energy, if the attack was a particularly sharp one. Generally, these effects are most noticeable with sharp, crisp attacks, and consist mostly of high frequencies that soon decay. These effects, and those associated with stopping vibrations or suddenly changing their character, are generally called "transients" because of their momentary nature.

By now we've covered most of the raw sonic materials that a hi-fi systems has to work with: tones and their classification by amplitude, frequency, wave shape, wave life, and transient characteristics. Next month we'll start discussing what happens to these raw materials in a sound reproducing system, and some of the characteristics that determine a system's fidelity. Æ



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AUDIO ETC.

Edward Tatnall Canby

1. THE DOLBY DERBY

This was to be a full-scale follow-up on last month's account of the Dolby S/N Stretcher (you'd better call it by its formal name, the Dolby A301 Audio Noise Reduction System). But, space being what it is and having to get in some words, too, about Super-Tracking (below), I'm going to compress my signal. I'm not taking back a thing concerning my feeling that the Dolby is a very important practical development for recording and that a lot of recordists are going to have to join the Dolby Derby for their own peace of mind, even if the ticket isn't cheap. But I'll have to sum up the practical values of Dolby-in-action as fast as I can.

Residual low-level noise can, of course, be reduced systematically via normal basic state-of-the-art improvements given enough time. Plenty of people are working on the problem. And this is, ideally, the right approach, too. Panaceas never help. It is easy to say that there is no easy way.

But meanwhile, to cope with the agonizingly practical *now*, we very much need an instant remedy for noise problems, providing it is a *good* remedy. The remedial approach. Instant remedies are always suspect. Nobody wants to be left on a limb with outdated, unusable gadgetry. A good instant remedy must be *compatible*, now and in the future.

The Dolby is no panacea. It *is* compatible in all important respects with every sort of recording equipment and tape that is likely to be around now or later on. True, every tape made via the Dolby system must be played back through a Dolby processor, for ever and ever. But aside from this rather formidable requirement (will your Dolby still be working in 1999?) the Dolby will go along with anything, complementarily. It simply plugs into the signal line, at the proper points, enclosing the noise-producing segments of the audio chain. Pushes the noise down 10-15 dB. Leaves the signal untouched. So Dolby tells us, anyhow. And so my own ears told me, as per last month. Wonderful.

(Just to remind—the Dolby processor takes the fresh signal and boosts up the low-level areas by 10-plus dB, in four frequency ranges. The de-Dolbyizer—the same unit; they operate in either mode and a "system" is a pair of them—restores these signal elements to normal, but at the same time pushes down any low-level noise that has appeared meanwhile. The main bulk of the signal, the louder part, is not affected. The system, then, is a *low-level-only* compressor-expander circuit, operating automatically and with fixed, permanent characteristics.)

Let's look at the major areas where the Dolby is likely to be a revolutionary tool of the remedial-preventative sort.

Tape Hiss

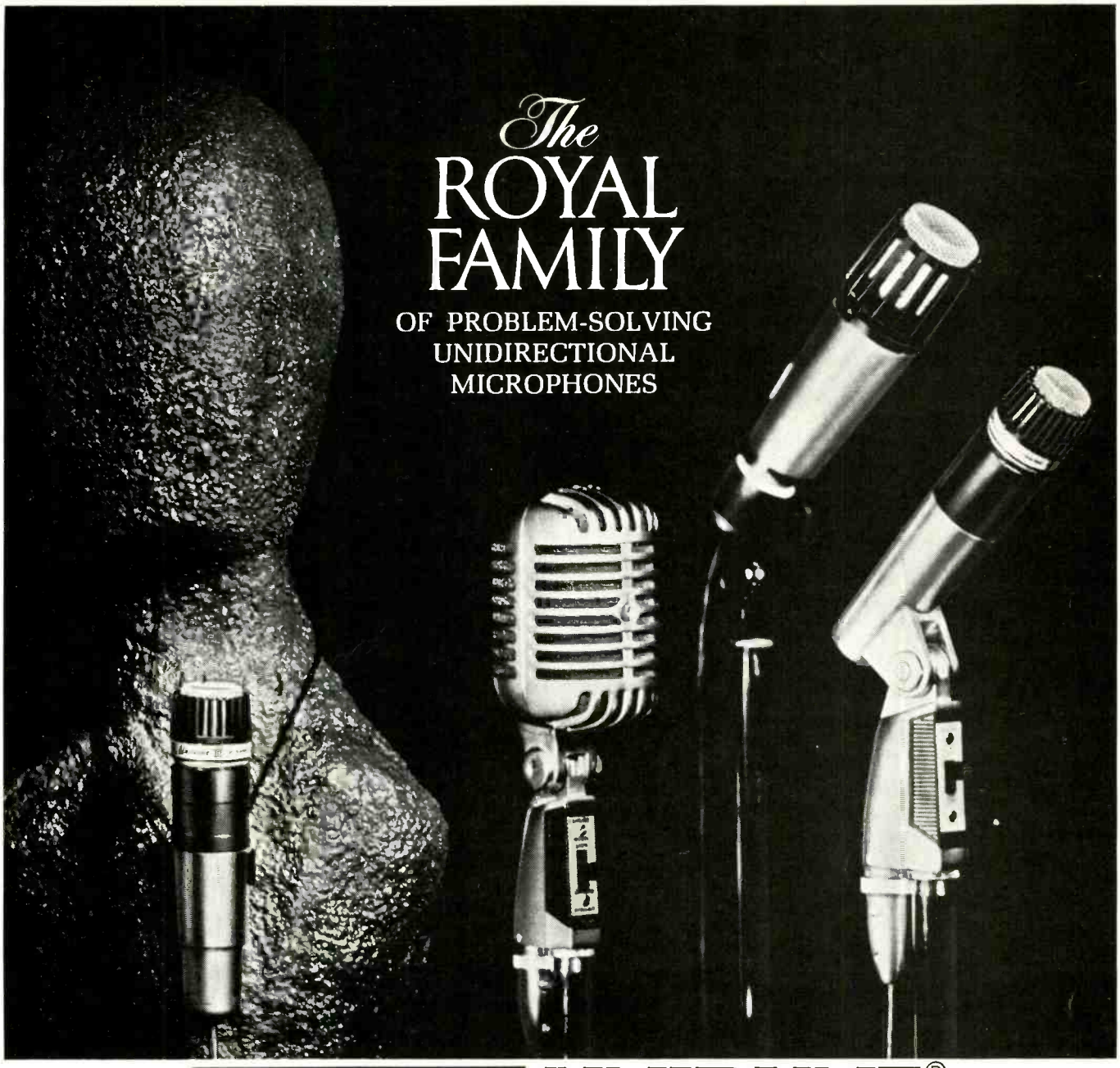
Tape hiss is the first and most striking gain via Dolby. Hiss is added *after* the original signal has gone through the processor. Therefore it is reduced in the de-processing by that fabulous 10-15 dB over the whole hiss spectrum, thanks to the four separate compression-expansion circuits. In effect, this puts it out of hearing. And there are no swishes, burbles, surges, irregularities, noise modulations. If you could hear this much-reduced hiss, it would be steady and smooth. But you won't. Utter silence.

With Dolby in your circuit you can use a much widened dynamic range, down far into the low-level end without noise. And/or you may center your signal on the optimum portion of the magnetic spectrum. A spectacular clarity, and a lot of new working flexibility.

Print-Through!

This bothersome, semi-unpredictable destroyer of music and speech on tape is a nasty disease, affected by painfully many indeterminate factors of physical contact, heat, tape configuration, magnetic force and so on. Worst of all is the fact that it appears after the recording is finished—seconds, minutes, hours, days, (years?) later and is thus a continuing problem in all tape handling and storage, never to be lived down. Any device which can guarantee a 10-plus dB reduction in print-through, now or in the future, *whenever it may appear*, is of enormous practical interest. This, I am sure, is the main appeal of the Dolby system to the big companies and to all who have priceless tapes to preserve, for days and for the years.

With Dolby units installed throughout (English Decca has already done so in Europe and other outfits will follow), a record company can revamp the whole foundations of its recording, tape-handling, and tape-storage system, change its equipment (see below), use different and perhaps better tapes, with the print-through risk so much reduced. A complete conversion may even involve dubbing all original masters to Dolby-ized



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tapes, for unified operations and to arrest any further deterioration, especially print-through. Enough to cure mega-ulcers.

Cross-Talk

Cross-talk between stereo channels is a calmer disease, easily controlled via lots of cash, extra-wide tape, wide tracks, better heads, and so forth. But Dolby does it better. And cheaper.

Cross-talk, too, is a signal added *after* the original stereo signal (which is presumably 100 per cent separated in its various channels . . . well, 99 44/100). And so the Dolby process pushes cross-talk down by the usual 10-plus dB, at the low but very audible cross-talk levels. Much cleaner stereo is the result.

In practice, Dolby says, cross-talk reduction is equivalent to the use of a tape *ten times as wide*. Even five times as wide would be something! So—you can throw out all those ultra-wide systems like 35 mm. Unnecessary, Dolby says. Moreover, you can re-activate equipment that is now obsolescent because it uses tape and track widths too narrow for current standards. Dolby-ize the signal first, and these machines can go right back to work minus any measureable cross-talk. (Nope, you can't rescue the older tapes made on them. Dolby's gadget thinks the cross-talk already present on the old tapes is a part of the signal—how is it supposed to know otherwise?)

Sub-Masters

Copying at top quality is a major business today. Virtually all of the floods of cross-licensed LP records, for instance, are made from copied tape submasters. The producers, natch, hang onto the original masters. They send out copies.

Thanks to today's high-quality circuits, distortion is, oddly, no longer the primary problem in this copying. Instead, it is noise, which builds up in the copies. A dubbing done via the Dolby pushes that noise straight down out of hearing—the same old 10-plus dB. Only the original noise on the master gets through. (And if the master was Dolby-ized too, the noise is doubly low.) Dolby can be immensely useful in dubbing, here as in many other kinds of dubbing operations.

Adding Them Up

If you will put all these factors together (they do happen simultaneously and automatically), you can measure for yourself the extent of the present Dolby impact upon the recording mind. The over-all improvement via this selective noise reduction is immense, and just has to be if the Dolby claim that the audio signal itself remains wholly unaffected is really true. It seems to be.

Add Dolby's in-use practicalities and you have even more. Simple plug-in electronic units, usable "in" or "out," standardized, stable, completely interchangeable, without controls and requiring no alignment or other adjustments, built with quickly removable slide-out modules. Tapes that may be freely interchanged, spliced, edited with any other Dolby tape anywhere. "Black box" operation, installed and forgotten.

So get going, fellahs, the Dolby Derby is underway and you'd better get with it. Get compatible, that is, so you, too, can play Dolby tapes. And make them.

2. SUPER-TRACKING

Every so often I receive an insignificant little package from Shure Bros. in Evanston, Ill., quite unsolicited. But I always open it quick-like. Because inside there usually is the Latest in Shure Cartridges, top of the line. Pleasant sort of mail to find in your post box! Not that Shure is sending it out of sheer good will or something—they hope maybe all the recipients of their little billy-dookses will say something nice, maybe.

Well, I've got some of those things to say about the latest package, which contained a V-15 Type II, subtitled SUPER-TRACK. It follows after the original V-15 of a season or so back, and it went straight into the same cartridge mounting, in two minutes flat, just as soon as I got it out of the box. Same connections, even to the color coding, same mounting hardware, etc.

Don't get me wrong—I wouldn't have a word to mutter about Shure if the results weren't interesting to talk about—whether good *or* bad. Just another cartridge, neutral-like, and I simply put it aside with fine professional boredom. Not this one, however.

The Type II V-15 is, as they say, a state-of-the-art cartridge as of the moment, though by no means the only one on the market. It represents the latest stage in the continuing rapid evolution of the stereo pick-up mechanism that began back in '58 when the audacious Audio Fidelity label jumped the gun with the very first stereo disc (I still have it)—Dukes of Dixieland on one side and some sort of railroad train on the other, the whole punctuated by frequent deliberate "drop-outs" (supposedly to render the material strictly non-commercial and for pure experiment) . . . but this is another tale. Now, eight-plus years later, the stereo disc is in the billions and there are cartridges like this Shure V-15, new-type, which amaze and astound. What else can be said?

The new Shure, like others of its generation, is smaller and lighter in the over-all than its immediate forebears. Every element, on direct visual comparison, has been pared down for a less boxy, less bulky appearance. But what really matters to the onlooker (the on-listener) is the vital streamlining of the inside works, the tinier stylus, the lowered mass of the whole thing, including tip, and the new elimination of the very-high-frequency resonance that has been common in many pickups during the past years.

All of which, as you may have heard, makes this and a number of other new state-of-the-art cartridges sound even smoother and better than those recent models we had so recently been calling superb. Yes—it does happen, and quite without publicity-motivation! One cannot imagine an improvement—until it comes long. I would not have believed it myself, being an old cynic as to "claims" and a listener who listens to pickups as music-makers, not as reproducers of test material. But it was so.

I noticed the difference the instant I put the newer Shure model on a record. It sounded duller, less exciting, perhaps a bit less forceful.

Right! Just what I should have expected. It *is* a better pickup. No two ways about it.

So I have definitely put the old V-15 away and I'm sticking with the Type II. I know when my ears have played me false.

Super-Adaptable

Er . . . what? Why of course. One's ears (mine, anyhow) are very adaptable. Ears have a way, along with the listening mind, of getting used to a sound, adjusting to it, in order to gain the maximum content-message. It's true of speaker sound. Pickups too. The difference between the two Shure V-15s, to be Shure, isn't more than tiny. But it *is* audible—that's the amazing thing—and when one is entirely familiar with the older model, the newer one, minutely cleaner and flatter, better tracking in the difficult groove contours (both the big, loud ones and the small super-high-frequency ones), tends to sound duller—at first. Absolutely correct.

In short order one's ears adjust to the new sound, as mine did. Then it no longer sounds duller. Just better.

The physical operation of the new Shure is all that I have left to comment upon—and it is weird. "Super-track" is, really, an accurate term, even if it did come from Shure's public relations.

(Can't you see the boys huddling in a brown study. . . . "Now whaddl' we call *this* baby??? How 'bout ALL-TRACK, or maybe TRACK-OR-TREAT? *Loud boos.* Well, then, maybe the EVERSHURE, you know, like the Eversharp . . .? Nope? Then let's kick the ball around some more fellows . . . how about WIDE-TRACK? *Even louder boos.* Yeh, a tiger in every groove, huh? How about SUPER-TRACK, then. *Still louder boos; then a sudden silence.* Hey, *wait* a minit! Now you're kicking! Say that again? SUPER-TRACK. Wow! We *got* it!)

. . . The darned thing does track, you see. It is, in fact, the first cartridge I have ever tried that will track *anything*. That is, if you mean by "track" that it will play any groove that ingenuity can cut into a record without a trace of distortion.

It is simply impossible to make this cartridge distort, just so long as its stylus manages to touch the groove wall,

We've looked at the other ads and now we think you ought to know about the Celestion range of high fidelity speakers

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The Ditton 15 and Ditton 10 — a revelation in 'compacts'!

The Ditton 15 (21 x 9½ x 9¼ in)

The latest product of Celestion research—a three element, 30 watt peak, full range compact loudspeaker enclosure. This system incorporates a new Celestion design concept—the ABR (auxiliary bass radiator) giving outstanding distortion-free bass down to 30 c/s. In addition there is a long throw 8″ loudspeaker plus the HF1300 Mk.2 high frequency unit. Impedance: 4 ohms. Finish: Satin walnut or oiled teak.

The Ditton 10 (12¾ x 6¾ x 8¼ in)

This represents the most advanced and sophisticated design yet seen in mini systems. The high frequency unit is developed from the HF1300 already in use by major broadcasting authorities, including the BBC, and the 5″ long throw bass unit gives solid lows down to 35 c/s. Power handling capacity: 20 watt peak. Impedance: 3-4 ohms and 15-16 ohms. Finish: Satin walnut or oiled teak.

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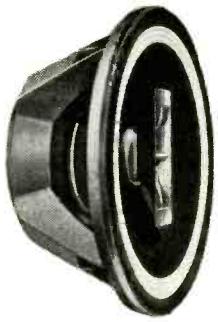

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or maybe even just one side of the top edge of the groove wall. Perfectly clear sound, invariably.

Splitting Hairs

On the other hand, if you mean "following the groove," tracking in the macro-sense, I'll have to put in an interesting reservation or two. It all depends on what's in the groove (like dust) and what's with the arm, etc., in which this amazing cartridge is mounted.

At zero grams you can "float" this stylus in the air at the record surface and it will faithfully play, with utter clarity, whatever tiny segments of groove it happens to hit as the record turns beneath it. At about a tenth of a gram it will skim nicely along the top edge of any old groove, sliding up and over to repeat the same message again and again, clear as a bell. At a fifth of a gram, roughly speaking, the Shure will begin to cleave to the inner depths and you may get a whole sequence of turns, a dozen or so, with perfect continuity, until a bit of invisible hair or a micron-sized dust mote intervenes. Then we go back to repetition. Ultra-clear. Oddest effect I ever heard.

I note that one turntable maker (whose table I am using) recommends a stylus force of 1 gram for this cartridge, which is the lowest among some thirty recent models he lists, as of December, 1966. To be Shure, he splits his hairs; two other models require 1¼ grams, three 1½ grams and three 1¾ grams. But, anyhow, this Shure is the lowest, as of that date.

I didn't bother. I haven't yet. The reason is (and both Shure and the said table manufacturer will be gasping with horror, *I* suppose) that this type of cartridge has a lovely built-in *visual* weight-setter.

All you do is to bend down, put your eye at turntable level in a strong light, and look at the stylus as it plays in the groove. Shure has thoughtfully provided a small plastic bump, rounded smooth, which engages the disc if you put on too much weight. Like, say, a nickel on top on the cartridge shell. The stylus just bends, like an old fashioned trolley pole going under a low bridge only upside down. It stops bending when you hit the rounded bump.

Too little weight, and the thing just dangles in the air, or stands out at the dangling-angle, barely touching the groove.

That gives you an accurate visual range. You set your weight to bend the stylus just a bit beyond the dangling-angle, but not much. Leave plenty of leeway, to avoid the low-bridge bump-stop. And you've got it. I haven't measured the force-range which this covers but I know it is *very* small. Couldn't be anything else, with that bump there to limit your vertical excursion.

Now all you have to do is to play. And there is where, to conclude this set of observations, I find the most trouble. The same is true of the other newest cartridges. They play too darned easily. They defer to anything which happens along, like that hair or micron-sized dust mote. I do what I can but, expecially in the dry months, it isn't easy. Carefully wash your disc, or do it over with a plush record cleaner; and approximately one minute later there are already several million micronic dust motes on hand, plus a thousand tiny hairs. And every one of them seems to be solid enough to cause our fine pickups to lose traction! Nope, you can't add much more weight. Maybe a quarter-gram or so, at best. Doesn't help much, that.

The Considerate Stylus

The normal warning for these oncoming interruptions is no longer the old fuzzy distortion. Not a trace. Super-tracking. Instead, you begin to get slight drop-outs in the clean, clean sound. The stylus is considerately stepping over the obstruction and coming down again on the other side.

Pretty soon (unless the dust mote comes unstuck, which it occasionally does), the point starts to hop into the next groove in its super-politeness. At that stage you get up to do something.

But—oh no!—you can't do that old blowing trick that used to impress the audience. If you blow now, the dust will stay put but the cartridge itself will take off and land somewhere over in the gutter.

I usually try, therefore, to pick up the invisible bit of lint without touching the cartridge at all. It often works. Just apply a light finger, or a more circumspect record cleaner pad, or even a handkerchief, *in front of* the stylus while the record keeps turning. This often does the trick and your music resumes its course. If not, then you have to cease fire, lift the cartridge, clean carefully and/or blow mightily, clean the record itself and wipe dry (have to get rid of the static, of course), then start in all over again.

* * *

P.S. You know those nice pickup arms with the vertical viscous damping so that if you drop the arm it doesn't crash but, instead, floats easily down to the record, whereupon the damping lets go? Well, mine was set up a couple of years back for the enormous, gross pickups of that distant era, and I haven't yet changed it. Don't think I will. Marvelous demonstration.

You see, with the Shure V-15 Type II, the cartridge runs so light that the damping works 100 per cent. That is, the arm merely floats in the air above the table when I let it go.

So, to startle my friends, I let it float, then *push* it gently down onto the record. Damping lets go and Shure goes to work, undamped, and plays. As above.

(I used to do the same trick via zero force and an ancient steel table. The pickup pulled itself against the steel. But that was 'way back in mono days. No more tables like that now! The stylus would flatten itself right down against the bump-stop.) Æ

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The Marantz components illustrated, top to bottom: SLT-12 Straight-Line Tracking Playback System • Model 15 solid-state 120-watt Stereo Power Amplifier • Model 7T solid-state Stereo Pre-amplifier Console • Model 10B Stereo FM Tuner

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EDITOR'S REVIEW

THE SECOND WEEKEND in February held a double bonus for the audio-minded residents of our nation's capital—it didn't snow, the sun shone, and there was a hi-fi show to visit at Washington's famed Sheraton-Park Hotel, where some 21,000 people filed through the rooms of the 60-odd exhibitors during the three-day show. As usual, the visitors showed the high degree of sophistication we have come to expect at Washington shows—they asked intelligent questions, and they were understanding of the answers. Mrs. Theresa Rogers and her advisory committee of five "reps" are to be congratulated for the fine show they ran.

AUDIO'S ANNIVERSARY "KICKOFF"

Since the May issue this year will celebrate our twentieth anniversary, and since this is the last time the industry will gather together before then, AUDIO chose the occasion to host a Sunday morning brunch which was attended by most of the exhibitors. The guest speaker was FCC Commissioner Robert E. Lee, whose talk was perfectly tailored for an audience composed of people who make their livelihood from audio. His thesis was that FM was the real solution to satisfactory sound broadcasting, and that he "hoped to see the day when satellites would feed stereo FM programs to broadcast stations in big cities, tiny hamlets, and translator stations located in faraway places, and thereby run AM ragged if not out of business.

"When the late Major Armstrong developed FM, it was primarily for the purpose of overriding static which plagued — and still plagues — amplitude-modulated standard broadcasting," Commissioner Lee said. "But with the advent of FM came a whole avalanche of technical advances in recording, playback, and broadcasting techniques that now assure the 'listener who cares' the capability of hearing, via FM broadcasting, recorded music and speech with a superb quality which could have been beyond Armstrong's expectations," he continued.

"When the FCC issued the order which forced the divorce of AM and FM in cities of 100,000 population or more, there were horrified groans from broadcasters who didn't really cherish their FM facilities but neither did they cherish the idea of losing their FM channels to real and potential competitors," the commissioner said. "But while there were 337 AM-FM combinations in cities of over 100,000 population in March, 1965, 270 have now complied with the regulation, and only 67 remain who have requested additional time to make the divorce.

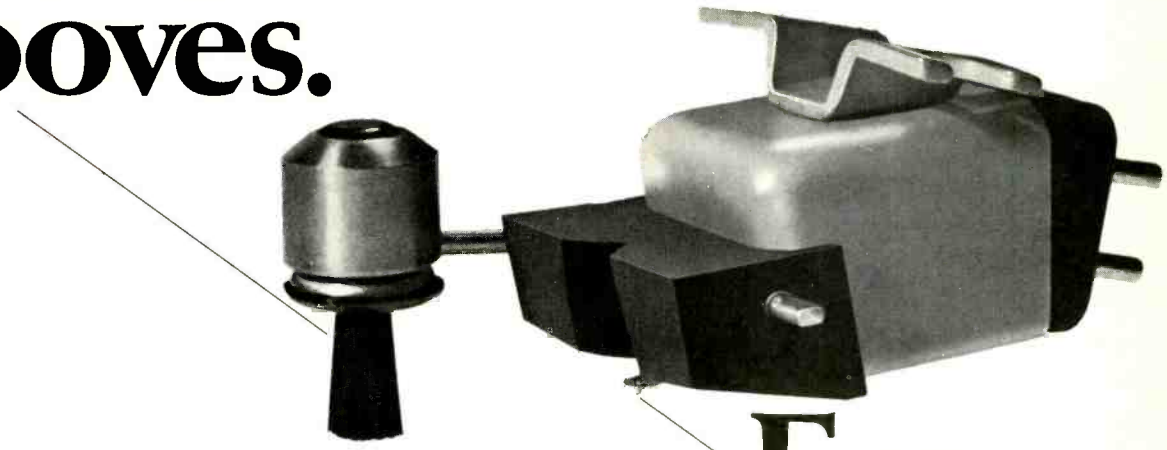
"Perhaps the most important development for FM will be its expansion into sparsely settled areas where FM broadcasting is not yet economically possible. This development may come about as a result of a recently enacted proceeding which looks toward the use of translators—such as used for TV—to receive, translate, and rebroadcast FM signals. We recently authorized a developmental translator and a developmental on-channel booster, both in California," he continued.

The commissioner told us that the FCC had issued a Notice of Inquiry (in Docket 17159) which may ultimately lead to new FM services in rural areas, which up to now have depended on AM radio. The prospect of high-fidelity radio on the farm should be an exciting one to the industry, because of the enormously increased market potential. Anyone interested in submitting comments on this subject for consideration by the FCC is urged to do so. Such comments must be submitted before April 5, with one original and fourteen copies, and we are promised that they will receive careful consideration. Copies of the Notice of Inquiry may be obtained by writing to the Secretary of the FCC.

The commissioner told us of another exciting prospect—the use of satellites to interconnect FM broadcast stations. He explained that these signals would not be in the FM broadcast band to avoid interference with earth-bound signals. "I listened to a taped stereo recording of a musical program relayed via satellite Relay II on two consecutive passes over the receiving station. The maximum total distance up and down for the first pass was 11,400 miles and for the second pass was 12,600 miles. The up frequency was 1725 MHz and the down frequency was 4170 MHz. The music I listened to was of excellent quality and is a clear indication of the feasibility of this transmission medium," the commissioner concluded.

And that fills you in as much as though you had been there, except for the breakfast itself and our birthday cake. The latter was all gone by five o'clock that same afternoon.

For cleaner grooves.



For cleaner tracing.

New Pickering V-15/3 cartridge with Dynamic Coupling for minimum tracing distortion and maximum tracking ability, plus Dustamatic™ feature for dust-free grooves.

As stereo cartridges approach perfection, dust in the grooves becomes intolerable.

The Pickering V-15/3 Micro-Magnetic™ cartridge has a new moving system that reduces tracing distortion close to the theoretical minimum, thanks to Dynamic Coupling of the stylus to the groove. But what good is perfect contact between the stylus tip and those high-velocity turns if dust particles get in the way?

That is why the Dustamatic brush assembly is an essential part of Pickering's total performance cartridge. It cleans the groove automatically before the stylus gets there.

The new moving system also provides a further refinement of Pickering's famous natural sound by extending peak-free response well beyond the audible range, and the patented V-Guard Floating Stylus continues to assure the ultimate in record protection.

There are four "application engineered" Pickering V-15/3 Dustamatic models with Dynamic Coupling, to match every possible installation from conventional record changers to ultrasophisticated low-mass transcription arms. Prices from $29.95 to $44.95.

For free literature complete with all details, write to Pickering & Co., Plainview, L. I., New York.

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COVER STORY

End Table Loudspeaker

C. G. McPROUD

SOME TIME AGO, the writer was faced with the problem of providing a second loudspeaker which would match the performance of the Corner Loudspeaker System, originally described in these pages in 1949, to give a suitable stereo spread in an apartment living room. Several attempts to use a conventional speaker system failed in the latter requirement unless the listener were content to sit in one particular spot (X in *Fig.* 1) —one of the still existing problems of stereo reproduction. The room plan was that of *Fig.* 1, with the arrangement and the necessary furniture limiting the possible location of the right-channel speaker, assuming that the corner unit were to be maintained as the left-channel speaker.

About that time, the Ravenswood speaker[1] system made its appearance, and in the course of experimentation with one of the smaller Ravenswood units—about 16 in. high, 24 in. long, and 6 in. deep—the stereo solution was found. The next problem was where to put such a unit. The logical place seemed to be behind a sofa, but the particular piece of furniture selected for that spot had legs which projected backward, leaving no place for the speaker. Furthermore, the addition of a second sofa at right angles to the first one made a table necessary at their junction. The second sofa and the projected location for the end or lamp table are shown in dotted lines in *Fig.* 1.

Having solved the type of furniture required and also having similarly solved the type of loudspeaker desired —and the combination not being an available product, we proceeded to design and build what we wanted.

The first step was to visit a furniture store. The selection of end or lamp tables gave us a number of choices, and the one selected, shown in *Fig.* 2, measured 22 x 26 in. on the top, 23 in. high, and with a 10-in. depth below the top to accommodate a single drawer which had a false front simulating two drawers. The side and back walls were of ¼-in. material, but we planned on stiffen-

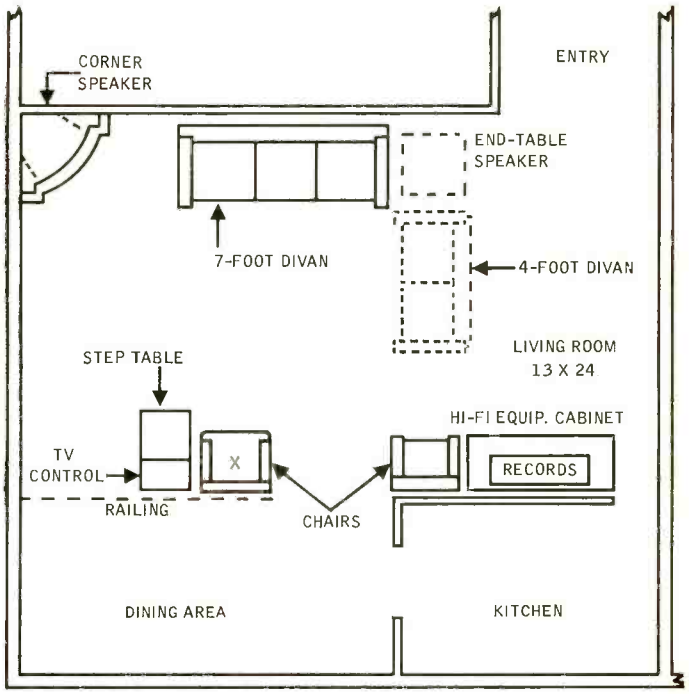

Fig. 1. Plan of room in which it was desired to use a corner loudspeaker for the left channel, and some other type for the right channel.

[1] Leon Knize, The reflection coupler. AUDIO, June, 1961.

Fig. 2. The completed loudspeaker, with no grill cloth or other "speaker-like" visible characteristics.

Fig. 3. Looking down on the rear of the end-table speaker to show one type of reflector in front of the midrange cone.

ing them and deadening them against vibration.

The first step was to remove the drawer and separate it from the false two-drawer front—easily done with a saw. The entire front opening was then framed with 1 x 1½ in. strips so the front could be attached by screws from the inside. Care was taken to make tight joints, and the entire framing was solidly attached with casein glue and wood screws from the inside.

After cutting a 7-in. hole in one of the longer sides for the mid-range cone, and a 4-in. hole alongside it for the tweeter, we framed the bottom all around with 1 x 1 in. strips, also glued in place, and screwed into the side walls. This framing was placed about 1½ in. above the lower edge of the sides to accommodate the woofer baffle, which was cut from an old 1-in. drawing board. We planned to have the woofers radiate from the bottom. Since all internal work had to be done before the woofer baffle was put in place, we stopped at this point to finish the inside fittings.

Theory of the "Reflection Coupler"

Digressing from the actual construction, the reflection coupler system depends on the radiation from the mid- and high-frequency units being reflected at right angles to their axes, and thus parallel to the side wall of the cabinet which is placed about three inches from the wall of the room. This design was originally that of Dan Greenfield, of Danby Radio in Philadelphia, later adopted by Ravenswood, and now used by its successor, Bentley Audio, of Annapolis, Md., in consoles. In this usage, the entire stereo speaker system is contained in a box about 18 in. high and 5 in. thick, and as long as the console with which it is used. The speaker enclosure hangs inside the back of the console cabinet, and sound issues from the back along the wall. Some observers feel that the stereo spread is considerably superior than that usually obtainable from a console only five feet in length with conventional speakers about 3½ ft. apart. In any case, the design eliminates the "point-source" effect, and does have some merit, particularly when used with a corner speaker as one of the two in a stereo system.

In order to direct the sound at right angles to the normal axis of the speakers, several types of reflector have been employed. The one used in the end-table speaker for the mid-range cone was a complicated shape made of plastic, as seen in *Fig.* 3 and was originally used in some of the Ravenswood models. For an 8-in. cone, a simpler reflector can be made by using a piece of Masonite hardboard 3 in. wide, and mounting it on triangular brackets in front of the cone, as shown in *Fig.* 4. The Masonite strip should be placed with its axis at an angle of 45 deg. from the vertical, and in a stereo pair should face outwards.

Some similar reflector must also be used with the tweeter in a three-way system. Our solution was to procure a pancake turner and a cyclist's pants clip, riveting them together as shown

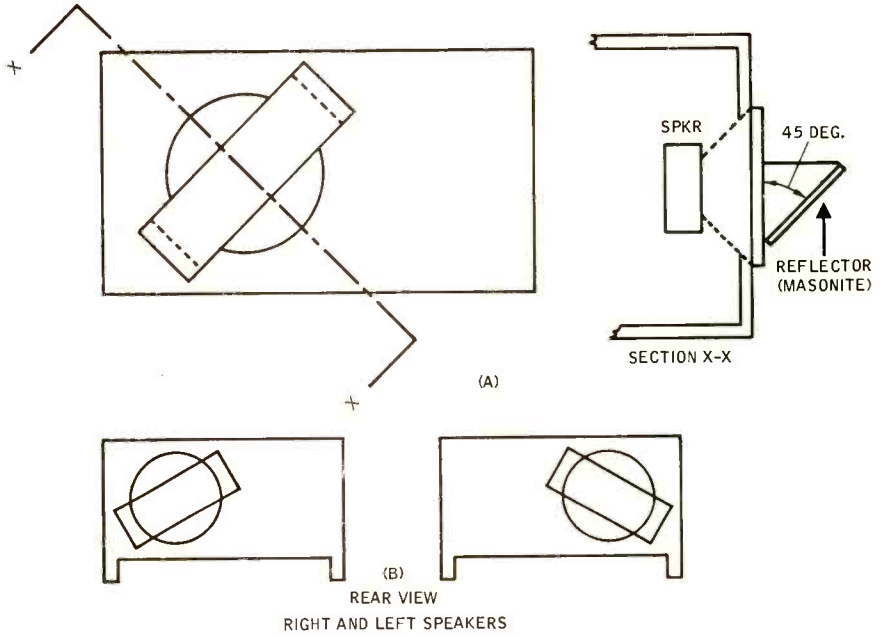

Fig. 4. Simpler reflector recommended uses only a piece of Masonite hardboard set at a 45-deg. angle as shown at (A). For stereo speakers, both reflectors should face outward as shown at (B).

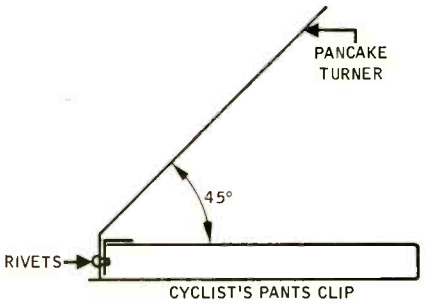

Fig. 5. Method of making reflector for the Sphericon tweeter by using a cyclist's pants clip and a pancake turner.

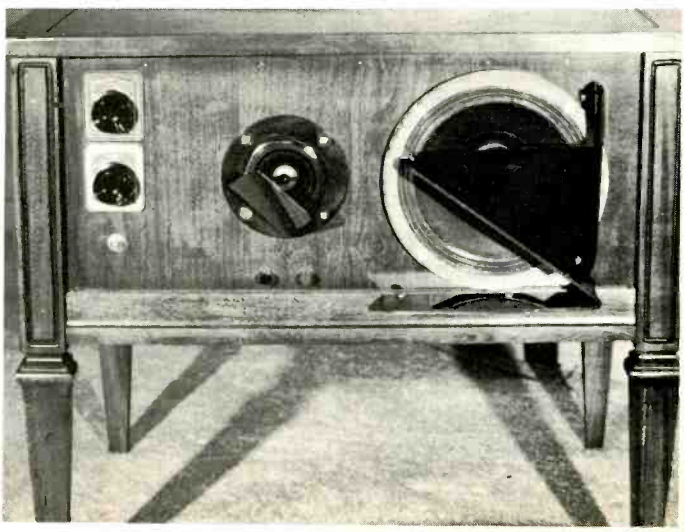

Fig. 6. Rear view of completed loudspeaker.

in *Fig.* 5. The pants clip fits around the neck of the University Sphericon tweeter, and the pancake turner, set at an angle of 45 deg. from the clip may be rotated around the tweeter to direct the high frequencies where the best effect was obtained.

The low-frequency cone has controllable damping, a development of Sam Bryan of Bentley Audio. Two identical cones are mounted in the same airtight enclosure, but only one of the cones is driven—the other is shunted by a potentiometer with a resistance of about three times the impedance of the voice coil. With maximum resistance across the coil, the cone is relatively undamped. As the resistance is lowered, the cone becomes progressively more damped, since the voice coil of the drone cone, as it attempts to follow the driven cone in the airtight enclosure, develops an e.m.f. which is working into a short circuit, and this stiffens the cone movement. This is particularly effective with amplifiers which have a low damping factor, but less so with highly damped amplifiers.

Construction

Returning to the end table, we planned to use speakers we had on hand—two University C-12HC 12-in. woofers, radiating out the bottom, a Stephens Trusonic FR80 for the midrange, and the University Sphericon for the tweeter. With the woofer baffle cut to size, two holes were cut for the woofers themselves. This took a bit of doing, because there was just barely enough room for the two woofers, even when placed on an angle. If a smaller cabinet were used, it would have been necessary to use smaller speakers.

Because of the ¼-in. walls, it was considered necessary to stiffen them to avoid drumming of the sides. This was done by cementing ⅜-in. piano felt on the sides and back, using linoleum cement, which is almost heavy enough to use alone. Practically any type of mastic could be used for the deadening material, since the primary requirement is to add mass to the walls.

To prevent the back pressure from the woofers acting on the back of the 8-in. midrange cone, it was housed in a separate box made to fit behind the opening for the speaker, which was mounted from the outside. This box, of ½-in plywood, was covered inside and out with the piano felt. The Sphericon tweeter was similarly mounted from the outside, since it is designed for this type of mounting, and is totally enclosed.

Level-balancing pots were next mounted on the side adjacent to the tweeter, one for the midrange and one for the tweeter. A third control, with a resistance of 50 ohms, was also mounted on the panel. *Figure* 6 shows the rear view of the completed cabinet. The two upper controls at the left are the balancing pots for tweeter and midrange, and are equipped with knobs and the dial plate that comes with the Sphericon, another control of the same type being obtained for the midrange unit. Two binding posts are provided for the external connections. The lowest potentiometer is for damping control, and has no knob—only its knurled shaft.

The dividing-network components were next installed on the woofer baffle. A simple two-way network is all that is required, since the Sphericon contains its own network. The crossover frequency selected was 900 Hz, which matched that of the corner speaker system. *Figure* 7 shows the electrical connections for the entire unit, together with the values for the network. Leads were left on the network components and the two woofer cones for final connection when the baffle was finally installed on the framing. Remember that the leads from one of the woofers are to be connected only to the damping-control pot.

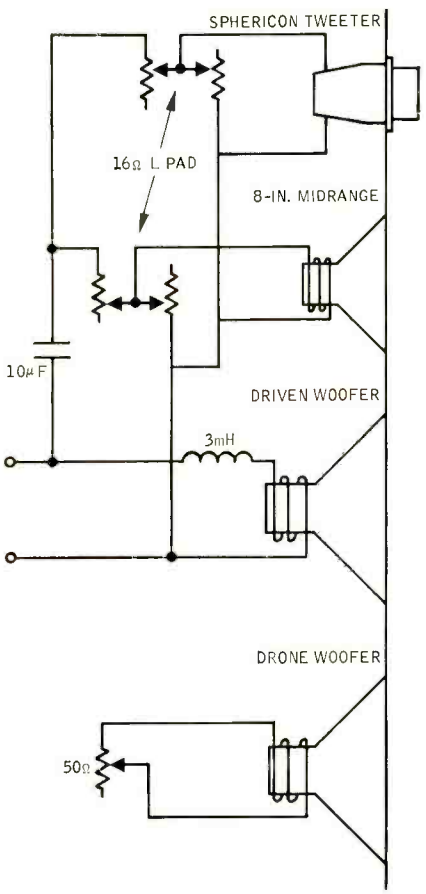

Fig. 7. Electrical connections and component values.

After all connections are made, the space in the cabinet is filled with layers of rock wool, using a total of about 10 feet of the usual rolled material obtainable from building supply stores. With all connections made and checked, you are ready to install the woofer baffle. First, however, place a ring of putty all around the framing strip to ensure airtightness. Press the baffle down firmly and evenly, and then screw it in place, using plenty of wood screws. A protective screen should be placed over the woofer baffle if children or animals are among the inhabitants of the household.

Performance

While no rigorous measurements have been made on this unit, let it be said that it compares favorably with the large corner speaker with which it is used over the entire frequency range from 80 Hz on up. Playing a sweep record monophonically through the two speakers, the sound appears to emanate directly from the center all the way up from the 80 Hz mentioned to well over 12,000 Hz. The drop-off below 80 Hz was not considered a fault since the speaker was to be used only with the corner unit, which would supply adequate bass for both channels. A little experimentation would undoubtedly improve the low end, but in this application it has not been considered necessary.

The stereo effect with this type of speaker is considerably better than with any conventional cabinet with which the corner unit had been paired. Many who have heard the system were unable to locate the source of the right channel—finding it hard to believe that an end table holding a tall lamp could be a loudspeaker.

Variations

While the idea of this end-table system may appeal to many on the distaff side, who might well urge the reader to construct a similar unit, it is not likely that the same size and style of cabinet would be selected, even if it could be found. Not every home is adapted to Italian Provincial, for example. However, there is no doubt that some suitable table can be found which would fit the decor and would be adaptable to this system. The writer would welcome photos of any similar units built by readers. This end-table/loudspeaker system is not made commercially, so if the reader wants one, he will have to build it. Æ

Loudspeaker Directional Characteristics

DAVID L. KLEPPER

Choosing loudspeakers for sound reinforcement applications requires a knowledge of their directional characteristics as well as their over-all frequency response and their power handling ability.[1]

THE EFFICIENCY OF HORN-TYPE loudspeakers relative to direct radiators (single or line-source) is well known.[2,3] The directional characteristics of a number of commonly available horn loudspeaker types, perhaps even more than their efficiency, make them applicable to a wide variety of sound-reinforcement applications, particularly where central systems are employed.

Olson provides sample curves showing the directional characteristics of single exponential horns as a function of frequency for different flare rates.[4] Physically, one can state that the apparent mouth of the horn moves inward from the physical mouth with increasing frequency, reducing the size of the radiating source, and so reducing the trend to increasing directivity, or reduced coverage, with increasing frequency. Unfortunately, this change in effective mouth location does not happen fast enough to keep a single horn from becoming increasingly directive at higher frequencies; but the increasing directivity is merely less noticeable than in usual cone-type loudspeakers.

Single horns with a usable bandwidth of several octaves invariably are relatively directive at high frequencies. In 1933, the first multicellular horn was developed to solve problems of high-frequency distribution for the first stereophonic transmissions of the Philadelphia Symphony Orchestra, sponsored by A.T.&T. and using equipment developed by Bell Telephone Laboratories.[5] The multicellular horn, *Fig.* 1, was then developed commercially for motion picture sound theaters by several organizations working together, and have been the standard for motion picture sound reproduction since that time.[5,6] Each multicellular horn consists of a series of single exponential horns with their throats combined and fed by a single loudspeaker driver unit, or by a group of drivers. To ensure smooth frequency response and high efficiency, the exponential area expansion, essential to proper operation of such a horn, is continued from the drivers to the mouths of the multicellular horn.

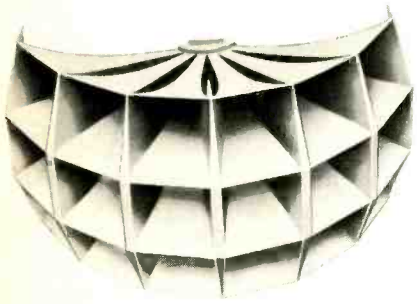

Fig. 1. Typical multicellular horn for large sound systems. This is an 18-cell unit, Altec Lansing model 1803B.

Multicellular horns are currently available in combinations of several different usable bandwidths and an almost infinite number of cell configurations (and resulting directional characteristics) from Altec Lansing and Western Electro-acoustic Laboratories in this country, Vitavox in England, and Philips in Holland. The rule of thumb for their application is generally: "If you can see through a cell to the throat, you're covered by the horn."

An engineering analysis of their directional characteristics can use the approximation of a segment of a radiating sphere. Olson compares the results of equations deriving their directional characteristics on this basis with a summation of the effects of individual cells, and Beranek plots 6-dB-down points as a function of frequency for 2, 3, 4, 5, and 6-cell horns using the 8- x 8-in. cell mouth size and 25-deg. angle between horns typical of most Altec Lansing horns.[7,8]

A study of this material indicates that the old "rule of thumb" has its limitations. Phase interference between cells (or between portions of the theoretical segment of a sphere) at the horns' mid-frequency range, especially with more than two or three cells in width, reduces coverage at mid-frequencies, similar to the curved-line source discussed earlier. This reduced coverage at mid-frequencies shows up as mid-frequency dips the typical frequency response at the edge of its coverage pattern in the "wide" direction.

Another, relatively minor, defect of multicellular horns is the result of increasing directivity of the individual cells at extreme high frequencies. This produces a "fingering" effect; with variations in level between a position on-axis of one of the cells and a position mid-way between axes. The difficulty of mid-frequency phase interference can be mitigated by proper horn selection, location, orientation, and electrical connection, singly or together in clusters; but the problem of fingering will always be characteristic of these loudspeakers, particularly with much program material above the 8000-Hz limit common for theater and auditorium sound systems until recently.

The second horn type that evolved from the straight, exponential horn for better distribution of high-frequency energy was the straight sided horn with parabolic-shaped top and bottom, as in *Fig.* 2, developed by John E. Volkman of RCA. Along its wide axis, the directional characteristics of this horn follow those of a curved-line source very closely; in the vertical plane the horn behaves much as a single exponential horn. Directional characteristics for one horn of this type, with a nominal 90-degree coverage, are available and

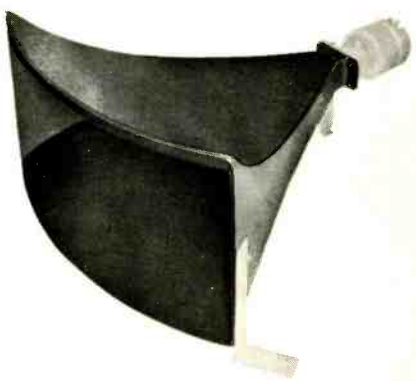

Fig 2. Straight-sided horn with exponential top and bottom, an RCA type.

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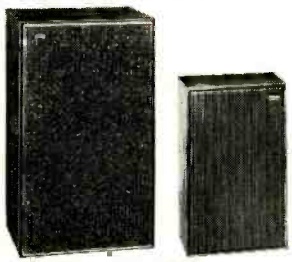

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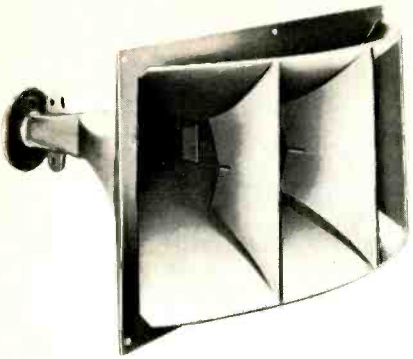

Fig. 3. Altec 5118 Sectoral Horn.

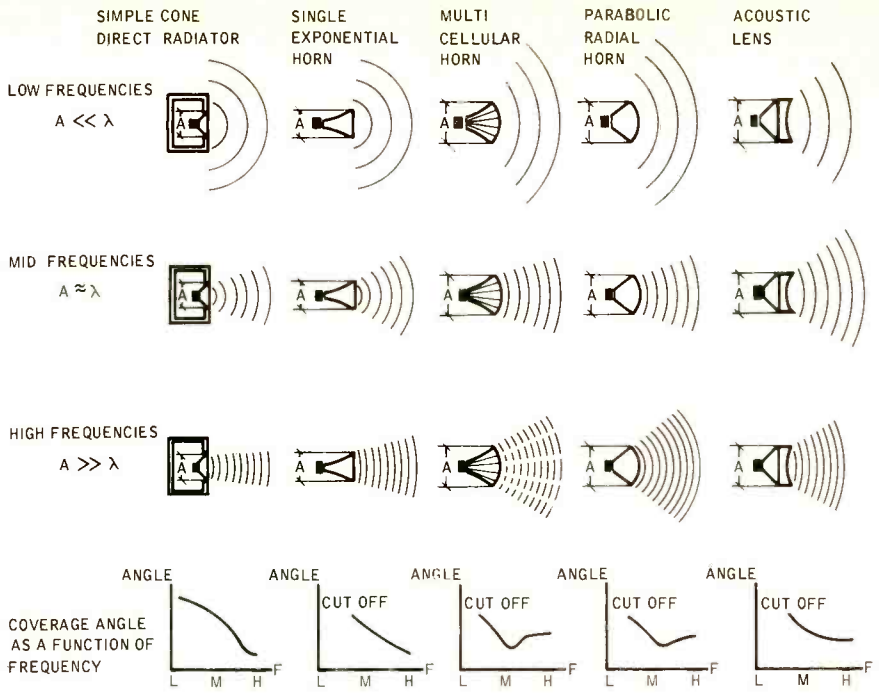

Fig. 4. Coverage of four types of horns. Characteristics of a direct radiator are shown for comparison.

are an excellent guide to the horn's application in engineered sound systems.[9] Similar "sectoral" horns are available from Altec Lansing, such as the model 511B horn shown in *Fig.* 3. Even the largest (RCA) horns of this type must be fairly small to ensure smooth response at high frequencies, smaller than one large multicellular horn but larger than individual cells; therefore, they are less directional at lower frequencies. However, they tend to be smoother in frequency response at the edges of their coverage patterns and do not have the "fingering" effects at high frequencies common to a multicellular configuration.[10] *Figure* 4 compares the characteristics of several types.

A third type of loudspeaker system that has highly controlled directional characteristics is the acoustic-lens radiator. An acoustic lens employs a series of obstacles which are small compared to the wavelength of the sound being transmitted and which refract and diverge sound waves in a manner analogous to electromagnetic-wave lenses.[11] J. G. Frayne and B. N. Locanthi have described two types of acoustic lenses that have been developed commercially by JBL. The first type, *Fig.* 5, employs perforated discs and is a circular lens, with a distribution angle of approximately 50 deg. in both horizontal and vertical planes. There is a second type, employing slanted plates, retaining the 50-degree vertical coverage angle, but having horizontal coverage angles of 100, 120, or 160 deg., depending upon the unit selected.[12]

A study of the available data indicates that acoustic-lens radiating systems have probably the most constant directional characteristics as a function of frequency of all directional horn loudspeaker systems. (Commercial acoustic lenses are generally used at the end of conventional straight horn coupler units.) Their only disadvantage as compared with multicellular horns or radial direct-expansion horns described earlier, is a gradual dropoff, as opposed to a sharp dropoff, at the edges of the defined coverage pattern.

Mention should be made in passing of several other types of commercially available horn loudspeaker systems: the re-entrant horn, and the diffraction horn developed by Electro-Voice. Neither of these loudspeakers is particularly designed to have controlled directional characteristics, although the diffraction horn does attempt to cover a wide area from a single horn. The diffraction-horn frequency response is generally a great improvement over that of the re-entrant horn; but the application of all these horns is generally confined to less critical areas (outdoor events, gymnasiums, and so on).

Frequency response is generally outside the scope of this discussion on the directional characteristics of loudspeakers, but we should point out at this juncture that it is relatively easy to equalize a loudspeaker system with nearly directional characteristics as a function of frequency to have smooth frequency response at all points within the coverage pattern; but it is impossible to equalize a loudspeaker system with widely varying coverage patterns as a function of frequency; if the response is flat at one observer position, it is likely to be ragged at another. In general, multicellular horns, radial horns, and acoustic lenses, if applied properly, can all provide a system with reasonably smooth frequency response.

Low Frequency Horn

The low-frequency loudspeaker components most commonly used with the mid- and high-frequency horns discussed are straight horns with either an exact or an approximate exponential taper, with the low-frequency response below the cut-off frequency of the horn enhanced by bass-reflex loading of the back of the horn. In order to preserve horn loading down to low frequencies, these low-frequency enclosures must be relatively large. Typical "two-woofer" enclosures, such as the one in *Fig.* 6, have a front face approximately 7 ft. x 39 in., and a depth of 3 ft. Smaller low-frequency front-loaded horn en-

Fig. 5. Round acoustic-lens horn, JBL Model 537-500.

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Why all the fuss about a little screw?

closures are available, but their low-frequency cut-off can be as high as 80 or 100 Hz, because of their flare rate and small mouth area. As opposed to utility enclosures, the author prefers to recommend even such smaller front-loaded horns as the Altec A7-500, (if an enclosure 42 in. high and 30 in. wide can be called small) because horn loading the low-frequency loudspeaker increases its efficiency, ensuring a better match to the efficient mid- and high-frequency horns, and, perhaps even more important, phase alignment between the low-frequency loudspeaker and high-frequency horn driver is easily accomplished. The problem of crossover networks and proper electrical phasing at cross-over frequencies is a separate subject and will not be discussed in this particular article. Considerable information is available from the manufacturers of theater-type loudspeakers on the problems of phasing at crossover. In any case, we can make the statement that it is much easier to phase low-frequency woofers and high-frequency drivers when they are spatially phased—in other words, when there is approximately equal path length from both sound sources to most of the listeners—than when they are out of alignment.

Since the low-frequency horn enclosures described are single horns, they exhibit constantly increasing directivity up to the crossover region. The largest low-frequency units are the most directional with 6-dB-down-points 50 deg. off-axis in the horizontal plane and somewhat *less* in the vertical plane, assuming that the horn is oriented with its longer mouth axis horizontally, and measurements are made at just below the crossover frequency. We have found that the somewhat less defined directional characteristics of the low-frequency reproducer are no great problem, since filtering of feedback frequencies is easily possible on the space region without noticeably affecting speech intelligibility or quality, and since the ratio of reverberant to direct energy can climb at low frequencies without adversely affecting speech intelligibility.

Sometimes, single direct low-frequency units are used in utility enclosures, either bass reflex or completely closed, to complement high-frequency horns. Most crossover networks do not have adequate provisions for level matching between the units used in this manner. In any case, the directional characteristics of the low-frequency loudspeaker are those of a direct radiator of its particular construction.

Multihorn Clusters

Proper phasing of the individual horns is also very important in a multihorn cluster; otherwise, phase-interference effects can destroy the desired directional characteristics. For example, horns aimed in the same direction in the horizontal plane but differently in the vertical plane should always be located one above the other; and horns aimed in the same direction vertically but in a different direction in the horizontal plane, should always be located side by side. The important consideration is equal path length from the sound source (driver) and the "overlap" listening area covered by both horns.

The mid-frequency narrowing of coverage angle discussed earlier can become a very important factor when the multihorn cluster is employed with all drivers receiving the same signal level. Tapering of line-source loudspeakers has been discussed heretofore; similarly, we generally find that some level tapering of horns in a multihorn cluster serves two useful functions: (1) it can result in more-even high-frequency distribution, with the level fed to each horn compensating for inverse-square law distances from the horn to the area covered; and (2) mid-frequency phase-interference effects are reduced.

Choice of Loudspeaker Type

This discussion of loudspeaker directional characteristics does not, of course, present a conclusion that one particular type of directionally controlled loudspeaker is better than any other. The reader is, instead, invited to (1) study the references, (2) check the directional characteristics he requires for a particular installation, (3) determine the architectural limitations as regards size and location, (4) consider requirements of efficiency, power handling capacity, and frequency range, and then (5) make his choice. Æ

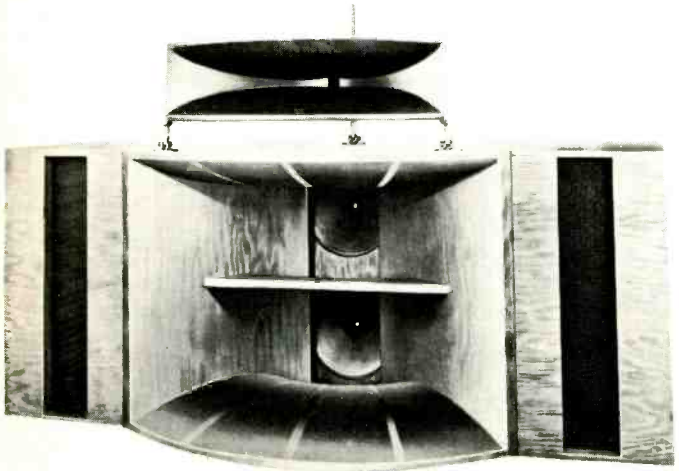


Fig. 6. Large theatre-type RCA model, with straight-sided low-frequency horn and bass-reflex reinforcement, together with high-frequency horn of similar design.

[1] This article is a continuation of the author's article of the same title which appeared in September, 1965.

[2] Harry F. Olson, *Acoustical Engineering*, D. Van Nostrand Company, Inc., Princeton, N.J., 1957, pp. 40-42.

[3] L. L. Beranek, *Acoustics*, McGraw-Hill Book Co., Inc., New York, 1954, pp. 268-284.

[4] Olson, *op. cit.*, pp. 48-49.

[5] E. Flannagan, R. Wolf, and W. C. Jones, Modern theater loudspeakers and their development, *JSMPE*, vol. 28, March, 1937, pp. 246-264.

[6] John K. Hilliard, A study of theater loudspeakers and the resultant development of the Shearer two-way horn system, *JSMPE*, vol. 27, July, 1936, pp. 45-60.

[7] Olson, *op. cit.*, pp. 50-53.

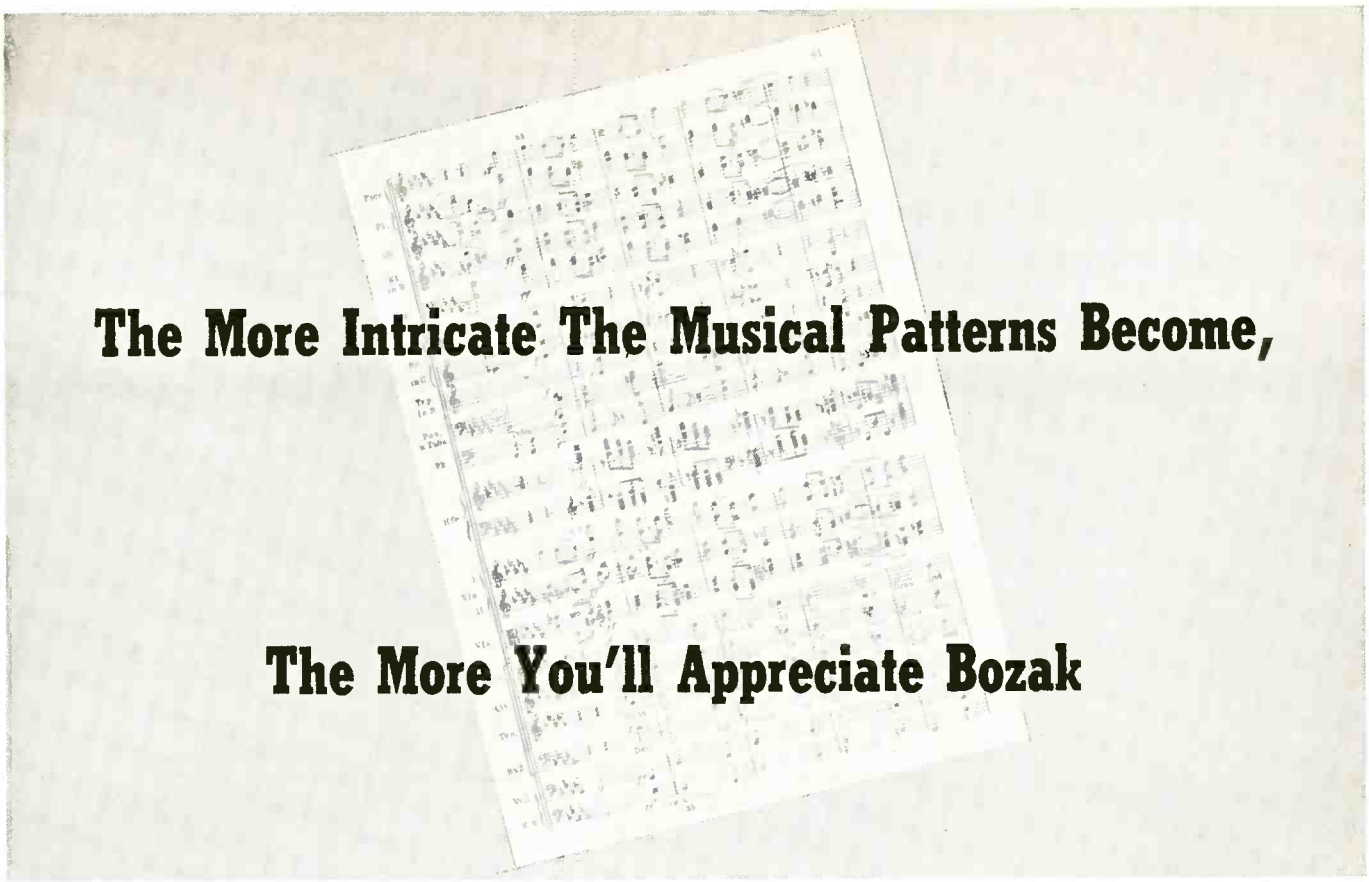
[8] Beranek, *op. cit.*, pp. 106-108.

[9] Olson, *op. cit.*, p. 51.

[10] An effect similar to "fingering" and noticed with both multicell and radial horn (and curved-line sources) results from the finite length of the curved source. Olson, *op. cit.*, p. 42 and 51.

[11] W. E. Kock and S. K. Harvey, refracting sound waves, *J. Acous. Soc. Am.*, vol. 21, September, 1949, pp. 471-481.

[12] J. G. Frayne and B. N. Locanthi, Theater loudspeaker system incorporating an acoustic-lens radiator *JSMPTE*, vol. 63, September 1954, pp. 82-85.



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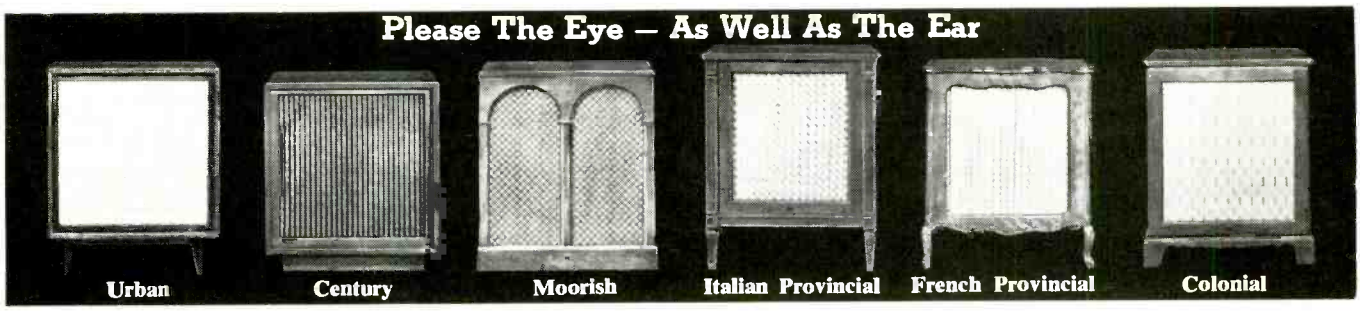

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Forum on Loudspeakers

LARRY ZIDE

WHY DO TWO SUPPOSEDLY good speakers often sound so different from each other? "Well, I'd say that brand X caters to folks who like 'lots of bass,' and brand Y to those who complain at the concert that the orchestra has too much bass. Response curves of these two speakers (and I have in mind specific ones) show 20-db peak/trough ratios, and the locations of the 'well chosen peaks' show that the designers' choices were different." So said *Paul W. Klipsch, Klipsch and Associates.*

"All Scotch whiskies do not taste the same, but the distiller, despite the fact that it comes from the same basic materials, interprets his conception of what is right. It is our considered opinion that companies of repute produce the loudspeaker which, in their opinion, epitomizes the correct approach to the reproduction of sound. We feel that our speaker possesses little or no coloration . . . but we feel sure that other manufacturers view their own products in the same light. The ultimate result is what we term the 'personality' of the speaker.

"Fortunately, one individual does not like the same Scotch as his fellow man, nor do we all prefer blonds—nor do we all hear the same. To some degree, therefore, it is fortunate that speakers do have different personalities, in order to satisfy the widely varying requirements and tastes of today's user." *Frederick A. Towler, Tannoy (USA) Ltd.*

"Among the few good speakers in a given price class, there is no strong difference in sound quality at all. Strong differences would indicate that most or all of the speakers being compared simply were bad. Differences among the few good loudspeakers are subtle and based on very slight variations in the designer's choice of the octave-to-octave balance of the system." *John B. Milder, KLH Res. and Dev. Corp.*

Answers to this question fell between these extremes for most of the speaker manufacturers queried for this Forum. We set out to find the answers to some of the more common questions and problems that face the prospective buyer of a speaker system. There is perhaps more *mystique* involving this product than any other component in the high-fidelity chain. And there need not be.

The speaker is a legitimate component. It has the simple job of converting the near-perfect electrical signal from the amplifier into an equally perfect acoustical signal in the room. Speakers are called (as are also microphones and cartridges) transducers. That is, they convert one kind of energy into another. In this case, it is electrical into mechanical. A speaker pushes and pulls air, causing it to move in the same manner as when the original sound was produced.

But as a transducer, there are certain transduction losses. The signal that goes into a speaker is not necessarily the signal that comes out. Most of the experts we spoke with agree that the speaker is today's weak link; it is the least-perfect component in the music chain.

The questions we asked were posed to find the answers to this problem; that is, if an answer exists at all. At the very least we did find that we are still dealing, for the most part, with a product that is designed by means of an inexact science. The degree of inexactitude is reducing. Eventually it will no longer exist. Then *all* good speakers will sound virtually the same.

Let's begin at the beginning. We wanted to know from the manufacturers what *they* considered the prime guideposts to the consumer's selection of a speaker system.

Said one manufacturer, "The guideposts must include considerations of size (maximum acceptable) cost and, all important, the quality of the sound it produces. The speakers should speak clearly and distinctly and be free of discernable resonances. I would suggest that several types of program material be used in listening to each speaker, i.e., speech, male and female singing voice, guitar and percussive material, chamber music, and symphonic music with especially heavy orchestration. The music used, if properly selected, will reveal the smoothness (or adversely, the aberrations) of the system. A good speaker should play everything well and sound natural doing it. It should not sound heavy in the bass, nor shrill and strident in the high-frequency end, nor should there be much "hissiness.' All instruments should sound properly prominent. This is all by way of indicating that quality is *the* all-important attribute to look for in a speaker."

Pioneer's *R. von Sacken* felt that "No speaker system made today handles *all* types of music performance equally well. I feel that the consumer ought to bring his own records, or at least, insist on hearing the kind of music he prefers to hear when he is evaluating speakers. Then he should buy the speaker that sounds best to his ear. And if a speaker sounds better at a low price than one at twice the price don't automatically assume that quality is equated with cost. Buy the speaker that sounds best."

AR's Edgar Villchur summed it up best by saying, "Look for sound as close as possible to the original live music, considering the limits of budget." We agree. Of course, there is a clear implication here to the effect that a consumer can best fortify himself by regularly attending live concerts. If the ultimate goal is indeed to be the simulation of "live" music, then it behooves us to be familiar with that sound. All too many people today criticize live-performance sound on the basis of its comparison to recorded sound. Isn't this a bit like the dog being wagged by the tail?

What Makes Good Speaker Sound?

Here is where we found sharply differing opinion among the manufacturers. The question of speaker size and quantity (in a system) is hardly one on which many speaker engineers agree. One-way, two-way, three-way, and more- speaker systems are common and you will find advocates of each. The same is true of big *versus* little speakers. That battle goes on undiminished.

Speaker Size

"Good speaker systems and bad speaker systems come in all sizes. Nevertheless, it is a theoretically valid and easily demonstratable fact that a good big speaker system is better than a good little speaker system. Dynamic range is greater. Distortion is lower. Efficiency is higher. And a big system is less at the mercy of individual room acoustics than a little system." So says *James B. Lansing Sound, Inc.'s T. J. Jennings.*

From *Empire's Herb Horowitz,* "Generally, speaker quality relates to speaker size. The low frequencies are directly related to speaker enclosure size."

$$f_L = \frac{1}{2\ MC}$$

f_L = low-frequency resonance
M = mass of cone mechanism
C = compliance of air in the enclosure.

"The larger the enclosure the more air inside, the more C.

"The larger the C, the lower the low-frequency resonance—which is roughly the lower limit of frequency range.

"For any given woofer—the larger the box, the better the lows.

"Of course you can make M heavier. This lowers the resonance, but sacrifices efficiency. This is the technique which is used with smaller enclosures —two cubic feet and less—but it forces many amplifiers to drive beyond their linear operating range.

"It's much better to enlarge C if space permits."

Allied Radio's S. S. Schuerr stated, "A speaker's size DOES NOT (capitals his) relate to over-all speaker quality. Some very small speakers give very excellent sound reproduction. Some eight-inch speakers sound better and out-perform some twelve-inch speakers."

A manufacturer/importer-that asked not to be quoted felt that size was not necessarily related to quality but that design objectives are more likely to be satisfied, with less compromise, as the system is allowed to grow in size.

"We are still dealing with the unalterable laws of physics," he said.

"Yes, generally the larger woofers or multiple woofers, guarantee a higher quality standard. They require larger enclosures and are capable of higher quality and extended-range bass response," said *F. L. Mergner* of *Fisher Radio.*

From KLH, "If the question means 'does the size of a box have any relationship to the size of the sound?" the answer is definitely no. The overall spaciousness and breadth of sound, of course, is a function of high frequencies, which require a very small speaker indeed. As for bass there is simply no problem in getting a fully adequate amount from virtually any cabinet size you choose. The point is to consider bass response and efficiency together. In terms of the amplifier power needed to deliver good response at 40 Hz, it makes no sense to attempt this in a cabinet of shoebox size, since you are simply making the customer pay in amplifier power for your expertise. Once you are up to a cabinet of normal bookshelf size, however, there is simply no problem whatsoever in getting an adequate level of bass response."

From Tannoy, "In our opinion a good big one will always beat a good little one: the larger low-frequency diaphragm produces more-open sound of the original source. Here we come to a quality of the speaker which is not capable of being measured: its 'personality.' The basic design of our twelve- and fifteen-inch Monitor Dual Concentric loudspeakers is identical; the frequency response is the same. In fact, all measurable factors are reasonably equal and yet there is a difference, and we relate it to the difference in low-frequency diaphragm area and excursion."

Edgar Villchur summed up his thinking by saying, "Speaker size relates only to power-handling capability. For example, our own AR-4x could be designed to have the same frequency characteristics as the AR-3 (resonating at the same 44 Hz) if we were willing to accept a very low power-handling capability."

How Many Speakers Make a System?

As with the previous question this was answered in accordance with the marketing philosophies (which are dictated by the basic design philosophies) of the respective manufacturers.

Robert Schmetterer of Hartley Products Corp. puts it succinctly, ". . . we believe that multi-speaker units should be as limited in number as possible, commensurate with obtaining the quality desired. Since every speaker has some distortion it is evident that this should be kept as low as possible by using as few speakers in a system as possible."

R. T. Bozak, president of the company that bears his name felt that several speakers in a system can do a better job than fewer; ". . . multiple loudspeakers enhance the realism quality by virtue of reducing the energy content."

Fred W. Nichols of Electro-Voice covered all of the principal points.

"This is really two questions in one. The most common approach is to divide the audio spectrum into a series of bandpass ranges, each fed to a special speaker. Less commonly, multiple speakers may be employed to cover a specific frequency range.

"A one-way speaker is the ideal case. However, at the present state of the art we know of no way to design a single speaker with the desired smoothness and transient response throughout the entire audio range while maintaining the desired dispersion even at high frequencies. As a result, we are forced to design specialized components for different portions of the frequency spectrum and to combine them with the fewest possible deleterious effects."

Mr. Nichols continues, "An eneering maxim of interest here states that the simplest design which provides the desired performance is the best design. Applying this principle to system design, the first crossover point should be picked as high as possible for simplicity and yet not compromise the performance factors. A ten-inch woofer, for example, can be designed to maintain the desired qualities as high as 1 kHz or so before the dispersion begins to narrow. At the present state of the art, a tweeter can be designed with the desired smoothness, transient response, and dispersion from approximately 1 kHz to the limit of audibility. Thus, it is presently possible to design a two-way, ten-inch speaker system uncompromised in any area of performance. With a larger woofer three-way design becomes necessary.

"One school holds to the concept, 'the more speakers, the better.' While this may be the result of an inability to design state-of-the-art speakers, it more likely is simply a yielding to consumer demands. Given the choice of a two-way or three-way speaker system at the same price, the consumer will take the three-way system because he reasons he is getting 50 per cent more speakers for his money. Some manufcturers take this course of least resistance for two reasons: it is easier to supply the consumer what he thinks he wants than to educate him to what he needs; and more importantly, it is easier to design a poor three-way system than a good two-way system."

Mr. Nichols concludes, "The use of multiple speakers covering the same high-frequency range is never

satisfactory. Although the on-axis response may be improved by this technique, the phase cancellation between the two speakers when off axis gives the response curve the appearance of an alpine skyline. Because of the long wave-lengths involved at low frequencies, multiple woofers may be used, provided they are crossed over at a low-enough frequency to avoid this problem."

It's clear to us at least that there are as many answers to this question as there are manufacturers. We must however, underscore one point made above. All too many consumers that we have known or met are seeking *quantity* in a speaker system; all too few know how to find *quality*.

Dispersion

The dispersion characteristics of a loudspeaker system may have a profound effect on the quality of the sound you will hear. Most speakers tend to narrow down in dispersion width as frequency goes up. Most experienced listeners are all too familiar with the type of speaker that sprays high frequencies as from a high-velocity garden hose. This can be a most disquieting sort of sound. It can reach the point where you feel as if you are experiencing a cranial lobotomy.

Bass dispersion is no problem. Not that it is not desirable but as one manufacturer put it, "Bass is going to disperse . . . you can't keep it from it unless you make the bass radiator comparable to a wave length or two . . . say 40 or 60 feet in diameter!"

But treble dispersion is another thing. High frequencies must be dispersed.

According to Fisher Radio, "high frequency dispersion is important since poor dispersion reduces the acceptable listening area in a room. If good dispersion is lacking there will be a small 'hole-in-the-wall' sound."

"High-frequency dispersion is of great importance to the listener in stereo reproduction especially, since it is in the area of higher frequencies that the clues to exact placement of sound source can be found. The first step to reproduction, naturally and accurately, of a musical instrument or a group of musical instruments must be to duplicate to some close degree the dispersion characteristics produced by the original. The size of the stereo listening area can be seriously affected by high-frequency dispersion characteristics. The wider the area of dispersion the larger the stereo listening area—that is, the area where real stereo can be heard. The use of a 360-deg. dispersion would best satisfy these criteria and produce the most lifelike and useful results." So states *Oscar Kraut of KSC Systems, Inc.*

Every manufacturer to whom we spoke was in agreement on the importance of high-frequency dispersion— ". . . a directional loudspeaker gives a different ratio of direct to reflected sound than one with wide dispersion. But exactly how far we should go in making a loudspeaker non-directional has yet to be established. What is more important than the actual distribution angle at a given frequency is the uniformity of distribution up through the crossover frequency . . .," states JBL's *T. J. Jennings.*

Specifications

One of the numbers that accosts the speaker buyer is the rating for power-handling capability. We doubt that there is an area of more confusion than is engendered by this specification. This is so even when it is understood there is little knowledge of the relationship of this figure to the use of the speaker.

From Allied Radio, "Speaker power ratings should be considered by the user in home installations to make sure that his speaker is capable of handling the total power output of his amplifiers to avoid damage to the speaker system by any accidental increases in volume."

"Power rating provides a guide for the user in selecting safe amplifier power relative to the maximum power handling of his speaker. This capability not only relates to failure hazards but also to distortion," said Altec Lansing's spokesman.

One manufacturer felt that "the user must know the minimum power required for his speaker, and, in some cases (halls, for example), the acoustical power capability of the speaker."

Another numbing figure that is often tossed about is the impedance rating of a speaker. Some firms are realistic enough to call it the *nominal* impedance rating. Most speakers rise significantly in impedance as frequency is lowered toward the resonance point. And there is no reason to assume that the impedance curve is "flat" over the range of the speaker. Nominal ratings by manufacturers usually reflect the 400-Hz impedance (if it is a full-range system) but this need not be so.

The peculiarity of this situation works, in part, to the advantage of transistor amplifier outputs. Solid-state amplifiers will transfer less power to a speaker as the apparent load is increased. We've already noted that impedance goes up as speaker resonance is approached, reaching a peak at resonance. So too does amplitude tend to rise. With the reduced output caused by the higher-impedance load, there tends to be a strong damping effect on a loudspeaker, often resulting in improved response over that achieved with a vacuum-tube output-transformered amplifier.

A few amplifiers cannot tolerate extremely low-impedance loads. These amplifiers will not operate to complete satisfaction with speakers that present a 4-ohm load. (This is particularly true if the speaker's impedance curve actually dips below 4 ohms at the bass or mid-range end.)

Said *Altec-Lansing's H. S. Morris,* "Although it has always had a hazardous bearing on vacuum tube amplifiers, loading of a transistor amplifier by a loudspeaker having an impedance lower than the rated output impedance of the amplifier invites failure of the amplifier. Most manufacturers have developed various devices to protect the amplifier in case of such 'loading down' of output either by direct short circuits, or by the use of poorly designed loudspeaker systems which, although carrying an acceptable nominal impedance rating, do at some frequencies offer impedances much lower than the amplifier was designed to work into."

Lawrence W. Fish of *H. H. Scott* had this to say. "Speaker impedance is of *primary* importance with transistor amplifiers. A well-designed amplifier is essentially a constant-voltage source, delivering the same output voltage into any load, regardless of its impedance. Since power output is equal to the voltage squared divided by the load impedance, $E^2 \div R = W$, the lower the impedance, the higher the output power. A given set of output transistors can only deliver so much power before its maximum current rating is exceeded. Therefore by lowering the impedance below the minimum recommended value (usually 4 ohms), it may result in output fuses having to be replaced fairly frequently.

"Another important consideration is that the speaker impedance remains constant over the operating frequency range of the amplifier. If the impedance varies, so does the power output. One may find that at 1 kHz his amplifier is delivering 5 watts to the speaker, and because of a dip in impedance, at 5 kHz it is delivering 25 watts. Needless to say, this would make the system sound a bit peaky, and if the system is being played at a high power level and a burst of 5

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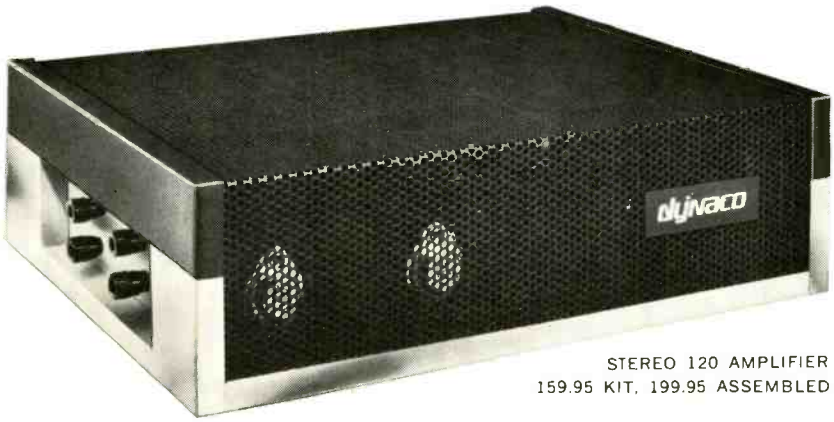

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kHz program material comes through —pop go the fuses."

R. Schmetterer of Hartley cautioned, "In view of the output ratings given on the new transistor amplifiers, many are attaching a great deal of importance to impedances of speakers today. They find that what may have been purchased as a forty-watt amplifier may only be capable of half that, if used with certain impedances. Thus a purchaser should make certain of the figures on both components before making his decision."

Electro-Voice's *Fred Nichols* added, "There has been some discussion of the impedance-*versus*-frequency variation of a speaker and its relation to transistor amplifiers. Not only is impedance compensation unnecessary, it is undesirable. Speakers are designed for use with constant-voltage sources. This means that the amplifier voltage output should not vary as the load changes. This requires low internal source resistance, which is high damping factor, one of the *fortes* of the transistor amplifier. Although the speaker impedance does rise as frequency increases, the efficiency increases also to maintain a flat curve. Any attempt to keep the impedance down near the nominal system impedance will increase the total power required from the amplifier, and thus may introduce additional distortion."

The Weak Link

Is the speaker the weak link in the high-fidelity component chain?

"Yes," said KSC Systems," loudspeakers produce distortion—both harmonic and intermodulation—far in excess of what is at present acceptable in amplifiers. So long as speaker performance remains a matter of preference based on vagaries and conflicting mis-information, the worst speaker made is entitled to vie with the best, sometimes at a similar price, occasionally even higher. Once we decide exactly what a speaker is supposed to do and how well the average interested music listener (who is, after all, the interested stereo-components buyer) can hear, areas for improvement will become apparent. When this happens, improvement will be necessary, and as a result, possible. Loudspeakers are roughly at the point amplifiers were 25 years ago."

JBL does not see it that way. "Surprisingly, transducers (phono pickups and loudspeakers) today are considerably better than the recorded material which they are expected to reproduce. Moderately-priced home loudspeakers have improved to such a degree in the past ten years that room acoustics make a bigger difference in sound quality that the differences between many of the loudspeakers themselves. The weakest link is without question the average buyer's listening room."

"I agree that the speaker system is the weak link of the high-fidelity system. Nor do I see any breakthroughs in the foreseeable future." So said *R. von Sacken* of *Pioneer*.

Fred Towler concluded, "We do not agree that the speaker, providing of course that it is a quality product and designed with the ultimate reproduction in mind, is the weakest link in the chain. The record itself, and the cartridge, share an equal problem, particularly in stereophonic reproduction. The strongest link is undoubtedly the amplifier."

Speaker-System Efficiency

Efficiency has nothing to do with quality but it is, nevertheless, a factor to consider. Speaker efficiency may be likened to automobile weight. A heavy car, or a high-speed car must have a high-horsepower engine. So, too, must the low-efficiency speaker be driven by a more powerful amplifier. But just as the Volkswagen can go with all of 60-odd horsepower, so too can the high-efficiency speaker operate with a lower-power amplifier.

But the question of a standard by which this information could be conveyed to the consumer is one that remains unsolved.

From Empire, "The EIA efficiency measuring system (a specific sound-pressure level on axis at a given distance with a given power input to the speaker) would be useful if it were related to per cent efficiency."

Said KLH, "It would seem rather simple to come up with a formula for stating the efficiency of a speaker in the range of piston operation when it is mass controlled between 200 and 600 Hz. This would be based upon the area of the cone, the mass of the moving system, the volume of copper in the voice-coil gap times the square of the magnetic field strength, and the percentage of resistance of the copper outside the magnetic gap to that inside. Differences in efficiency derived from these simple factors correspond exactly to the difficult-to-measure audible differences in efficiency."

And from AR, ". . . the most comprehensible system would be to specify the amplifier power required for a given sound level in a given room. While the elements of this specification can be defined rigorously from the consumer's point of view it is only important that they represent typical room size and absorption."

Lawrence W. Fish of Scott offered a consumer store-test system. "A person may determine the relative efficiency of a speaker system by listening and comparing. With the same level setting on the amplifier, the louder sound will be the most efficient. Such a comparison should be made with a great deal of care and with all different types of program material, since it is possible that the increase in sound level may occur only over a limited frequency range.

"Unless the dealer has a 'free home trial' arrangement, this is an almost impossible test to perform in his showroom. There is, however, an alternative. Random noise should be fed through the systems being compared (the best source of random noise is from an FM tuner tuned off-station), and the listener can then judge the relative sound level and can also get a very good idea of the smoothness of the frequency response curve. If the sound approaches a roar, there is a peak in the low frequency end of the curve. If the sound is like a bright hiss, there is a peak in the high frequency end. You can get a good idea of what these peaks sound like by boosting bass or treble with the amplifier tone controls. Ideally, it should sound pretty much like the shower running in your bathroom."

The Big Question of Standards

A common consumer complaint is that it is impossible to judge a speaker from its published specifications. Is this because the manufacturer is not willing to give these specs?

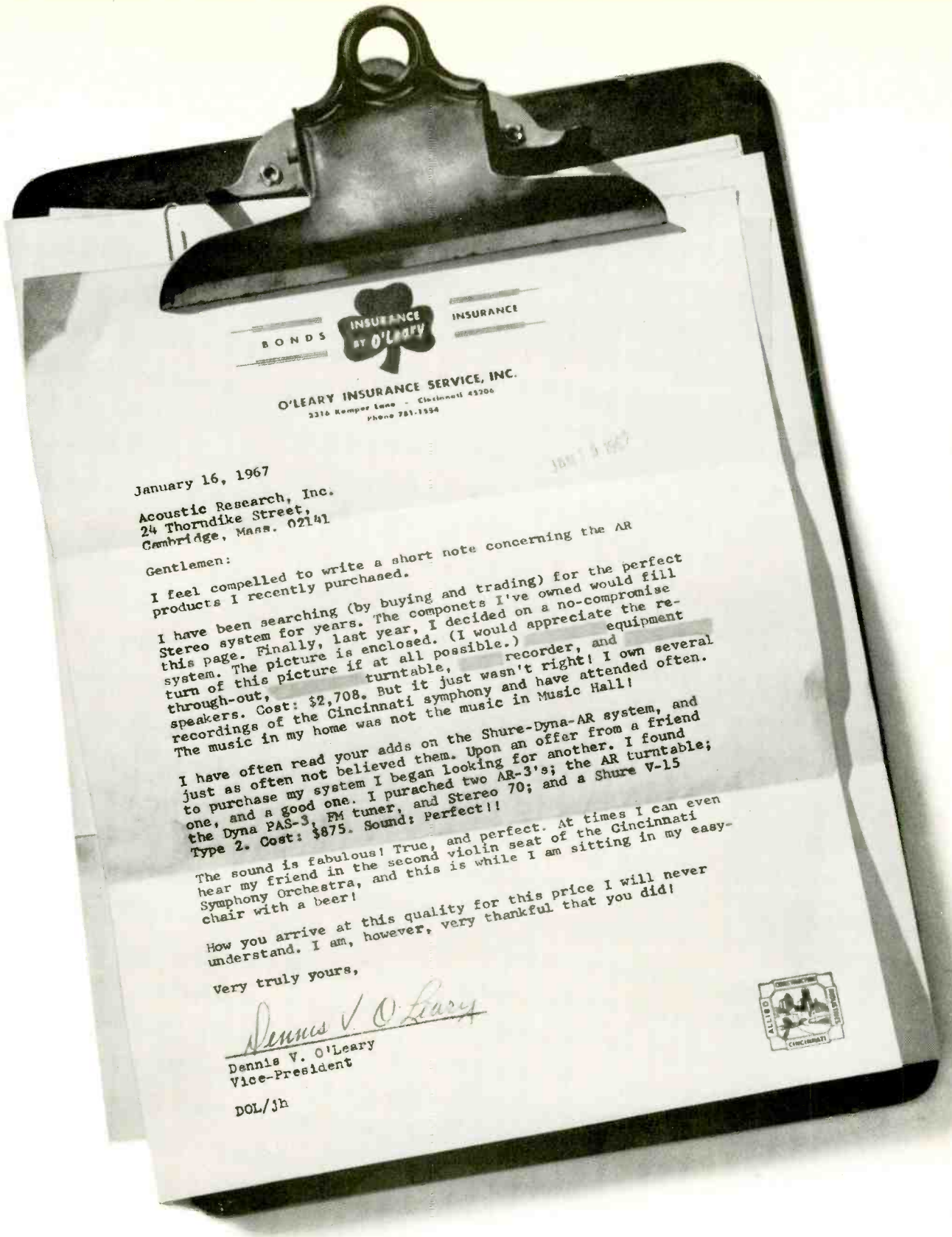
Said one, "It is because if specifications are to be honest they will look very bad in comparison to what consumers are used to seeing in amplifier specifications."

But when we began to ask about additional meaningful specifications we found ourself embroiled in a controversy that seems as big as the number of speaker design engineers.

"A family of frequency-response curves from zero to at least 60 deg. off axis and distortion-*versus*-frequency curves at typical acoustical power outputs," according to *Edgar Villchur* of AR.

"I would suggest standardization of impedance, efficiency, and power-handling capacity as a first step toward consumer education," said *Herb Horowitz*.

Allied Radio's spokesman had this to say, "Specifications are needed for power-handling ability, to be given in watts in sine wave. Meaningful frequency-response and dB variations are needed; the diameter of the actual cone, not just the frame as is common now, should be given; magnet



BONDS INSURANCE BY O'Leary INSURANCE

O'LEARY INSURANCE SERVICE, INC.
2316 Kemper Lane - Cincinnati 45206
Phone 751-1554

January 16, 1967

Acoustic Research, Inc.
24 Thorndike Street,
Cambridge, Mass. 02141

Gentlemen:

I feel compelled to write a short note concerning the AR products I recently purchased.

I have been searching (by buying and trading) for the perfect Stereo system for years. The componets I've owned would fill this page. Finally, last year, I decided on a no-compromise system. The picture is enclosed. (I would appreciate the return of this picture if at all possible.) equipment through-out, turntable, recorder, and speakers. Cost: $2,708. But it just wasn't right! I own several recordings of the Cincinnati symphony and have attended often. The music in my home was not the music in Music Hall!

I have often read your adds on the Shure-Dyna-AR system, and just as often not believed them. Upon an offer from a friend to purchase my system I began looking for another. I found one, and a good one. I purached two AR-3's; the AR turntable; the Dyna PAS-3; FM tuner, and Stereo 70; and a Shure V-15 Type 2. Cost: $875. Sound: Perfect!!

The sound is fabulous! True, and perfect. At times I can even hear my friend in the second violin seat of the Cincinnati Symphony Orchestra, and this is while I am sitting in my easy-chair with a beer!

How you arrive at this quality for this price I will never understand. I am, however, very thankful that you did!

Very truly yours,

Dennis V. O'Leary

Dennis V. O'Leary
Vice-President

DOL/jh

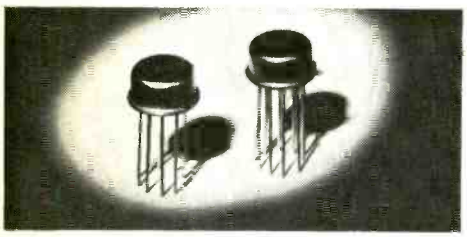
The thing that intrigued us most about this letter from Mr. O'Leary (whom we have never met) was his use of a "live vs. recorded" comparison—the Cincinnati Orchestra in concert and on records—to evaluate high fidelity components.

We asked and received Mr. O'Leary's permission to reproduce his letter, and here it is, secretary's typos and all. Only the first group of brand names has been deleted.

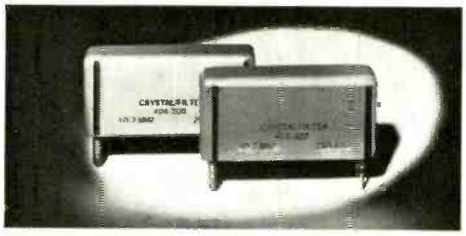
ACOUSTIC RESEARCH, INC., 24 THORNDIKE STREET, CAMBRIDGE, MASSACHUSETTS 02141

Check No. 122 on Reader Service Card.

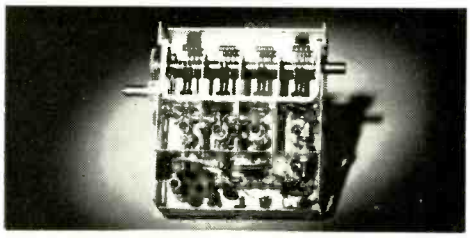
Announcing The World's Most New Heathkit® All-Silicon Transistor AR-15...150



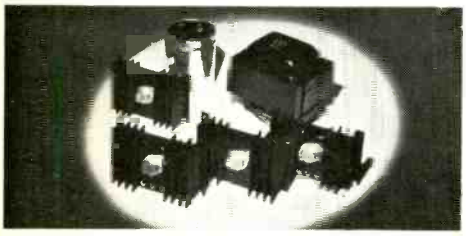
INTEGRATED CIRCUITS . . . tomorrow's electronic miracle today . . . first time ever in a stereo-hi-fi kit. Two are used in the IF amplifier section for hard limiting, excellent temperature stability and increased reliability. Each integrated circuit is the size of a tiny transistor, yet each contains 28 actual parts . . . 10 transistors, 11 resistors and 7 diodes!



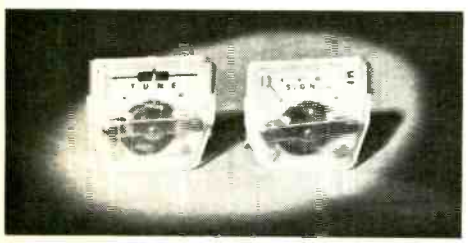
CRYSTAL FILTERS . . . another exclusive. Two are used in the IF amplifier section to replace the usual transformers. No coils, therefore no alignment or adjustment is ever required. Precise controlled bandwidth produces the finest fidelity with alternate channel selectivity of 70 db.



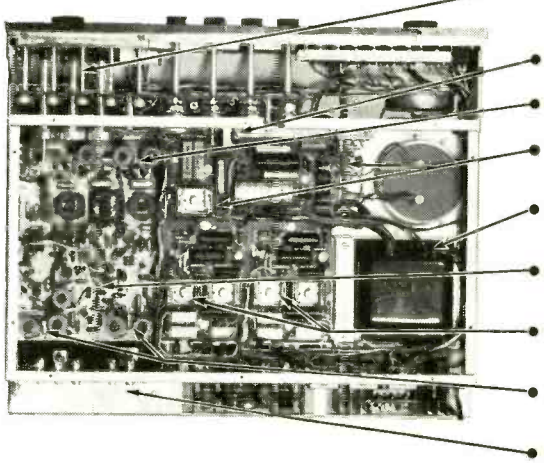
FIELD EFFECT TRANSISTOR FM TUNER . . . cascode 2-stage FET RF amplifiers and an FET mixer provide high overload capability, excellent cross modulation index and image rejection. The completely shielded tuner has a 4-gang variable capacitor and 6 tuned circuits for extreme selectivity under the most adverse conditions. Factory assembled & aligned to speed kit construction, assure peak performance.



150 WATTS DYNAMIC MUSIC POWER . . . the highest power output of any stereo receiver! Made possible by 4 conservatively rated, individually heat-sinked and protected output transistors powered by an unusually large power transformer and filter capacitor. 75 watts music power per channel — 50 watts continuous power per channel.



TWO CALIBRATED TUNING METERS . . . another exclusive! A signal strength indicator tells you when you receive the strongest signal . . . a special "Center-Tune" meter puts you on exact station frequency. Both meters use d'Arsonval movements.



All-Silicon Transistor Circuitry . . . for maximum reliability, superior stability.

Front Panel Input Level Controls . . . up front for convenient adjusting — protected from accidental setting changes by an attractive hinged door.

Tone-Flat Switch . . . bypasses tone control circuitry for completely flat response.

Super SCA Filter . . . removes SCA & noise frequencies above 57 kHz for clean, quiet listening.

Electronic Filter Circuit . . . provides power supply with exceptionally low ripple and excellent regulation.

Massive Power Supply . . . for low heat and superior regulation — electrostatic and magnetic shielding for lowest hum and noise.

Noise-Operated Squelch . . . a step ahead of the normal circuitry to hush between-station noise *before* you hear it.

Transformerless Design . . . direct coupling between driver and output stages for lowest phase shift and distortion.

Filtered Left & Right Channels . . . for direct "beat-free" stereo recording . . . a low cost way to build your own music library.

Recessed Inputs & Outputs . . . no protruding array of leads to waste valuable space — fits flush against any wall or surface.

Check No. 128 on Reader Service Card.

"Black Magic" Panel Lighting

Even when not in use, the new Heathkit AR-15 remains quiet and well-mannered . . . its majestic midnight face unmarred by any dial or scale markings. And when you're ready for the finest in stereo listening, a simple touch of the power switch and presto! . . . the "black magic" panel lights up with an extended slide-rule dial for easy tuning, and immediate identification of all controls. The "black magic" is in the unique tinted acrylic "dual-panel" design.

Advanced Stereo Receiver... Watts... AM-FM-FM Stereo...IC's...$329.95†

Crowning Achievement Of The World's Most Experienced Solid-State Audio Engineers . . . the new Heathkit AR-15. Compare the advanced features on the opposite page. Compare the "state-of-the-art" features below. Compare the specifications. There's nothing like it anywhere in the transistor stereo market place!

Positive Circuit Protection . . . four Zener diodes and two thermal circuit breakers protect the driver and output transistors from overloads and short circuits of any duration. A special front-panel Hi-Temp indicator lights when the thermal breakers have opened.

Stereo Threshold Control . . . for automatic switching to stereo *and* automatic switching to mono when signal/noise ratio becomes too low for good stereo reception. A stereo indicator light automatically signals when stereo is received.

Adjustable Phase Control Compensator For Station Differences . . . so *you* can adjust for the best possible stereo.

Stereo Only Switch . . . silences all monaural transmissions when you wish to listen to stereo broadcasts only. An added tuning convenience!

FM Stereo Noise Filter . . . eliminates noise *without* diminishing high frequency response.

Two Stereo Headphone Jacks . . . conveniently located on the front panel for private listening. In addition, there's a speaker ON/OFF switch.

Capacitor Coupling to the speaker terminals protect the speakers.

Direct Coupled Output Circuit — no output transformers — for improved high frequency response.

Built-In Test Circuit Volt-Ohm-Meter . . . the signal strength indicator doubles as a VOM for check-out during or after kit construction. Lets you test kit circuitry before final assembly.

Choice Of 3-Way Installation . . . mount horizontally or vertically in a wall, your own custom cabinet or optional Heath factory-assembled wrap-around walnut cabinet with vented top. The AR-15's heavy die-cast, chrome-plated front panel with machined anodized aluminum knobs add a touch of luxury to any surroundings. Order yours now!

† Kit AR-15, (less cabinet), 28 lbs. **$329.95**
AE-16, optional walnut cabinet, 7 lbs. **$19.95**

AR-15 SPECIFICATIONS—AMPLIFIER SECTION: Dynamic Power Output Per Channel (Music Power Rating): 8 ohm load; 75 watts. **Continuous Power Output, Per Channel*:** 8 ohm load; 50 watts. **Power Bandwidth For Constant 0.5% Total Harmonic Distortion*:** 6 Hz to 25 kHz. **Frequency Response (1 watt level):** ±1 db, 6 to 50,000 Hz. ±3 db, 4 to 70,000 Hz. **Harmonic Distortion:** Less than 0.5% from 20 to 20,000 Hz at 50 watts output. Less than 0.2% at 1,000 Hz with 50 watts output. Less than 0.2% at 1,000 Hz with 1 watt output. **Intermodulation Distortion (60 Hz: 6,000 Hz=4:1):** Less than 0.5% with 50 watts output. Less than 0.2% with 1 watt output. **Damping Factor:** 45. **Input sensitivity:** PHONO; 2.2 millivolts (overload 155 mv). TAPE; 200 millivolts (overload 4.5v). AUX; 200 millivolts (overload 4.5v). **Hum & Noise:** Volume control at minimum position; —80 db. PHONO; (10 millivolt reference); —60 db. TAPE & AUX. (200 millivolt reference); —65 db. **Channel Separation:** PHONO; 45 db. TAPE & AUX.; 55 db. **Output Impedance (each channel):** 4, 8 & 16 ohms. **Tape Output Impedance:** 100 ohms. **Input Impedance:** PHONO; 51 K ohm (**RIAA equalized). AUX., TAPE & TAPE MON.; 100 K ohm. **Tape Output:** 0.17 volt. **FM SECTION (Monophonic): Tuning Range:** 88 to 108 MHz. **Intermediate Frequency:** 10.7 MHz. **Frequency Response:** ±1 db, 20 to 15,000 Hz. **Antenna:** Balanced input for external 300 ohm antenna, unbalanced, 75 ohm. **Volume Sensitivity:** Below measurable level. **Selectivity:** 70 db*. **Image Rejection:** 90 db. **IF Rejection:** 90 db minimum*. **Capture Ratio:** 1.5 db*. **AM Suppression:** 50 db*. **Harmonic Distortion:** 0.5% or less*. **Intermodulation Distortion:** 0.5% or less*. **Hum & Noise:** 65 db*. **Sensitivity:** 1.8 uv*. **Spurious Rejection:** 100 db*. **FM SECTION (Stereophonic): Channel Separation:** 40 db or greater. **Frequency Response:** ±1 db. 20 to 15,000 Hz. **Harmonic Distortion:** Less than 1% at 1,000 Hz with 100% modulation. **19& 38 kHz Suppression:** 55 db or greater. **SCA Suppression:** 50 db. **AM SECTION: Tuning Range:** 535 to 1620 kHz. **Intermediate Frequency:** 455 kHz. **Sensitivity:** 12 microvolts at 1,000 kHz. **AM Antenna:** Built-in rad type, connections for external antenna. **Image Rejection:** 60 db at 600 kHz. 40 db at 1,400 kHz. **IF Rejection:** 70 db at 1,000 kHz. **Harmonic Distortion:** Less than 1.5% at 400 Hz, 90% modulation. **Hum & Noise:** 45 db. **GENERAL: Transistor & Diode Complement:** 69 transistors, 43 diodes & 2 integrated circuits. **Front Panel Controls & Switches:** AM & FM Tuning; 535 to 1,620 Hz and 88 to 108 MHz. SOURCE Switch; PHONO, AM, FM, TAPE & AUX. Dual Tandem VOLUME Control; Dual Tandem BASS Control; provides 15 db boost and 17 db cut at 20 Hz. Dual Tandem TREBLE Control; provides 15 db boost and 15 db cut at 20 kHz. The Bass and Treble controls can be disabled for FLAT frequency response. BALANCE Control. SPEAKERS Switch. POWER Switch. MODE Switch. TAPE MON. Switch. FM Switch. NOISE FILTER Switch. LOUDNESS Switch. PHASE Control. SQUELCH Control. STEREO THRESH (Threshold) Control. L & R AUX. Controls. AM-FM Level Controls. PHONO Level Controls. TAPE Level Controls. TAPE MONITOR Level Controls. SEP ADJ (Separation Adjust) Control. 19 kHz Test-Adjust Switch. SIGNAL Meter V, R, Normal Switch. **AC Outlet Sockets:** Accessory outlets, rear chassis apron, one switched (350 watts maximum), and two unswitched (350 watts maximum). **Power Requirements:** 105-125 or 210-250 volt 50/60 Hz AC. **Dimensions:** Overall, 16⅞" wide x 4¾" high x 14½" deep. **Mounting Position:** Horizontal or vertical.

*Rated IHF (Institute of High Fidelity) Standards.
**RIAA (Record Industry Association of America).

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weight and strength in gauss and flux; the size of the coil; the depth of cone travel; damping factor needed; impedance; and cone material and/or suspension."

From KSC came the advice that meaningful standards of a wide scope do exist. "I suggest reference to standards recommended by the International Electrotechnical Commission (IEC) and summarized among others in the Bruel & Kjaer catalogue. Many pieces of their equipment were designed with an eye to these standards being used as recommended."

The whole question of measurement techniques really boils down to one problem. So we tossed it at the manufacturers. Can we take a speaker into a laboratory, measure it, and come out with the knowledge of how it sounds?

". . . we believe that there are very simple laboratory methods for evaluating and predicting the ultimate sound quality of a loudspeaker. The important thing is to integrate the performance of the speaker with the characteristics of an average listening room. In developing speakers at KLH, we begin with slow-sweep sine-wave frequency measurements, with a microphone placed close enough to the speaker to avoid room effects. This, of course, simply gives an indication of point-to-point smoothness, and says nothing about desirable balance and over-all sound quality. We then move the microphone back, and from several positions, measure overall response by using filtered segments of random noise, rather than sine waves, to give what we think is the clearest indication of the speaker's response when integrated with room conditions. The filtered-noise technique minimizes grossly unrepresentative room effects, and enables us to adjust the octave-to-octave response of a basically excellent speaker mechanism by acoustic and electrical means for desirable balance. This is the best way we know of to design a finished speaker system."—*John B. Milder.*

"Yes, it is possible for a laboratory to evaluate a loudspeaker. This is always the first step and in the end is also resorted to so as to confirm what the ear feels it hears," said Altec Lansing.

"Yes, the measurements I have described earlier as significant are not simply a matter of our opinion, but have been validated on the basis of whether or not they predict the accuracy with which a speaker will perform in live-*versus*-recorded tests, using both white noise and live musicians."—*Edgar Villchur.*

"Within limits, yes," stated *Oscar Kraut* of KSC.

"No" said *Robert Schmetterer* of Hartley Products, "there are too many intangibles which affect actual sound; very few people live in anechoic chambers (*do any?* Ed.). Lab measurements help but are not the be-all and end-all. The 'tone' of a speaker cannot be measured, there are warm sounds, hard sounds, cold sounds, and so on."

"The simplest explanation of this question is the case of a slightly rubbing voice coil. This condition is extremely difficult to detect with response curves and standard test procedure. However, the sound is horrendous to the ear," according to Altec Lansing's *Glenn Malme.*

T. J. Jennings of JBL concluded with ". . . even with all the measurements in the world the ear can pick up deficiencies that can be measured in no other way. You buy a Steinway because it sounds good. You choose a brand of color film because it looks most 'natural' to you. You must actually hear a loudspeaker before you know that you will like it."

Fuse Protection

Several of the manufacturers we reached commented on the oft-asked question of speaker fusing. Under certain conditions speakers can be driven into overload condition. Is a fuse a protection? We have always held that fusing a speaker to protect it against overload is a waste of time. There is no protection. A number of engineers agreed. One said it best, "On the surface this seems a reasonable and worthwhile thing to do. However, even an 'instantaneous' fuse will stand a five times current overload for approximately a tenth of a second before it blows. This means that the speaker is receiving 25 times the power rating of the fuse for a fraction of a second. If any damage will be done by such an overload, it can be done during this split second."

There are, we suspect, many other areas of speaker design which time and space do not permit us to touch. One manufacturer commented, quite rightfully, that any one of the areas we covered could well have been expanded into a full-fledged article.

There is the big question of crossover networks. They cannot be inserted into a system without substantial effect on a part of the audio spectrum. But the meaningfulness of this is not at all clear when it comes time to relate it to the sound that speakers make.

Prognostication

What does the future hold for loudspeakers?

"Company secrets," said one.

"Nothing new in sight," said another.

". . . we would like to be able to carry the concept of the integrated amplifier/speaker farther than we have already. For example, suppose we could match the low-frequency characteristics of the speaker system to correct for undesirable room characteristics . . . suppose we could refine the coupling between amplifier and loudspeaker to the point that the combined system would have no more distortion of any kind than the best amplifier available today . . . suppose we could control sound energy so that the perceived source of sound could be located independently of the physical location of the loudspeaker? All of these exist today only in imagination, yet all of them are possible and may well be practical in the future."—JBL.

". . . we are constantly improving the grade of polymers we use. We are now working on the reproduction of sound in the region of 8 Hz."—Hartley.

"I do not expect to see any dramatic change in speaker design in the near future, but rather a gradual improvement of the existing design. Samples of speakers with better cone suspension, voice coil, and magnet structure are being evaluated and incorporated in systems every day. Generally speaking, what this means to the consumer is that as improvements are made, systems can be put in smaller boxes and still maintain good sound reproduction."—Scott.

"Developments in the fields of plastics and bonding techniques have already influenced speaker production and will affect it even more in the future."—KSC.

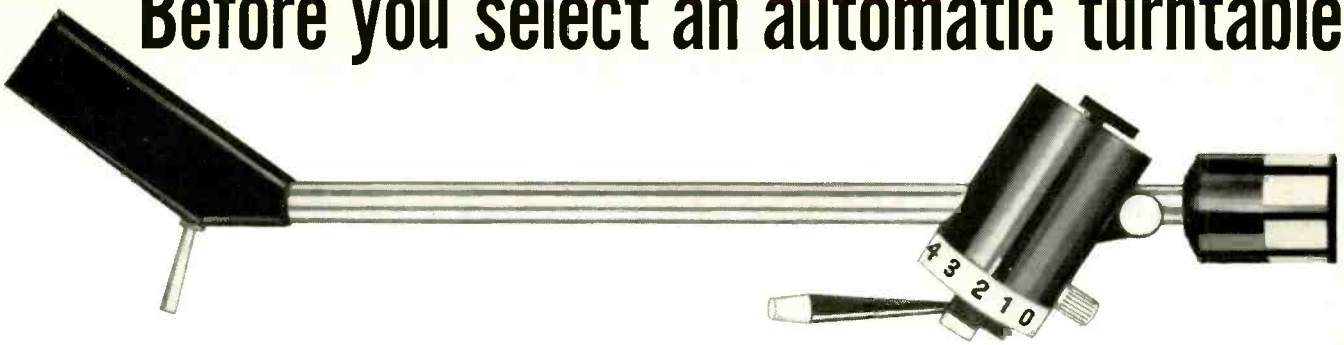
"Greater attention to loudspeaker styling."—Altec Lansing.

"Foreseeable future? . . . I quote Mr. Anon (who must have been a prolific writer like Mr. Ibid) 'If the work is research, you don't know where it is going. If you know where it is going, it isn't research' (Arthur D. Little)."—*Paul W. Klipsch.*

That is the state of the art as it is. If you have been looking for an easier way to select a speaker you haven't found it. But perhaps you have found the reason why it is not possible to reduce the science/art of speaker design to black and white on a page. It all boils down to this advice from Electro-Voice:

"The safest course for a consumer is to choose the product of a manufacturer known for his integrity and technological leadership. In addition to that, listen, listen, listen"! Æ

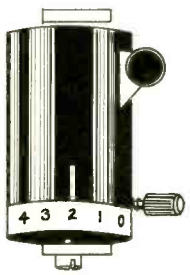
Before you select an automatic turntable



let us arm you with the facts.

Probably the most critical way to evaluate the quality of any changer is by closely inspecting the tone arm and its capabilities. Let's examine

the tone arm of the BSR McDonald 500 automatic turntable. This is the resiliently mounted coarse and fine vernier adjustable counterweight. It counter-balances the tone arm both horizontally and vertically and assures sensitive and accurate tracking. Here you see the micrometer stylus pressure adjustment that permits ⅓ gram settings all the way from 0 to 6 grams. This assures perfect stylus pressure in accordance with cartridge specifications. Here's another unique and valuable feature . . . the cueing and pause control lever that lets you select the exact band on the record, without fear of ever damaging the record or the cartridge. It even permits pausing at any point and then gently floats the tone arm down into the very same groove! Whenever the turntable is in the "off" position the arm automatically returns and securely locks in this cradle to protect it and keep it from movement. This is the low-mass tubular aluminum pick-up arm . . . perfectly counter-balanced both horizontally and vertically to make it less susceptible to external shock. Of course, there are many other quality features on the BSR McDonald, just as you would find on other fine turntables that sell for $74.50 and higher. The big difference is that the BSR McDonald 500 sells for much less. Now are you interested? . . . Write us for free literature . . . or see it at your nearest dealer.



BSR McDONALD 500

Precision crafted in Great Britain
BSR (USA) Ltd., Blauvelt, N.Y. 10913

Check No. 123 on Reader Service Card.

LOUDSPEAKER SYSTEMS

On these three pages will be found a representative sampling of the speaker systems available today. Many of the manufacturers listed offer much more than is shown both in terms of componentry and decor. Do-it-yourselfers will also find that a large variety of raw speakers may still be had from most of those listed here.

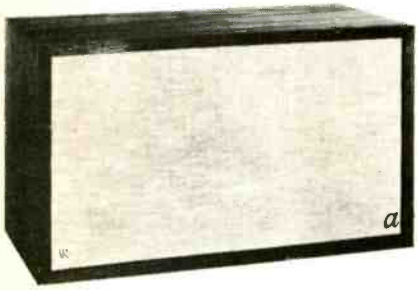
ADC
325. Six in. full-range speaker in compact cabinet. Freq. resp: 45-20,000 Hz; imp: 8 ohms; oiled walnut; 19" x 8" x 10½". Price $49.50.

18. Deluxe two-way system with polystyrene rectangular woofer. Freq. resp: 20-20,000 Hz; imp: 8-16 ohms; oiled walnut; 17" x 12½" x 4"; light or dark grille. Price: $195.00.

ACOUSTECH
X. Full range electrostatic speaker/amplifier system. These are two free-standing panels 26¾" wide x 72" high x 4" deep. The price includes dual amplifiers and two speaker panels. The speakers must be used with the Acoustech VI preamp. Price of the speakers/amplifiers (built into the base of the panels) is $1690.00.

ACOUSTIC RESEARCH
AR-4x. Two-way miniature system with eight-in. acoustic-suspension woofer and 2½-in. wide-dispersion tweeter. AR says that, of all its speaker models, the AR-4x represents the highest quality per dollar by a wide margin. Price, depending on finish, $51-57.

AR-2ax. Three-way acoustic suspension system. Uses ten-in. woofer, 3½-in.



wide-dispersion mid-range, and 1⅜-in. dome tweeter. This is an improved version of the AR-2a unit. Owners of such older units can obtain conversion kits to change the mid-range. Kit price is $15.00. The AR-2x is $109-128 depending on finish.

AMPEX
815. Two-way compact system. This system is only sold in pairs; it features a built-in connection cord with a molded phono plug. Freq. resp: 50-15,000 Hz; imp: 8 ohms; oiled walnut; 9 9/16" x 13½" x 7½" Price $65 pair.

4010. Three-way system with vinyl-paper woofer cone and horn tweeter; freq. resp; 30-18,000 Hz; imp: 8-16 ohms; oiled walnut or unf; 24" x 14" x 12". Price $210.00.

ALTEC LANSING

890A Bolero. Two-way system with phase inverter cone. Freq. resp: 40-22,000 Hz; power handling cap: 25 watts; imp: 8 ohms; walnut with snap-on grille; 14½" x 25¾" x 12" deep. Price $169.50.

Flamenco Ensemble. These extraordinary cabinets house the Altec Voice-of-the Theater components. Frequency response is flat over the 35-22,000 Hz range, power handling cap: 30 watts; imp: 8-16 ohms; oak wood cabinets. Speakers are 28⅜" wide at bottom; 19⅜" deep x 27¾" high. Price is $345 for the speaker system; the equipment cabinet is $359.00.

ELECTRO-VOICE
Model Eight. Ultra-miniature two-way system. Freq. resp: 60-17,000 Hz; power handling cap: 50 watts peak;

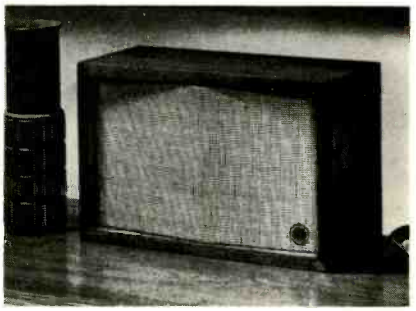
imp: 8 ohms; polymer-coated walnut veneer; 8¼" x 15¼" x 7" deep. Price $44.00.

Patrician 800. The latest in a series of four-way systems. Uses a 30-in. woofer capable of response below 20 Hz. A 12-in. mid bass speaker covers 100-800 Hz. A treble horn driver covers 800-3500 Hz where a horn super-tweeter takes over to 23,000 Hz. The enclosure is available in contemporary or traditional designs in walnut, mahogany, or fruitwood. 30" x 17" x 16⅞" deep. Price $1,095.00.

BOZAK
B-313. Compact three-way system with rigid-metal mid- and high-frequency units. Freq. resp: 45-16,000 Hz; imp: 8 ohms; matte walnut; 17" x 24" x 12". Price $195.

B-4000. Deluxe multi-speaker three-way system with two woofers, eight-tweeter array, and one mid-range. Freq. resp: 35-20,000 Hz; imp: 8 ohms; fruit finish on mahogany; 44" x 28" x 16". Price $535.00.

AZTEC



Coquette 500. Compact two-way system. Freq. resp: 40-18,000 Hz; power handling cap: 20 watts; imp: 8 ohms; oiled walnut; 15⅞" x 10" x 7". Price $39.95.

Athena 11a. Four-speaker system. Freq. resp: 30-20,000 Hz; power handling capacity: 40 watts; imp: 8 ohms; oiled walnut or dark oak; 20¾" x 25⅛" x 20¾" deep. Price $209.50.

EMPIRE
Model 8500. Three-way system mounted on wall-fitting board. Freq. resp: 30-20,000 Hz; power handling cap: 40 watts cont. midband; imp: 8 ohms. Walnut front is designed to fit between wall studs at the rear. $174.95.

Model 4000M. Two-way system in a marble-topped walnut enclosure. Freq. resp: 30-18,000 Hz; power handling cap: 60 watts music power; imp: 8 ohms; satin walnut; 25" height x 18" diameter. Price $160.00.

PHOTOGRAPHED AT CAPITOL RECORDS BY FRANZ EDSON

Good records start with Stanton.

A professional needs to know for sure. When he listens to a test pressing, he needs a cartridge that will reproduce exactly what has been cut into the grooves. No more, no less. Otherwise he would never be able to control the final product. The record you buy in the store.

That's why the professionals keep using Stanton. It tells them the whole truth, and nothing but.

In the photograph above, studio engineers are shown listening to a test pressing. This is a critical stage in record making. The stereo playback system they are listening through is fronted by a Stanton 581 EL Calibration Standard. (The turntable also happens to be a Stanton. Other fine turntables will work, too.) They're getting the whole message. You'll get it, too, in an upcoming release.

Each Stanton Micro FLUXVALVE® Calibration Standard is custom made. That means that each will perform exactly as the original laboratory prototype. We laboriously adjust them until they do. It also means that you will get the same accuracy that the professionals get. Guaranteed.

Stanton Calibration Standards are hard to make. And the price reflects it. $49.50. But that really isn't much to pay for uncompromising accuracy.

STANTON **Stanton Magnetics, Inc.** Plainview, L. I., N. Y.

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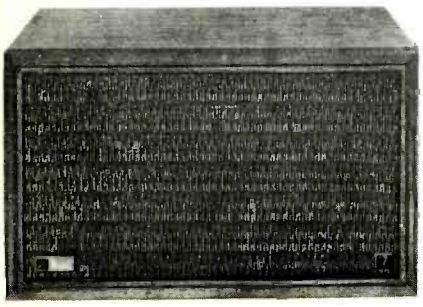
ERCONA

Leak Sandwich. Two-way system with extra-stiff woofer diaphragm. Freq. resp: —5 dB at 40 and 20,000 Hz; imp: 15 ohms; walnut, sapele mahogany, or teak; 26″ x 15″ x 12″. Price $199.00.

Leak Mini-Sandwich. Dimensions are 18½″ x 11″ x 7″ and weight is 22 lbs. Other specifications are identical to the Leak Sandwich above except for a reduction in the lowest octave's output. Price $135.

FISHER

XP-33. Miniature two-way system. Freq. resp: 38-18,500 Hz; 7″ x 13″ x 6″ deep; weight 10 lbs; oiled walnut. Price $99.00 pair.



XP-7. Three-way free-piston system. Freq. resp: 30 Hz to beyond audibility; two-speaker mid-range; imp: 8 ohms; 24½″ x 14″ x 12″ deep; Scandinavian walnut. Price $149.50.

HARMAN-KARDON

HK-40. Two way system with 24 feet of cord and removable grille. Freq. resp: 30-18,000 Hz; imp: 4 ohms; oiled walnut; 13⅝″ x 10½″ x 22⅞″. Price $100.

HK-30. Two way compact system. Freq. resp: 40-18,000 Hz; imp: 4 ohms; oiled walnut; 11⅛″ x 8″ x 16½″. Price $70.

HARTLEY

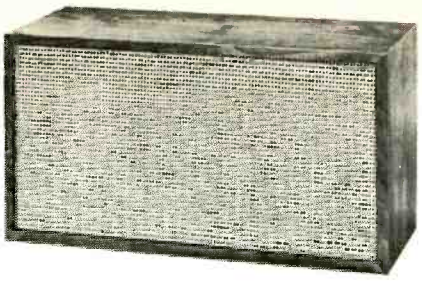
Concertmaster III. Utilizes the 218MS 18-in. woofer and 10-in. 220MS mid/high unit. Crossover at 350 Hz at 12 dB droop per octave. Oiled walnut; 38″ x 29″ x 16″ deep. Price $495, also available as Model IV in Mediterranean style at $525.00.

Jr. Concertmaster. Two-way system with 210MS woofer and 207MS mid/high unit. Oiled walnut; 34″ x 24″ x 14″ deep. Price $395.00.

ISC

Plus III. Two speaker, 360 deg. radiator. Two "free apex" cones face each other apex to apex push-pulling sound in a complete circle. Freq. resp: 30-15,000 Hz; power handling cap: 35 watts; imp: 8 ohms; 29½″ x 15″ x 15″. Price $189.95.

HEATHKIT



AS-16. Miniature, two-way acoustic-suspension speaker system. Freq. resp: 45-20,000 Hz; power handling cap: 50 watts peak; imp; 8 ohms; 10″ x 19″ x 8½″. Finished walnut cabinet is preassembled. Price $49.50.

AS-10. Deluxe two-way acoustic-suspension system using 3 ½-in. cone tweeters. Freq. resp: 30-15,000 Hz. Kit construction involves wiring the crossover and tweeter level control and installing speakers in prefinished cabinet. Mahogany or walnut is available. In unfinished birch the price is $59.95.

JENSEN

X-40/X-45. Ultra-compact two-way systems. The X-40 uses a three-in. direct radiator while the X-45 has a compression horn. Both use a long-throw eight-in. woofer. Power handling is 25 watts; cabinet is oiled walnut; impedance is 8 ohms; price of the X-40 is $57 and of the X-45 is $63.

1200XL. Deluxe four-way systems with four 15-in. woofers, compression-type upper bass, compression horn tweeter, and dome-type ultra tweeter. Freq. resp: 15-25,000 Hz; power handling cap: 100 watts; imp: 8 ohms, contemporary, Mediterranean, or early American styles. Price $895.

KLH

Twenty-Two. Compact two-way system with acoustic-suspension woofer. Wide frequency response in a modest-priced system capable of operating properly from amplifiers of 12 watts or more. Impedance is 8 ohms and size is 18″ x 10¼″ x 7 5/16″ deep in an oiled-walnut cabinet. Price $54.95.

Five. Four-speaker system of three-way design with an acoustic-suspension woofer. The dual mid-range units are also acoustically suspended in sub-enclosures. Impedance is 8 ohms; finish is oiled walnut, dimensions are 26″ x 13¾″ x 11½″. Price $179.95.

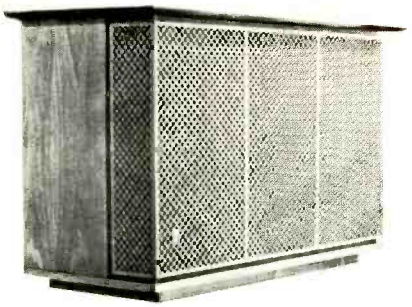
KSC

Model 6. Newest in the KSC line. The manufacturer advises us that specifications are in preparation. Price of this new unit is to be $130.

Model 3. Three-way system with 360 deg. dispersion mid-range and tweeter. Freq. resp: 30-20,000 Hz; power handling cap: 30 watts; imp: 8 ohms; oiled walnut and black grille enclosure; 13″ x 13½″ x 30″ height. Price $195.

JAMES B. LANSING

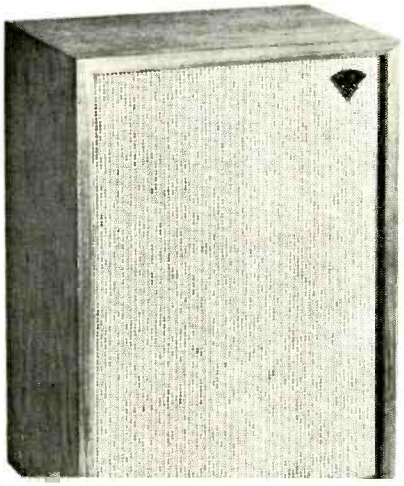
L88. Two-way system of small size. A 12-in. long-throw woofer, LE20-1 high-frequency transducer and electrical dividing network are in the walnut enclosure.



Olympus. This is one of the new breed of big speaker systems. This cabinet is available with either of two of JBL's top-of-the-line loudspeaker systems.

KLIPSCH

Klipschorn®. Virtually flat from 30 Hz to 20 kHz. Frequency modulation distortion 0.1 per cent at full rated 3 acoustic watts output. Oiled walnut $804.00; black fir at $519.00; other finishes at comparable prices.

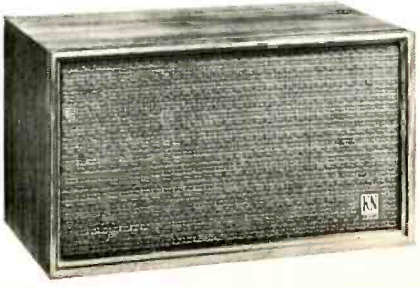


MODEL H—Klipsch's Heresy. This speaker shown in oiled walnut is a three-way with horn loaded midrange and tweeter. Crossover points 700 Hz and 5 kHz. Outstanding distortion and polar characteristics. Priced at $225 in several furniture finishes and $188 in theatre black fir.

KNIGHT

KN-2300C. Kit or assembled three-way acoustic-suspension system. Freq. resp: 25 Hz to beyond audibility; power handling cap: 30 watts cont; imp: 8 ohms; oiled walnut; 14″ x 25″ x 13½″. Kit price $69.95, wired: $84.95.

KN2350A. Three-way acoustic-suspension system. Freq. resp: 20 Hz to beyond audibility; power handling cap: 35 watts cont; imp: 8 ohms; oiled walnut; 14″ x 25″ x 13½″. Price $99.95.



WHO SAYS THE KLIPSCHORN® IS SO GREAT?

Only the people who have heard one and that takes in some pretty important people.

The Klipschorn® has been chosen as the most advanced state of the loudspeaker art at the Brussels World's Fair, at the American Exhibit in Moscow and in demonstrations to the most critical scientific and musical ears in the world. Always the response is the same. "This is the finest reproduced sound we have ever heard."

WHY IS THE KLIPSCHORN® SO OUTSTANDING?

The Klipschorn® has the lowest distortion and widest full power frequency response of any speaker system in the world . . . 1/10 of 1% FM distortion* from 30—20,000 cycles per second at over 115 decibels of sound output. It is actually able to radiate fundamental tones down to 25 cycles.

Each speaker goes through exhaustive testing to insure its ability to deliver undistorted, full power sound. All testing is personally supervised by Mr. Klipsch in a laboratory/listening room especially designed for the purpose.

The construction of a Klipschorn® is a handcrafted job. It takes over 30 hours of a skilled-cabinet-maker's time to construct the extremely complicated bass horn and its allied cabinetry.

The Klipschorn® is offered in a wide range of fine hardwood, hand-rubbed finishes comparable to that found on the highest quality grand pianos. Satin lacquer and oiled finishes are also available.

The Klipschorn® is a loudspeaker created without any compromise. It contains three carefully matched horns. These horns were developed and combined with only one thought in mind . . . the finished product must offer the closest possible identity with original sound.

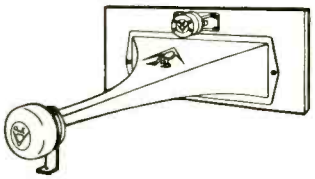
THE BASS HORN (WOOFER)

The Bass Horn which occupies the solid looking bottom portion of the loudspeaker, is of the Klipsch folded/corner horn design. It has an air column large enough to reproduce, without distortion, and at full power, the lowest note of the pipe organ (32.7 cps). No other bass speaker of comparable, or smaller size has ever achieved this. Miniaturized bass speakers are on the market but no one has yet invented a miniature 32-foot wave length.

The construction of this horn is beyond compare. Nearly 288 screws, plus other fastening devices, plus high grade adhesives, are used to make the horn as rigid as possible. Also each bass horn is checked with a water manometer to insure absolute air tightness of the rear air chamber.

THE MID-RANGE HORN (SQUAWKER)

The mid-range horn operates from about G above middle C (400 cps) to well beyond the highest fundamental on the piano. This horn, over 2 feet long with its driver attached, has gone through some 15 years of research and development. The massive



cast horn is of straight-axis design and is completely free of the irritating distortion which occurs in reflexed horns. The horn is mounted on a specially designed flange which effectively increases the horn's mouth area and adds measurably to its smoothness of response . . . less than 6 db. variation from 400 to 5,000 cps.

THE HIGH FREQUENCY HORN (TWEETER)

The highly refined horn tweeter takes over at 5,000 cps and extends to 18,000 cps with variations of less than 6 db. This horn tweeter is mounted on the same flange to which the mid-range horn is fastened.

THE KLIPSCH BALANCING NETWORK

This network has been designed to provide the best match between the 3 horns in the system and also to act as a dividing network.

ONLY THE KLIPSCHORN® REPRODUCES THE FULL RANGE AND DYNAMICS OF A SYMPHONY ORCHESTRA

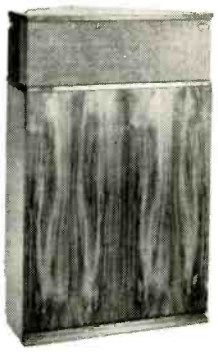
A special concert was staged in which Klipschorns® reproduced, at original loudness, the Hartford Symphony Orchestra. This was a live vs. recorded concert and the majority of the large listening audience could not tell the difference between the live orchestra and the sound of the orchestra as reproduced by Klipschorns®.

To the best of our knowledge, no other commercially available high fidelity loudspeaker has passed such an arduous test.

KLIPSCH HIGH EFFICIENCY ALLOWS YOU TO USE LOWER POWERED AMPLIFICATION

The sound output of the Klipschorn® is approximately 10 decibels higher than the best direct radiator enclosure type systems and is 20 decibels higher than typical systems.

A 10 watt (2 for stereo) amplifier is adequate for home use and has proved ample for audiences of 900 people.



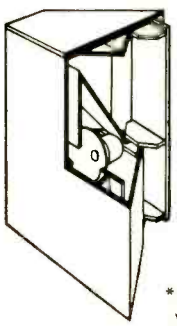
In reproducing the full Hartford Symphony Orchestra, only 2 watts peak power feeding each of two Klipschorns® in stereophonic array were used. This may seem difficult to believe if you are accustomed to the typical loudspeaker system, but you will be quickly convinced once you hear a Klipschorn® Wide Stage Stereo System.

OUR PHILOSOPHY: TRY IT BEFORE YOU BUY IT!

We sincerely hope you will listen to many systems before you purchase. Don't be fooled by advertising claims. We are confident that once you have heard the Klipschorn®, you will be satisfied with nothing less.

KLIPSCH

KLIPSCH & ASSOCIATES
Box A4
Hope, Arkansas
71801



Please send me complete information on the Klipschorn® loudspeaker system. Also include the name of my nearest Klipsch Authorized Audio Expert.

KLIPSCH & ASSOCIATES
BOX A4
HOPE, ARKANSAS 71801

NAME_____

ADDRESS_____

CITY_____ STATE_____

OCCUPATION_____ AGE_____

*In Klipsch speakers all forms of distortion are minimized—especially AM and FM distortion which are many times as objectionable as simple harmonic distortion. Technical papers available on this subject.

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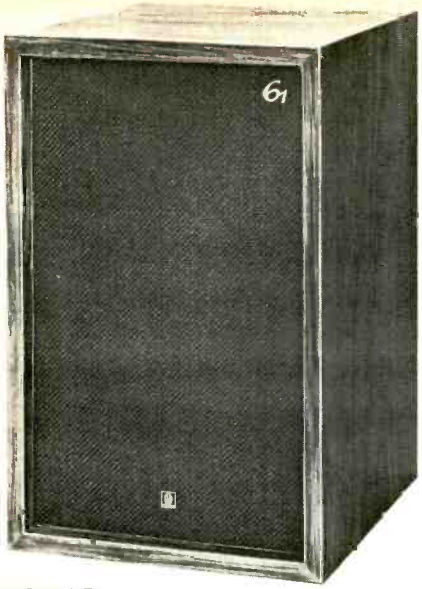


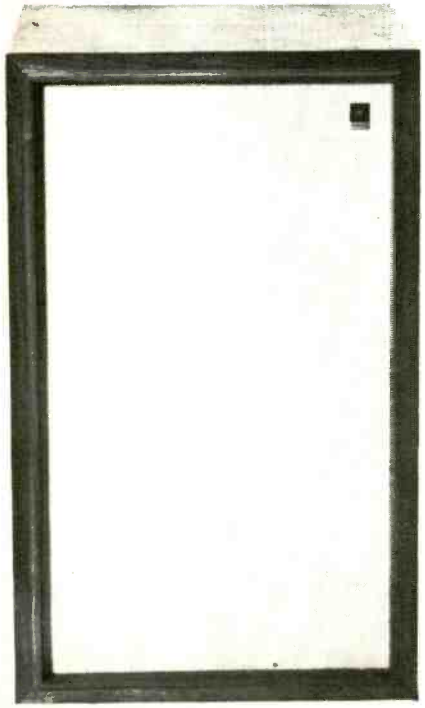
PIONEER
CS-24. Thin wall or shelf system. Ideal for small stereo or auxiliary speaker applications in the home or office. Unusually good clarity, definition, and sensitivity. Power handling cap: 10 watts; 8-ohm imp; 10⅝" x 16⅛" x 4¾". Price $27.50.

CS-61. Five speaker, three-way system. Freq. resp: 30-20,000 Hz; power handling cap: 60 watts; imp: 8 ohms; 24⅞" x 16½" x 13", oiled walnut. Price $175.00.

SONOTONE
RM-1. Compact two-way system with air-suspension woofer. Freq. resp: 45-20,000 Hz; imp: 8 ohms; oiled walnut; 10½" x 14½" x 7¼". Price $44.50. Also available in unfinished birch as a kit—RM-1K, price $35.50.

H. H. SCOTT
S-9. Two-way compact acoustic-suspension system. Freq. resp: 50-15,000 Hz; imp: 8 ohms; 14" x 8¾" x 6"; oiled walnut. Price $39.95.

S-11. Deluxe three-way speaker system with controlled impedance. Freq. resp: 40-20,000 Hz; imp: 8 ohms; oiled walnut; 14½" x 24" x 11½" deep. Price $149.95.



SHERWOOD
SR-1. Compact two-way system with air-suspension woofer. Freq. resp: 53-17,000 Hz; imp: 8 ohms; oiled walnut; 13" x 9½" x 24". Price $84.50.

SR-4. Deluxe three-way system. Freq. resp: 38-18,000 Hz; imp: 8 ohms; oiled walnut; 24" x 13" x 31½". Price $219.50.

WHARFEDALE
W-20. Ultra-compact, two-way system. Has an 8-in. woofer and Mylar domed tweeter mounted in oiled-walnut enclosure of 9¾" x 14" x 8½" deep. Price $49.95.

W-90C. Six-speaker, four-way system with acoustic-suspension woofer. Separate 12-in. lower mid, two 5-in. upper mid, and two 3-in. tweeters complete the unit. Oiled walnut. Price $279.95.

TANNOY
"Biarritz" Speaker system. This system uses either the 12", or 10" Monitor Dual Concentric loudspeaker, and is essentially a bass reflex enclosure. Available in antique pecan and antique

white. Price, with 12" Dual Concentric $285.00; with 10" model $259.75.

GRF Speaker System. The Tannoy 15" Monitor Dual Concentric forms the heart of this system; the enclosure itself is a rear horn-loaded expanding sound source. Power handling capacity 50 watts; with a bass horn development effective loading down to 35 Hz. Size: height 42", depth 17", width 23¾". Price, complete with speaker: $385.00.

UNIVERSITY
UR-4. Two way system in RRL enclosure. Freq. resp: 30 Hz to beyond audibility; imp: 8 ohms; oiled walnut; 19" x 10½" x 9". Price $71.25.

Mediterranean. Deluxe three-way system with paper woofer and mid-range and horn tweeter. Freq. resp: 22 Hz to beyond audibility; imp: 8 ohms; finish antique white or butternut with eggshell or beige grille cloth; 22½" high x 24⅜" deep. Price $390 in white; $338 in butternut.

UTAH
Optica. Compact two-way system with dual cone-woofer and separate tweeter.

Imp: 8 ohms; power handling cap: 25 watts peak; oiled walnut; 1¾" x 19" x 8½". Price $39.95.

UTC SOUND
Maximus 5. Three-way pneumatic-suspension system. Freq. resp: 30-20,000 Hz; Power handling cap: 30 watts cont; imp: 8-16 ohms; oiled walnut with snap off frame; 24" x 14" x 12". Price $129.00.

Maximus 7. Three-way, four-speaker pneumatic-suspension system. Freq. resp: 25-35,000 Hz; power handling cap: 40 watts cont; distortion: less than 0.75 per cent, 50-35,000 Hz; imp: 8-16 ohms; oiled walnut, 24" x 14" x 12" with snap-off and replaceable grille. Price $189.00.

Check No. 121 on Reader Service Card.

Sorry, the new Sony FM Stereo Tuner won't be here until April

We don't presume to tell you how to spend your time between now and April. You can bug your dealer, if you wish, but please don't. What you can do is reserve a demonstration of what will be the most exciting FM Stereo tuner ever developed. You know Sony, and the kind of magic they work with transistors. Their new tuner is really something special and different. But we repeat, it won't be ready until April.

In the meantime, spend some time with your family, or visit your dealer and listen to Sony's fabulous solid-state stereo amplifiers. The TA-1120, an integrated model, delivers 120 watts of pure power with virtually no distortion and has the most sensible arrangement of functions. It's the one that is drawing rave notices from the high fidelity editors. The TA-3120 is a power amplifier only, identical to the one employed in the TA-1120. Prices are respectively $399.50 and $249.50, suggested list.

While you're at it, fiddle with the ingenious Sony PUA-237 and PUA-286 tonearms, or spend some time trying to detect a noise or rumble from the new servo-controlled Sony TTS-3000 turntable. Or check the new moving-coil cartridge, VC-8E. Above all, tell your high fidelity dealer to save a front-row seat to hear the new Sony FM tuner, available in April.

Sony Corporation of America, Dept. H, 47-47 Van Dam St., L.I.C., N.Y. 11101.

meanwhile...

Audio Measurements Course

PART 15

NORMAN H. CROWHURST

As THIS SERIES has progressed, a number of readers have written about measuring problems in various more specific areas than the items covered so far in the course, so I will now try to provide the answers to some of the more frequently asked questions.

Speaker-Impedance Measurements

Proper usage of loudspeaker impedance is essential (1), to achieve maximum power from the amplifier with freedom from distortion, and (2), to obtain the predicted or measured frequency response. For simplicity, loudspeakers have a rated impedance, but this is a somewhat "fictitious" value.

Every loudspeaker has an impedance characteristic whose value varies with frequency (*Fig.* 15-1). Also, its impedance is affected by the acoustic radiation. This latter fact makes measurement on a conventional impedance bridge difficult, because any sounds or incidental reflection effects will throw the bridge "off balance" and render it difficult to know when a true null reading is obtained.

The best method is to use a simple comparator method, using what is essentially an a.c. ohmmeter, which can easily be improvised for the purpose (*Fig.* 15-2). The output from an audio oscillator is fed through a relatively high resistance, say 500 ohms (which probably matches the oscillator output) to the voice coil. Thus the reading across the voice coil will be directly proportional to the voice-coil impedance.

Assume the oscillator output is adjusted to 5 volts and is held to that value at all frequencies. The 500-ohm resistor will maintain current at 10 mA. If the reading across the voice coil is 150 mV, the impedance is 15 ohms. The impedance is thus numerically equal to the indicated mV divided by 10. Other voltages and resistor values can be arranged similarly to yield "direct" readings like this.

This result is approximate, of course, but is well within the tolerances of parts used, provided the voltage measured across the voice coil does not represent an impedance approaching the series resistor value. This is the reason for picking a value large compared to the range over which voice-coil impedance is expected to vary.

At this point, when I explain this procedure in class, some student will ask at what frequency one should make this measurement to find the rated impedance. To which some students will suggest 400 Hz, believing this is a standard frequency for this purpose, while others suggest 1000 Hz, as being the usual reference frequency for response.

The fact is, no single-frequency answer is completely satisfactory, because speaker impedance can vary considerably over the frequency range. *Figure* 15-1 shows a typical moving-coil speaker impedance curve. If you've plotted this, either using point-by-point readings, or with an automatic curve plotter, what figure would you quote for the impedance of this unit?

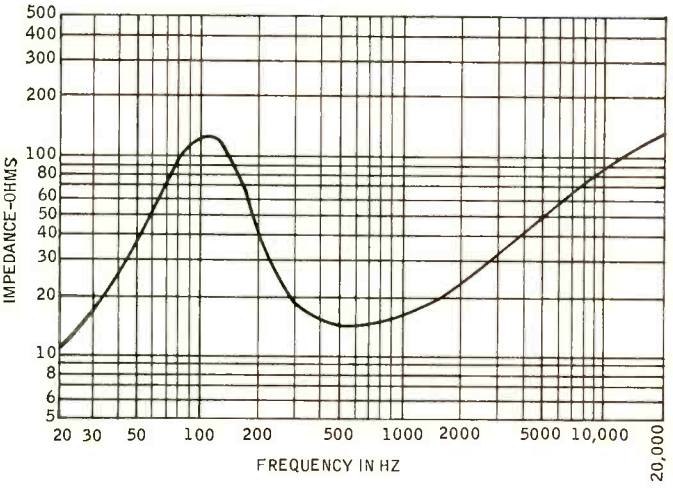


Fig. 15-1. Typical impedance curve of moving-coil loudspeaker unit. In the early days, by English custom, this unit would rate as 15 or 16 ohms.

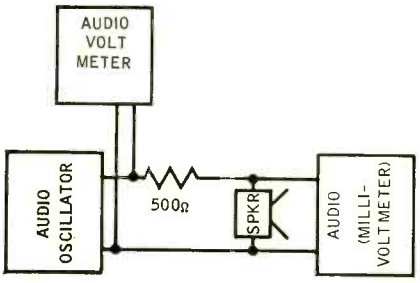


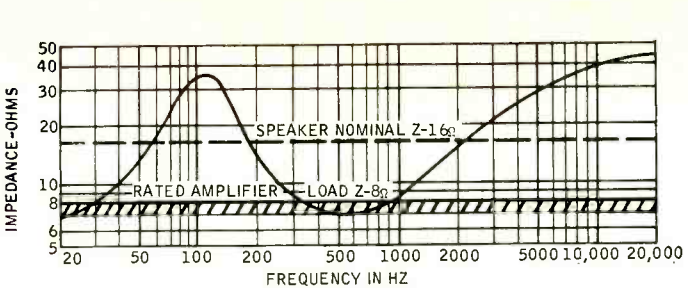
Fig. 15-2. Method of measuring loudspeaker impedance.

In the early days, in my native country (England) the result used would be the lowest value, or close to it (which usually occurs near 400 Hz, incidentally). The reason for this choice was that most amplifiers of the time used triode tubes, which deliver their maximum power into a specified load and a similar voltage into higher values of impedance, but they distort when loaded by values appreciably lower than that for maximum power.

Using a value close to the lowest impedance reading for the speaker thus enabled the amplifier to deliver maximum undistorted power into a load made up of speakers matched according to this rating. At frequencies where the impedance rises above this value, the same voltage is delivered, with low distortion. Although this is not full rated power at these frequencies, the result is an approximately level output, because the speaker's frequency response is based on uniform voltage, as a rule, not current or power.

Later, pentodes became popular and nowadays of course, amplifiers may be transistorized. This more general situation makes it more logical to pick some kind of "average" value as being representative of the range of values at different frequencies. But this practice had started, particularly among American manufacturers, before this justification was valid.

Although the earlier method enabled triode amplifiers to deliver max-



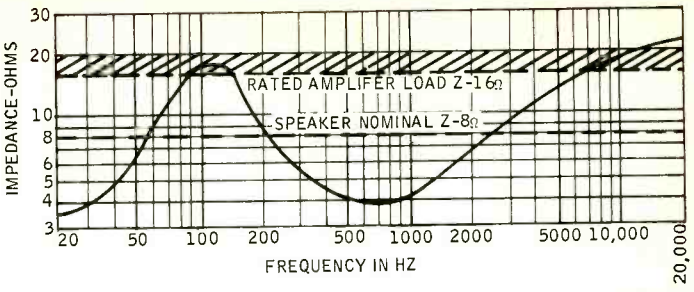


Fig. 15-3. (left). Matching speaker to amplifier when low loading of the amplifier (shaded side on 8-ohm line) either causes distortion or excessive dissipation. Here a 16-ohm speaker connects to an 8-ohm amplifier output. Fig. 15-4. (right). Matching speaker to amplifier when high loading of the amplifier either causes distortion or excessive dissipation. Here an 8-ohm speaker connects to a 16-ohm amplifier output.

imum undistorted power, use of ratings nearer the measured average enabled the speakers to sound louder, when compared with units rated the other way. This happened because the same unit was given a higher impedance rating or, conversely, the same impedance rating represented a unit with lower actual impedance (but similar variation of impedance with frequency).

Having a lower actual impedance for the same rated impedance meant that the unit received more current at the same output voltage, or used more driving power, although nominally working at the same "level" and having the same nominal impedance. So a speaker rated this way *seemed* more efficient than one rated the old way.

This difference in rating method led to various disparaging remarks, by Englishmen about American manufacturers, and responses in kind by Americans about the English! I'll not comment on that, in view of my involvement with both nationalities. I think I've presented a reasonably true picture without comment: it was all a matter of viewpoint!

However, the present-day average-value rating, which American manufacturers were first to adopt (whatever the original reason) makes sense now. But some comments on its intelligent use are in order. The fact remains that most amplifiers use output stages that tend either toward constant-voltage devices, like the old triode tubes, or constant-current devices, like the pentode tubes and most transistors.

Although use of negative feedback may modify this effect from the viewpoint of frequency response and damping effect, the power capability of the output device (tube or transistor) is still determined by its basic characteristics and operational mode (e.g., pentode working in ultra-linear circuit).

The over-all result of these differences is that some amplifiers distort more readily when loaded by impedance values below their nominal load, while others distort more readily if the values run higher. With transistor circuits there may be a dissipation factor to consider: either lower or higher values, in individual instances, may result in exceeding the dissipation limits.

Knowledge of these details can affect choice of matching.

For example, suppose you know that low-value loading increases distortion more rapidly than high-value loading. Then it would be better to connect a nominal 16-ohm speaker to an 8-ohm amplifier output. The impedance is then likely to vary between somewhere near 8 ohms and 30-40 ohms, and distortion is minimized (*Fig.* 15-3).

On the other hand, if low-value loading causes less distortion than high-value loading, it would be better to connect an 8-ohm unit to a 16-ohm amplifier output, for a similar reason. The impedance connected to the 16-ohm output would then vary between about 4 ohms and 15-20 ohms (*Fig.* 15-4).

Adjusting Bass-Reflex Enclosures

Every few weeks someone asks me about designing or adjusting a bass-reflex enclosure. Of course, a speaker manufacturer can set the unit and a mock-up enclosure up in an anechoic room and measure response with some precision, changing the port until he gets the response he wants. But most readers will not have ready access to an anechoic room, but would still like to "try their hand."

This is where impedance measurement can prove a big help, because what happens to the unit acoustically reflects on its electrical impedance. For this purpose it is useful to measure the phase characteristic of the impedance, as well as just its amplitude, as the frequency is varied.

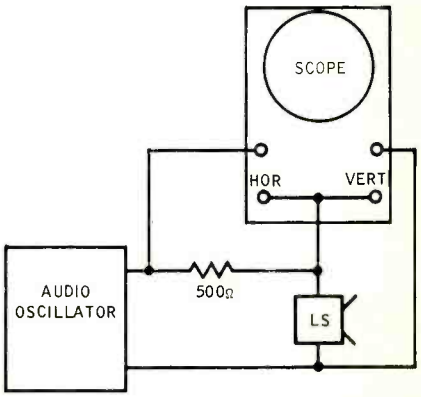


Fig. 15-5. Connections for using oscilloscopes to measure speaker voice-coil impedance, including phase effects. This is very helpful for working with enclosures when an anechoic room is not available.

Be sure you have your copy of AUDIO next month. Be with us to celebrate our twentieth year of publication. This will be a gala issue filled with information of the past, present, and future. All our regular features remain as usual. In addition, there will be much of interest drawn from the history of the audio industry over the past two decades. Don't miss it!

This is simple to do with an oscilloscope, which can be used as a meter as well, if desired (*Fig.* 15-5). First check the unit in free space (unmounted). Lay it on its back (don't make the mistake of placing it face down on the bench!) and run the oscillator through the frequency range.

Resonances and anti-resonances, shown by zero phase-shift closure of the ellipse to form a sloping line, will coincide with maximum and minimum points on the impedance curve. This enables you to spot them quickly and mark the frequency on a chart (*Fig.*

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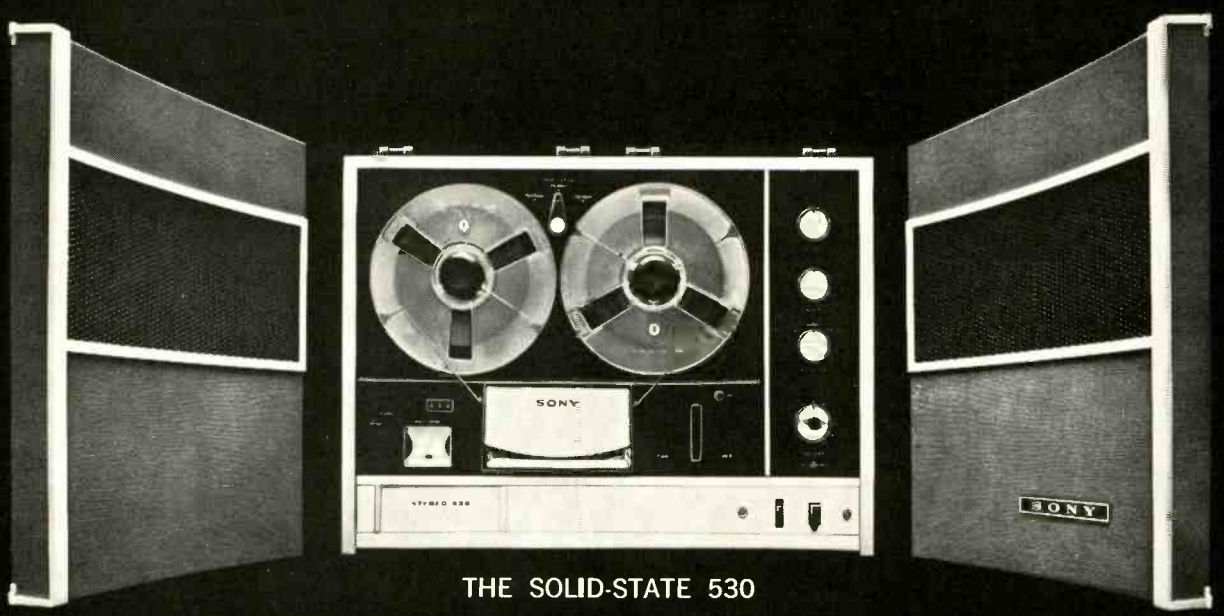

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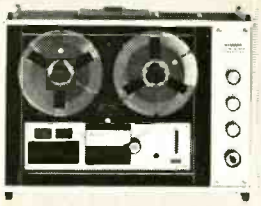

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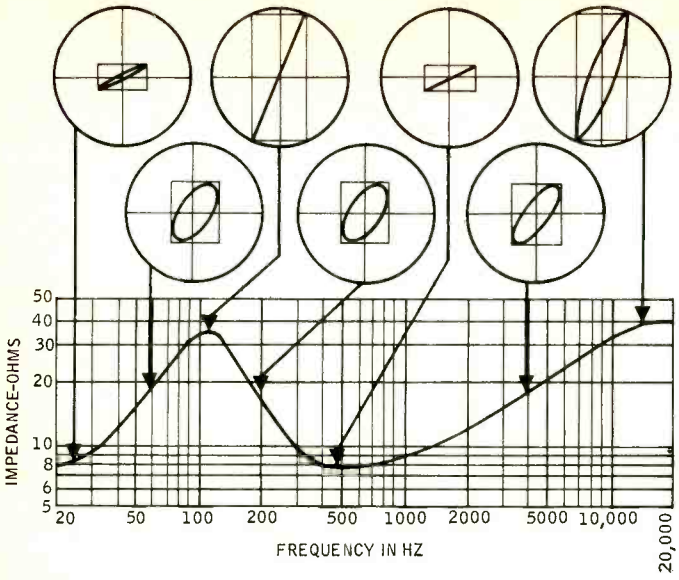

Fig. 15-6. Impedance curve for unmounted unit, with corresponding 'scope traces at the significant frequency points on the curve indicated by respective arrows.

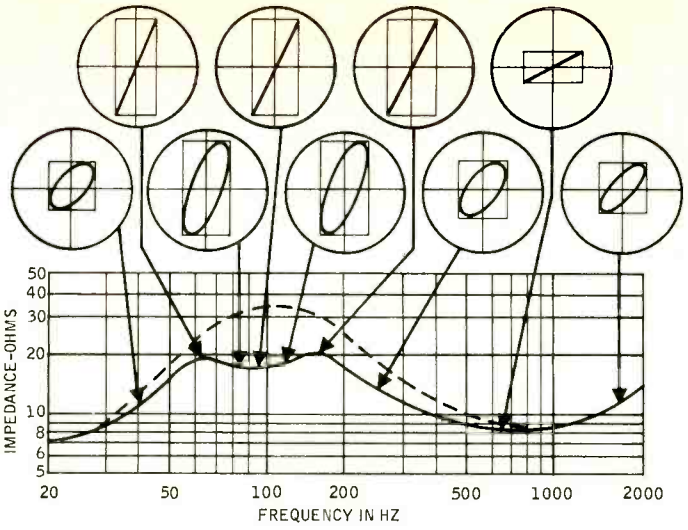

Fig. 15-8. The kind of impedance characteristic to seek in developing a bass-reflex enclosure. Dashed line shows unmounted impedance curve, for comparison. Oscilloscope traces for all significant frequencies are shown. Using the oscilloscope method, much work can be accomplished in short time, without need for elaborate plotting. For record purposes, just note frequencies and height of peaks, along with details of the port that produced this effect.

15-6). Degree of reactance is shown by how much the ellipse "opens up" between or beyond these straight-line traces.

Before you work on the unit in an enclosure, note the cone-resonance frequency unmounted. If it is too high, so that even bass-reflex design cannot be expected to extend response low enough, better find a more suitable unit before proceeding. Frequency response falls off rapidly below the cone-resonance frequency.

Mounting the unit in a sealed enclosure (closed back) will raise the resonant frequency, thus raising the point at which low-frequency response drops off. The smaller the box, the more low-frequency cutoff is raised.

Bass-reflex enclosures overcome this problem by making a double resonance, rather like that of a band-pass circuit in radio. The speaker diaphragm in its suspension forms one resonance and the enclosure with its vent forms the other. The combination splits the resonance, as it were, into two peaks. But in addition, the acoustic wave from the vent gets in phase with that from the front of the diaphragm for the lower peak of the double resonance formed.

Work on this can be done by watching the impedance resonances on the 'scope. The best way is to mount the unit in the enclosure before you cut at all for the vent. Mounting it and measuring impedance with the back off will show that the open-backed enclosure lowers the resonance by increasing air-mass loading on the cone.

Now use a removable back in which you can cut experimental vents. Cut a rectangular slot, which you can vary in size by partially covering it (*Fig.* 15-7). Checking what happens to resonance points as you change the opening size will show you which way you have to go. You are aiming for peaks approaching an octave apart, with one of them below the original resonance frequency, and with the two peaks of equal magnitude (but much lower than the original peak, *Fig.* 15-8).

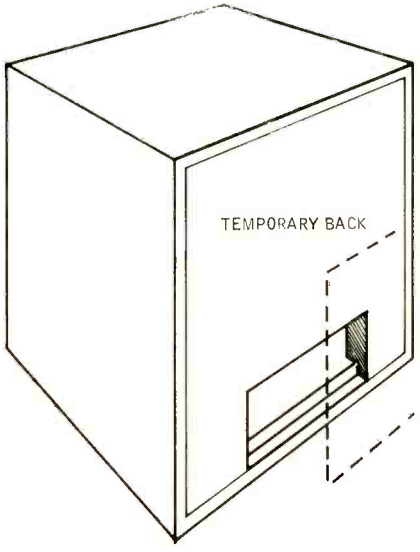

Fig. 15-7. How to experiment with port (or vent) opening before cutting the front of the enclosure. Dashed line indicates how another piece of wood can be used to cover up a portion of the opening, to explore the effect of changing its size.

Hopefully your first cut will be on the small side, so you need to enlarge your slot, rather than having to fill in. You may also find that a plain opening is not enough, however big you make it(even to taking the back out altogether)—that the port wants to be ducted. This you can also add to your experimental port, until you find appropriate dimensions. Varying the size and ducting of the opening will vary the spacing and relative height of the peaks.

When you have achieved your objective as closely as possible experimentally, you can translate this into a "front" design, with the port alongside the front opening for the diaphragm, where its low-frequency output will augment that from the front more effectively. If a duct is needed, it can be accommodated inside, unless it is big enough to reduce the remaining volume substantially, in which case, either a larger enclosure, or different duct dimensions, will be needed.

Usually the final design is a compromise, one way or another, and your choice of compromise may be quite as good as mine, so I'll not spend time advising you about that.

In the next installment, we'll discuss measurements associated with electronic filter design and development, about which I've received a number of inquiries. Æ

"MATERNITÉ" by Renoir.
An original lithograph signed in stone. Catalog Delteil #50. From the collection of James B. Lansing Sound, Inc.

Art as a component of perception.

Solid objects broken down into component elements of light, shade, and texture, combining to create an undistorted mosaic of reality; fleeting visual impressions captured and recorded with uncompromising lucidity of style. "Impressionism" was a technique of discovery, an examination and portrayal of the components of perception. True perception of sound results from the exact portrayal of each element of its composition.

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Equipment Profile

DYNACO STEREO-120 AND THE PAS-3X STEREO PREAMP

Dynaco has long been one of the more conservative manufacturers in this industry, and its history from the transformer-building Dyna Company in 1955 to its present impressive position as a manufacturer of high-quality components today is a tribute to Dave Hafler, who authored some of our best-received construction articles as far back as 1951. His designs were comparatively simple, easy of construction by even inexperienced kit builders—or those builders who actually assembled the parts and drilled the chassis before the days of complete kit availability.

And Dynaco's conservatism has been evident in the company's reluctance to jump into the solid-state field without first making sure that their first product would be worthy of the reputation the company enjoyed. And when the first solid-state amplifier did arrive, it filled those expectations.

As is generally known, one of the problems of solid-state power amplifiers is that it is possible to overdrive the output transistors to destruction unless some means of protecting them is provided. This is usually done by a circuit arrangement which effectively changes the bias on the driver stages when the current in the output stages reaches a safe limit. It can be done in a variety of ways, and Dynaco has chosen a simple but effective one. Two reversed silicon diodes are placed in the emitter circuit of the PNP driver transistor, and these are forced into conduction by bleeding a reference current from the power supply through them. When the driver current reaches a peak limit equal to the reference current, the current in the output transistors is prevented from increasing further, and a switching action takes place which reduces the driving signal. (Since most of the preceding is a direct quote from the instruction book, it is likely to be correct.)

Further protection is provided in the power supply, which is fully regulated up to its maximum output and thus is a low-impedance source, but when the output reaches its design maximum the power supply changes to a high-impedance source so that it can be short circuited without damage. The regulated supply also serves to protect against line surges and to maintain output over a wide range of line voltages.

The circuit employs a 40233 transistor as a voltage amplifier which feeds a 2N2053, which in turn feeds the two driver transistors—one a PNP 2N4037 and the other an NPN 2N3053. The drivers, serving as the phase splitter, feed the bases of the two power transistors, which are NPN 2N3055's. Feedback from the output is returned to the emitter of the voltage amplifier stage. Aside from the protective biasing arrangement, this is a fairly conventional circuit, and the two channels are electrically identical.

The power supply employs a bridge rectifier, a PNP 2N4037 current senser, which controls two NPN transistors—one a 2N3053 and the other the barretting 2N3055. All three circuit elements are in the form of modules which can be removed easily should servicing be required.

Performance

The Stereo 120 can deliver its full rated output, 60 watts per channel—actually about 66 watts measured at a harmonic distortion of 0.25 per cent, and with a measured distortion of 0.15 per cent at normal listening levels. And this rated power is maintained throughout the usual 20 to 20,000-Hz range. The half power points are at 6 and 62,000 Hz, according to our measurements. IM remained comfortably below 0.5 per cent up to the rated output. The advantage of the regulated power supply shows up in measurement when it is observed that with full power output on one channel only, no reduction in power in that channel is noted when the other channel is similarly driven to full output. These measurements refer, of course, to the 8-ohm condition; at 16 ohms, the output per channel measured 45 watts, and at 4 ohms, 43 watts. Unweighted noise measured 98 dB below rated output, and separation measured 72 dB at 1000 Hz, 71 at 20 Hz, and 69 at 20 kHz.

Two cautions are given in the instructions—one that the two outputs should not be paralleled, and the other that the output terminals should not be shorted. These are usual with practically any solid-state power amplifier, of course. It is also suggested that one should be careful not to maintain full rated output continuously at the frequency extremes—also a good precaution with any transistorized power amplifiers.

As to the latter caution, it is certainly never likely that anyone would be feeding a 60-kHz signal into the amplifier at such a level as to drive it to a 60-watt output, so for ordinary applications, the amplifier would never be subjected to such rigorous treatment. But for ordinary listening levels the performance of the amplifier leaves little to be desired.

Physically, the Stereo-120 measures 13 in. wide, 10½ in. deep, and is 4 in. high, and it weighs 20 pounds.

The PAS-3X Preamp

The current Dyna stereo preamp is not a completely new item—it bears many of the features of the original mono preamp which was reviewed in these pages in December, 1957. It is, instead, a highly refined version of the original, expanded to stereo, and incorporating a few new features. Dynaco does not subscribe to the usual practice of bringing out something completely new every season, which involves continual redesign and more and more engineering development, but instead prefers to make any possible improvements on what has already been proved a successful item.

The original Dyna preamp employed two 12AX7's, and obtained its plate supply from a solid-state rectifier. It also provided a well-filtered d.c. for the heaters of the tubes. The PAS-3X needs four

Fig. 1. The PAS-3X (left) and the Stereo 120 (right).

12AX7's—two for each channel—uses a 12X4 tube rectifier for plate supply, but still uses the same type of d.c. heater supply as in the earlier model. And the newer unit still has provision for the "special" input which may be made into a microphone input, or an additional phono input for either magnetic or ceramic cartridge, or for an additional tape-head input. Thus it can be modified readily to suit the individual user's specific requirements. The output is now designed to feed a power amplifier with an input impedance of 100,000 ohms, with an output signal anywhere between 0.5 and 2.0 volts. Furthermore, the unit can be reconnected to work on 240 volts, in case its owner should be transferred to some location where that was the available supply. (This also applies to the Stereo-120.)

The principal difference between the "X" models and their predecessors are in the tone controls. A new patented design provides continuously variable controls which are effectively out of the circuit when in the flat position—an advantage long exclusive to switch-type controls. Couple this with the complete refinement of the circuitry, and you have a preamplifier which takes a back seat to none when it comes to performance —which, by the way, is about all anyone could desire.

The PAS-3X has three pairs of low-level inputs—RIAA phono, NAB tape head (7½-ips), and the "special" input previously described. It also has four high-level inputs—FM-AM, which gives a certain amount of flexibility if the user wants to have two separate programs playing at the same time, one on each channel; FM-multiplex, "spare" which is usually called "aux," and tape (amplifier). It is equipped with a selector switch, a function switch which also serves as a blend switch, balance control, separate bass and treble controls for each channel, and a dual volume control. In addition there are switches for loudness, filter, and tape monitor. The filter switch reduces output at 8000 Hz by 3 dB, and the attenuation increases above that frequency at 12 dB per octave, effectively eliminating hiss or other high-frequency noise.

With intermodulation measuring less than .05 per cent at a 2-volt output, and harmonic distortion lost in the residual of our equipment, this preamp does give superb performance. Hum and noise on the phono input measured 75 dB below a 10-mV input, and 92 dB on high-level inputs. Separation was better than 35 dB anywhere from 20 to 20,000 Hz. The tone-control ranges are somewhat greater than usual, extending from ±20 dB at ±20 Hz, and 14 dB at 10 kHz.

The PAS-3X matches the FM tuner in appearance, and would provide an attractive companion to it. Earlier PAS-3 and PAS-2 models may be converted to the "X" models by obtaining the TC-3X tone control modification kit (price, $10.00) and making a few simple changes. This will update the older preamps. Check 1

Fig. 2. The Beyer DT-48s stereo headphones.

BEYER DT-48s STEREO HEADPHONES

The reasonably knowledgeable audio buff may not be expected to know the name Beyer. But the professional recording or broadcast engineer does and anyone that knows of the best electronics houses of Europe knows the name also. Beyer is principally known as a maker of the highest grade of microphone, but they have been suppliers of earphones as well.

This DT-48s is the latest version of a fine earphone we have known for some time. Their standard configuration (and the one tested) is a pair of 5-ohm phones terminated in a standard stereo three-way plug. There is also a 25-25 ohm model wired mono and made to match the Nagra recorder.

Either set are dynamic phones of sturdy metal construction. They are reasonably lightweight, about 12 oz.

The bass response of an earphone is largely dependent on the effectiveness of the ear-to-phone seal. Our sample had a pair of reasonably effective round sponge-type pads attached. However, we were also supplied with an ear-contour shaped set. After a bit of tugging and pulling we got them on. *They* make a most effective seal—one of the best we have seen. We are told that these will be supplied as standard equipment.

The DT-48s fits comfortably and remains so for a long period of time. The pads plus the spring metal band each contribute to make a firm yet not overtight fit that did not become tiring even after several hours of use. There is also more than adequate adjustment for thick, thin, short, and tall heads.

Stereophonic listening with earphones is a peculiar sensation to one who has not experienced it before. In mono, the sound source seems to be placed directly center in your head. (That's about two inches vertically above the pituitary gland.)

But switch to stereo and the stage magically expands from ear to ear. One of the nicest facts is that you can turn it up screamingly loud and no one cares. One of the disconcerting facts is that this big, beautiful stereo stage just doesn't sit still. Move your head and it moves right along. In short, the usual listening *to* music becomes listening *among* the music. If you've never tried it, you'll find it uncanny.

In the long run, however, a stereo phone set stands or falls on the same basis as any other component. That is, its ability to simulate the *truth*. It either sounds good or it does not. And if it is good, then how good is it?

These Beyer phones are uncannily good. They present a clear, wide-range, and indeed *listenable* presentation of music. We listened to them for long stretches without the slightest hint of aural fatigue.

The DT-48s covers the full spectrum with extreme smoothness. The net result at first, was a rather dull sound, that is until we realized that all the highs are there. There is no ultra-high-fi-sounding rising characteristic. The same is true of the bass end. It doesn't overpower you with bass response, but when a deep note is called for it is heard.

Frequency sweeps tell part of the story. The Beyer units run down to a strong 30 Hz with usable response continuing a good half-octave further down. The mid-range is smooth and uncolored. High-end response sails smoothly upwards until it passes beyond our audibility. No high-frequency peaks or dips. It just keeps going out there.

About all we could find to criticise, in fact, is the length of the cord. It is just over five feet. That doesn't let you get too far from the set.

We were also supplied with a Beyer UG-8 speaker/two-sets-of-phones box. This is a little jewel of an item. Small and neat, it boasts squared-off wiring that would do a computer proud. We also used a pair of 20:1 transformers that enable the phones to work with 600-ohm lines. These are the model TR-48 units, list $17.40 each (two are needed for stereo). The DT-48s stereo phones themselves are $85.00 and the junction box is $7.75.

So the Beyer DT-48s emerges as a masterful music reproducer; one that will do the finest source proud. Check 2

AUDIO MUSIC AND RECORD REVIEW

The Classics

- EDWARD TATNALL CANBY
- OSCAR E. KRAUT
- MARVIN ROTBARD
- LIONEL RUDKO

WORTH SPECIAL NOTICE

Bartok: Piano Concerto No. 1, No. 3. Peter Serkin; Chicago Symphony, Ozawa.

RCA Victor LSC 2929 stereo

The first and third of Bartók's piano concerti represent two notable phases of his work, surprisingly in tune with their respective times—1930-31 for the first and 1945 (just before his death) for the second.

No. 1 is sheer Nineteen Twenties, incredibly hard, propulsive, dynamic, lean, and deliberately dissonant (with tone clusters—fistfuls of notes all played together) and a generally "shocking" approach. Even in Bartók's special high-voltage terms, this was not unusual in those brassy days.

The Third Concerto, his final completed work, came at the end of the much more Romantic series of works that began in the middle Thirties after the Great Depression; everywhere the same thing had happened to music: a return to more "old fashioned" expression, to keys, melodies, eloquence, and an end to snazzy harshness.

This pair of very young performers, Seiji Ozawa, conductor (32) and Peter Serkin, pianist (20) are, in their turn very much the new neo-Romantic young people, who play things at a lower voltage, more caressingly, more slowly, than did the youth of the war and postwar periods. Accordingly, they do a splendid job with the later Concerto, the lyric and somewhat Romantic No. 3. It responds wonderfully well to their approach.

But No. 1, with its super-dynamo music, crackling with tough, high-tension energy, is badly muffed, I'd say. Not the notes—they're all there. The sense and the style is wrong. You can't reduce these incredible hammer-blow piano ideas to anything less rigid than trip-hammer steeliness without weakening the music. Exquisitely controlled, but diamond-hard, razor-edged and incredibly intense—that's how it must be.

In Serkin's playing of No. 1 there is still, somehow, too much consideration for the beauty of the piano mechanism—maybe a leftover trace of the limpid Schubert he plays so well. His piano voltage is just too low. The instrument doesn't whang out the notes, so to speak, in surprised pain. It should. And the tempi are almost thoughtful, instead of machine-fast.

The paradox is that when this machine-like Bartók *is* played with the right degree of controlled fury, it becomes superbly human! Quite amazing. The man really was a great soul (to use an old-fashioned word) in terms of profound human expression.

I'd guess it would take any young pianist long years to find this out through his own fingers. E.T.C.

J. S. Bach: The Art of the Fugue. Stuttgart Chamber Orchestra, Karl Munchinger.

London LCK 80181 (Ampex Library) 4 Track, Stereo, 7½ ips

This recording as released might be called a course in "instant" erudition. J. S. Bach, in the last year of his life decided to write an exhaustive treatise on how to write a fugue. It was evidently his plan not to write a set of rules to be followed but actually to demonstrate what could be done in realizing the fullest development of a single musical idea. He had already given a lifetime of study to all forms of contrapuntal composition.

Actually he was not an innovator, since he used methods and musical forms which were already well developed by the time he came on the scene. What he did from his earliest youth was study and copy (literally copy out) scores of all composers he admired. Bach was interested in learning of every problem that music of his day had to offer with a view to developing solutions that would please the ear and best answer his purpose. This was an era when it was customary for leading musical performers and composers to improvise on given themes or musical ideas and actually develop specific contrapuntal variations on the theme given. Johann Sebastian's ability on this score earned for him a reputation as one of the outstanding masters of his era.

As late as 1747, three years before his death, Bach performed extemporaneously on a subject for a fugue offered by Frederick the Great. Frederick, an expert flautist, requested a fugue in six parts and the revered master immediately obliged. On his return home from Frederick's palace in Potsdam, home being Leipsig, Bach further developed this same subject into his "Musical Offering" and sent it off as a gift for the king.

The art of counterpoint reached its highest development with J. S. Bach and by the time he finished spelling out what could be done, with his outstanding talent and knowledge, there was little left to explore.

So he conceived of writing on this subject and proceeded to work on it up to his death in order to demonstrate what could be done with knowledge and discipline gained during his lifetime. The year before his death (1749) he composed what he called *The Art of the Fugue* which consisted of 14 distinct fugues developed from one theme and closing with an unfinished fugue which his loss of sight and then death interrupted. This last fragment introduces three new themes in fugal development. This presented two major questions which music historians and other researchers have been trying to answer since Bach's death in 1750.

First, since the score indicated no instrumentation or performance indications, did Bach design this as a theoretical treatise to be studied or did he envision it being performed on any suitable instruments?

On this point, it is interesting to note that while many of the great composers since Bach—Schumann and Mendelssohn for example—recommended all young hopefuls study this monumental work in order to understand how to write a proper fugue, no theoretician writing on the subject after Bach's death refers to the *Art of the Fugue* as a source of information until 1891. His methods of writing fugues were evidently not acceptable to those who formulated the rules and regulations.

As for indications of performance, most of the score falls within reach of two hands on a keyboard instrument and all of it within the span of four hands. The Schwann catalog lists separate performances of the *Art of the Fugue* on organ, harpsichord, string orchestra, a string quartet with woodwind quintet added, and so on. In short, like many Baroque scores, various instruments can be used.

The second question posed by the unfinished work, as left by Bach, was, "How did he intend to finish it?"

The performing version presented by this London recording attempts to answer both these questions. The orchestration is attributed to Wolfgang Graeser who worked out the performing details in 1924 and rearranged the sequence of movements. Graeser scored it for a full complement of strings including double bass, harpsichords, and three woodwinds.

The performance is certainly competent and properly illuminates the score. This is after all an intellectual achievement all the way down the line. Graeser has added some interesting variations in color.

The 18th and last fugue remains a three-subject fugue as Bach left it, rather than developed on to become a more complicated four-subject fugue as intended from all indications. A chorale closes the work.

Some lengthy program notes, included, offer a quick orientation course into the mechanics of fugue writing. An attempt is made to clarify the subject with symbols on the cover of the instructive pamphlet. It looks like something straight off an IBM machine.

I would offer the constructive suggestion that performance times and other clues as to music program be transferred to the liner notes, where they can be read as the music is performed. O.E.K.

TRACKING

An Audio Obstacle Course. Trackability Test Record.

Shure TTR 101 stereo

I invariably jump for each new test record that comes along. And I always end up bored. They may be useful but they aren't often entertaining.

This one is issued by Shure in connection with its V-15 Type II "Supertrack" cartridge, though it can be used to test tracking with any stereo cartridge, of course. Appropriately, I tried out the V-15 on it and found, as expected, that this newest top-of-the-line Shure cartridge does pass all Shure's tests. It had better!

The first side is the best. General idea is to present various types of sound at four successive levels, low to very high (4 dB steps), the third being the normal fully modulated groove, if I'm right. The fourth level, still undistorted in the cutting, will toss many styli right out of the groove though not the V-15 Type II. (Nor other newest-generation cartridges of top quality.)

We hear first a little tune on some deceptively gentle bells. Violent high-frequency excursions. Then a drum roll and cymbal. Each, four times over. A blank anti-skating band and a band of silent grooves, for rumble, etc., use up space. Between these is a single boom of a big bass drum, the usual four times. There are very good accompanying descriptions (printed sheet) of the kind of sound you'll hear in each example when the stylus begins departing from the groove walls. ("A sandpapery, pulled-apart sound at the initial cymbal stroke."). You use the lower-level sounds for direct A-B sound-quality comparison—an excellent idea.

On Side 2, after phasing and channel balance (via spoken instructions on the record), the stereo channels are treated separately, electric organ, piano, accordion and harpsichord. Brief, uninspiring passages of music, each one played four times for each channel—eight in all. Here I bogged down and gave up. Too much repetition.

Why do test record narrators have to speak with such deliberate formality? We're all friends, and it's only a home living room. One gets terribly impatient with the measured pauses that surround every example and each speech. Pep it up, Shure Bros.! Make it livelier and we'll be testing-testinger. E.T.C.

OTHER RECORDS

Albeniz: Iberia; Navarra. Alicia de Larrocha, piano.

Epic BSC 158 (2) stereo

A very fine Spanish pianist here, who has been making sensations hereabouts lately, on tour, having just returned, matured, after a ten-year absence since her New York debut. You'll be hearing about her more frequently now; she's off on the usual endless series of whirlwind tours, right on schedule. Your town is probably on the list.

She is musically a big, florid, slightly old fashioned pianist—in the best sense, that is—who can put over these late Romantic suites of colorful, evocative Spanish piano music with the proper expansiveness, a la Flamenco. Two whole LPs, four sides of them, a few of which are familiar to us all—Evocacion, Triana (not the names but the music is familiar), the rest probably new for many ears who have heard these pieces only as individual short piano works. They all have names, to set the proper mood. But even nameless, in the living room background, they do their own mood-setting on the highest musical level. E.T.C.

Boccherini: Cello Concerto in G. Haydn: Cello Concerto in C. Maurice Gendron; London Symphony, Leppard.

Philips PHS 900-111 stereo

No—not what you think. There have been dozens and dozens of recordings of *the* Haydn Cello Concerto, and on the other side of every one there's always *the* Boccherini Cello Concerto. The two are as inevitable as twins. Here, however, you have a new and different Haydn concerto. And on the back—a brand new and different Boccherini concerto. Did you ever! Something new, for a change.

The Haydn work had its first recording, out of Czechoslovakia, a couple of years ago; it has been unearthed only in recent years, though the theme was in Haydn's own thematic catalogue all the time. It's a lovely little work, early Haydn in style but strong and tuneful, straight out of the *galant* pre-Mozart period, the early 1760s most likely. (The other Haydn concerto, the familiar one, is much later. I find it much duller, too, though it has always been a favorite with cellists.)

The new Boccherini—first recording here—is in comparison a milder, less meaty piece, full of elegant melodies and not much else. This is little more than incidental music and won't take much serious listening. It goes beautifully in the background, though.

Maurice Gendron is a superbly accurate and expressive cellist out of France who never plays a note out of tune, which is unusual. Easy to listen to for that reason! His only fault here is a shade too much of the professional virtuoso attitude, the old pro doing a job. The cadenzas, natch, are too long and too thick, as they always are, outbalancing the somewhat lightweight music. He should know better, but what soloist ever does? The London Symphony is somewhat too big and a trace heavy for these little picees, but only a trace. They move right along, as they should. E.T.C.

Boccherini: Four String Trios. The New York String Trio.

Dover HCR ST 7007 stereo

These sophisticated little trios, high-level entertainment music of the late Eighteenth century sort, are beautifully played by Gerald Tarack, Harry Zaratzian and Alexander Kouguell, all prominent in American music making. Two are from an Opus 14, two from a later group variously known as Opus 38 and

Opus 47—no matter; identification is unimportant for us listeners. The music, if you like the sound of a trio of strings, is perfect of its kind, not unlike late Haydn, much more outward and non-committal than Mozart of the same time, polished and witty and superbly tailored in a very quiet and unprepossessing fashion.

You can understand, here, why that clumsy phrase "Boccherini is the wife of Haydn" came into being. He *is* like Haydn; but his music has much less drive and force to it, less originality, more of an Italianate tunefulness. Haydn was in truth a bigger man. But Boccherini was no mean composer, within his own chosen area of expression. Use him as a nicely highbrow background on the hi-fi. Precisely right for it! E.T.C.

Haydn: Three Quartets, Op. 54, Nos. 1, 2, 3. The Juilliard String Quartet.
Epic BC 1331 stereo

The Juilliard Quartet is a top-quality, top-level American quartet that keeps rubbing me the wrong way. They couldn't be nicer, more conscientious players. They never muff *anything*, including Schoenberg and such. Their ensemble is as smooth as nylon; there are no rough edges anywhere, no disparities in balance between the four, never any frantic scratching (as even the Budapest does when hard pressed) nor any really dull playing.

And yet, as here, this group can be amazingly unsympathetic to the deeper, more sensuous values of the music they play. I've heard these Haydn quartets many a time elsewhere. I am astonished at how little these four players make of, so to speak, their known expressivities. They seem to play it all deadpan, hard and steely in the louder, faster parts, casually unfelt in the slow movements. The stringed instrument can be so expressive! There is so much humanity hidden under the glittery Haydn surface! Don't they realize it?

Perhaps not. But more likely, I think, they feel that Haydn *should* be underplayed in this fashion. I wish I could agree—and I'm no neo-Romantic. All I can say is that numerous other quartets, notably in Europe, make more profound music of Haydn, for most listening ears.

Oh-oh. I see the Juilliard has a present recorded monopoly on two out of these three works. Far better the Juilliard than no recording at all! Decidedly. E.T.C.

Leoncavallo: I Pagliacci. Carlyle, Bergonzi, Taddei, Bonelli, Panerai. Chorus and Orchestra of La Scala, Milan, Von Karajan.
Deutsche Grammophon DGG 9207 stereo

Rarely have so few done so much for so many. The few, in this instance, are Joan Carlyle and Carlo Bergonzi. The many are the remaining members of the cast of this performance of *Pagliacci*.

Strangely, the orchestra which performed so beautifully in *Cavalleria Rusticana* below does not maintain this standard here in *Pagliacci*. This score is more advanced harmonically and rhythmically and, perhaps, a few additional rehearsals were required. At any rate, the precision and control are not in evidence as they were previously.

The prologue, which was written to beef up Tonio's part, is one of the most familiar of all arias, and comparisons unconsciously must be made. Mr. Taddei is not in the vocal league of a Merrill or Warren. His voice, while robust enough, has an excessive vibrato and a forced higher register. His "sotta voce" tends to a falsetto rather than a true pianissimo.

Ugo Benelli, as Peppe, has a light, pleasant tenor and acquits himself well. While his Act II, Scene II aria is sung off stage, the microphone placement is too distant and there are times when he can barely be heard against the orchestra.

Early editions of *Pagliacci* indicate the role of Silvio as that of a bona-fide baritone. Time has transformed this role to a dramatic or even lyric tenor. Panerai, whose voice leans more to a baritone quality than a tenor, lends professional support to the performance.

Nedda (Joan Carlyle) and Canio (Carlo Bergonzi) save the recording. Miss Carlyle has an excellent voice, clear clear, and ringing. In time, I am sure, she will not attack her high notes with the force she now utilizes, but will learn to exercise greater control over her formidable talent.

Thank heaven for "little girls" and Carlo Bergonzi. Here we find the best singing of the opera. His rendition of the everlasting *Recitar*, Act I, Scene IV, is the high-point of this recording. Vocally, he rivals Gigli, both in this and the *No, Pagloccio non son* of Act II, Scene II. His voice is bright and even. The lower tones are full and resonant, while his upper register is brilliant and free with no feeling of forcing his voice on the high notes.

There are a few lapses of rapport between orchestra and cast but nothing catastrophic. Von Karajan's over-all conducting, however, is not of the quality of *Cavalleria*.

The recorded sound is again excellent, a seemingly happy habit with Deutsche Grammophon. L.R.

Mascagni: Cavalleria Rusticana. Cossotto, Martino, Bergonzi, Guelfi, Allegri, Chorus and Orchestra of La Scala, Milan, Von Karajan.
Deutsche Grammophon DGG 9207 stereo

Opera conducting, it is generally acknowledged, is the musical teething ring of all who would aspire to conducting immortality. Musicologists point to Toscanini and Bruno Walter as examples. However, the opposite side of the coin brings some interesting evidence to light. What about the primarily symphonic conductor who enters the operatic field? Leonard Bernstein, for example, in his recent excursion into the field has brought a new and vital excitement to the few performances he has thus far engaged in. Is the converse therefore true? Is it now necessary for the opera conductor to cut his teeth on the symphonic repertoire?

Herbert Von Karajan is by no means a newcomer to opera, but is thought of most often as a symphonic conductor. In this performance of *Cavalleria Rusticana*, the evidence of a firm symphonic hand is indisputable. The La Scala orchestra never sounded better.

The performance gets off to a rather shaky start, with some sloppy ensemble playing on the part of the orchestra and a disappointing opening by Turiddu (Carlo Bergonzi), which calls for more tenderness and some intelligent phrasing. I cannot understand how a musician can repeat an identical phrase without coloring it in some way to create interest and avoid monotony. These shortcomings are short lived, however, and all concerned get down to business.

Fiorenza Cossotto is a musicianly Santuzza. She sings well despite an occasional coarseness of the lower register. Her approach is straightforward and without excesses, which the Sicilian locale sometimes subconsciously intrudes upon Italian temperament. Maria Gracia Allegri (Lucia), Adriane Martino (Lola), and Giangiacomo Guelfi (Alfio) all perform well and add perceptibly to the balance and eveness of the performance.

Von Karajan handles all forces admirably, the tempi all feel right. The tensions and releases are calculated to give minimum and maximum reaction at the right moment. The chorus is bright and uniform and particularly exciting in Scene 9, where Von Karajan uses his whip to best advantage. Surprisingly absent from Von Karajan's conducting is any trace of teutonic influence. He takes to the Italian bravura style with gusto. This is a well paced, excellently recorded performance and although it must stand the test of the competitive RCA-Tebaldi-Bjoerling recording, it need have no apprehension on that score. It measures up with the best. L.R.

W. A. Mozart: Requiem Mass in D Minor K. 626. Elly Ameling (soprano), Marilyn Horne (mezzo-soprano), Ugo Benelli (tenor), Tugomir Franc (bass). Vienna State Opera Chorus and Vienna Philharmonic Orchestra, Istvan Kertesz.
Lon 90120 (Ampex Library) 4 Track, 7½ ips, Stereo

Once again we are confronted with the mystery of the last work of Mozart. He was convinced that the commission to write this Requiem came from some supernatural being. Out of his misapprehension grew the feeling that the Requiem was to be for himself. There was steady pressure, especially financial, to keep Mozart constantly on the go just to make ends meet. He couldn't afford to turn down any commission at this point of his life. After accepting the

responsibility for writing the Requiem, and before he could make any headway on this score, an invitation came to write an opera, *La Clemenza di Tito*, to be performed on the coronation day of Leopold II at Prague. Mozart had already agreed to write the *Magic Flute*. So it went that the young genius at the age of 35 had virtually burned himself out with work. Despite all the effort, nothing seemed to go well after this. *La Clemenza di Tito* was an anticlimax after the coronation activities in Prague. He had then to rush back to Vienna to finish work on the *Magic Flute*. This opera opened to a cool reception at the initial performance. It gained popularity and momentum subsequently, but by this time Mozart was confined to his bed, and trying to finish the Requiem. He felt that death was drawing close to him and expressed the strong feeling that someone had poisoned him. He worked feverishly with his assistant, Franz Sussmayr, to sketch out the music for the various sections of the Requiem. On the morning of Dec. 5, 1791, Mozart passed away. The official cause of death given as malignant typhus fever. Through the years there has been conjecture on the possibility that death was indeed due to other causes. Years later, Mozart's greatest rival, Salieri, insisted on stating on his death bed that he did not poison his former competitor.

We know that Mozart was carried off to an unmarked pauper's grave. His wife, Constanza, tried her best to get the *Requiem* manuscript completed in order to fulfill the commission. The obvious choice to do the job should have been Sussmayr, but as it turned out, he was the last of three that were approached. He undertook to complete the score and did so well that the expert musicologists are still trying to determine how he was able to rise to the occasion and produce music which could begin to measure up to that of Mozart at the height of his powers. The probability is that Sussmayr had sufficient sketches and notes to complete the greatest portion of Requiem according to the wishes and instructions of Mozart himself. His contribution was the insertion of the Sanctus, the Benedictus, and the Agnus Dei which he claimed to have composed in toto, as well as scoring and organizing the remainder.

The net result is beautifully sung in this recording. All solo voices blend well and the diction is especially clear and easy to follow. Istvan Kertesz seems to prefer a somewhat subdued orchestra with greater emphasis on the chorus and voices. All in all the performance just narrowly misses catching full-fire.

O.E.K.

Leonard Bernstein and the Juilliard String Quartet. Schumann: Piano Quintet in E Flat; Mozart: Piano Quartet in G Minor.

Columbia MS 6929 stereo

It was clear enough long ago that you can't get very good chamber music out of solo-type virtuoso performers. There's a contradiction in the very idea; for chamber music by definition is music for equal and totally co-operating protagonists.

Oddly, the present combo works out well on Side 2, in the Mozart, but wretchedly, if in lively fashion, for the Schumann on Side 1. The reasons are easy to spot, I'd say.

Bernstein—the conductor with the flair! He was and is a skilled pianist, but being the big boss for so long has, quite rightly, led him into habits of dramatic leadership that don't go well with chamber music. A leader not only dramatizes; he must exaggerate, to make his points. Just as an actor must speak whispers in a stage whisper. And a leader is a person not accustomed to taking other people's ideas as to interpretation, especially on terms of supposed equality.

SO—Bernstein being by nature a flamboyant protagonist of Romantic music, a dramatizer, the famed pioneer Schumann Quintet comes out as a sort of Bernstein TV show, complete with (audible, if not visible) gestures. The Juilliard, an ensemble that is not noted for its flamboyancy, follows along dutifully as well as it can. Things aren't helped by Schumann's obvious bias towards the piano at the expense of the puny string players. A proper performance minimizes this fault. This one maximizes it. It's a good-natured mess, at times, and at others simply a Bernstein solo with accompaniment, racy, hammy, and not very subtle. There have been, in music history, thousands of better performances.

Mozart, oddly, is *much* better. First, unlike Schumann, Mozart knew how to balance his (smaller) piano against his three strings. There is more dialog, strings versus keyboard, for instance, to make the duality meaningful. Second, Bernstein shows the Romanticist's respect for Mozart's classic leanness and economy; he plays here with an excellent restraint—and Juilliard, not very Romantic as a group, is now in better form. Side 2 is OK by me, if not Side 1.

E.T.C.

Tchaikovsky: Romeo and Juliet; 1812 Overture; Marche Slave; Waltz from Sleeping Beauty. Royal Philharmonic Orch. Sir Malcolm Sargent.

Seraphim 60023 stereo

This is a low-price reissue of works that have appeared on the regular Angel label. Seraphim are "Angels of the Highest Order" and certainly this example is just that. Sir Malcolm is a *Maestro* in every sense of the word. The performances and recording (it stands up against anything being released currently) are the real stars. These tired warhorses are brought to new life under the Sargent baton.

Of the four works, the *Romeo and Juliet* is most perceptive simply because it allows the most perception to come through. The *Waltz* is a little gem, as is the *March Slave*. This latter work is one of Tchaikovsky's patriotic throwaways, but it is no hack work. The Sargent touch transforms it into a jewel in miniature.

Not too much can be said or done for the 1812. Not even Tchaikovsky had much use for it. The wonder is that there are so many top musicians willing to lavish hard work upon it. This version is complete with some unnamed and unidentified cannon that goes off at the right times (unlike the premier performances). So it is a stunning sonic *tour de force*.

Still, I would urge this record on you if it was issued at the usual five-dollar-plus lists. At the Seraphim $2.50 list, if this music is at all to your liking, then this is the record to have in your collection.

M.R.

Wagner: Rienzi Overture; Siegfried Idyll; Lohengrin—Prelude to Act I; Die Meistersinger—Prelude to Act III, Dance of the Apprentices, Overture. Bavarian Radio Symphony, Carl Schuricht.

Everyman SRV-220SD stereo

Everyman is the low-priced classic label for items culled from the Vanguard label. This particular version features some of the most lyric music Wagner wrote. *Reinzi* is one of his earliest works, he was barely 25 when it was started. Yet it is a nearly mature effort. The opera itself is seldom heard today; it is longer than *Götterdämmerung*. Neither is a reasonable evening's performance. The *Overture* however, has become a staple concert piece.

If *Rienzi* represents the young artist, the *Siegfried Idyll* is born of fully mature talents. It was written as a surprise birthday gift to his wife (the daughter of Franz Liszt). It is marvelously expressive and colorful, yet it is scored for an orchestra of sixteen pieces.

The first act *Prelude to Lohengrin* is Wagner at his most ethereal and mystical; this only mirrors the opera itself. But if *Lohengrin* is mystical; *Meistersinger* is earthy. This opera represents the lusty Wagner. Happily we are treated to three musical excerpts arranged in reverse order so that the *Overture* ends the selections. It really is all logical and worthwhile.

This may be low-priced but it is certainly not inferior. If Schuricht and the Bavarian players are deliberate in tempo and a bit ragged at the edges, no matter. It is not all that bad. Wagner still shines through untarnished. Vanguard's Everyman sound is first-rate. All-in-all perhaps this is not polished Wagner, but it certainly remains musical. And, as a bargain disc it ought not be missed.

M.R.

Hollywood Pops: Alfred Newman conducts the Hollywood Bowl Symphony Orch. or his Studio Orch.

Capitol SP 8639 stereo

If the heading is a bit non standard, so is the record. It is in fact five classical snippets and seven Alfred Newman film score pieces. Side one is the Berlioz: *Rakoczy March;* Khachaturian: *Russian*

Dance (from *Gayne*); Khatchaturian: *Romance, Mazurka* (from *Masquerade*); and Delibes: *Procession of Bacchus* (from *Slyvia*). On this side we have Newman the conductor and the Hollywood Bowl players. They are all top-drawer professional. Newman leads with a sure hand and a firm beat.

Side two features the Newman film scores. They are: *Palm Sunday* (*The Robe*); *Hallelujah* (again *The Robe*); *23rd Psalm* (*David and Bathsheba*); *Anastasia; Pinky; Catana* (*Captain from Castile*); and *Conquest* (also from *Captain from Castile.*)

All of these should be well known to long-term moviegoers and late-night televiewers. Of these the *David and Bathsheba* and *Anastasia* works have rightfully achieved a degree of popularization. They are lovely works. But the *piece de resistance* is *Conquest*. This is a powerful and moving march, that alone makes the disc worth while. M.R.

From France With Love. Capitol Symphony Orchestra, Carmen Dragon, cond.

Capitol SP 8649 stereo

Here is one of these records that might well belong in the pop record listings but it has a classic label (and price) and it does feature some "legitimate" compositions. The whole point here is French music. So there is Offenbach's inevitable *Can Can*, two excerpts from Bizet's *L'Arlesienne Suite*, some Debussy, a touch of Gounod, and Ravel's lovely *Pavane For A Dead Princess*. There are also several traditional French tunes but the *coup de grace* is *Amaryllis* by King Louis XIII.

There *must* be something good I can say about this disc. Certainly it is well played. Capitol's sound is faultless. There must be a large market for these semi-serious records or there wouldn't be so many of them. For me, it's just first-rate background music. And who *listens* to that. M.R.

Light Listening

- RICHARD L. LERNER
- CHESTER SANTON
- ROBERT SHERMAN

The Apple Tree: Barbara Harris, Larry Blyden, Alan Alda and other members of the Original Broadway Cast.

Columbia KOS 3020 Stereo

Two of the three branches of *The Apple Tree* are laden with musical goodies of the most tempting sort. Barbara Harris is winsome, winning, and wonderful as Eve in Eden (a setting of Mark Twain's satiric tale) and Passionella, the "Moooovie" Star (in an adaptation of a story by Jules Feiffer). Everything she does seems exactly right, and her efforts are firmly seconded not only by those of co-stars Alda and Blyden, but by the inventive, brightly original songs of Jerry Bock and Sheldon Harnik.

The third part of the trilogy (based on Frank Stockton's *The Lady or the Tiger*) attempts a more pretentious style, aims for loftier musical satire, and misfires on both counts. Barbara Harris, it must be said, is still Number 1, even here, but she has to try harder.

Columbia, incidentally, has been surprisingly stingy with the fringe benefits, considering that the disc lists at $6.79: the album comes completely devoid of notes or plot synopsis, and you can't even find out the song titles without squinting at the small print on the record label itself. R.S.

Sergio Franchi

RCA Victor LSP 3654

The latest release by RCA's favorite Italian tenor in the popular field has a title (From Sergio—With Love) that I felt could be dispensed with in the heading lest it frighten away readers who otherwise might find a great deal of technical merit in this disc. To start at the beginning, Franchi happens to possess a voice that is exceptionally clean in timbre. This means he has a head start regardless of the particular type of microphone selected for his use at a recording session. Whatever mike was decided upon by engineer Bob Simpson for this session, it is obviously the right one for the Franchi voice. Also helping, and this can be a factor with any given mike, the distance at which this microphone was employed is the ideal one. I've never heard the voice to better advantage. This release may well supplant some of the earlier vocal stereo discs I've kept on hand to demonstrate my system to the neophyte. Veteran readers who have gone through the demonstration process over the years with newcomers hardly need to be reminded that a familiar voice can do wonders in pointing up the difference between a top system and the average stuff. How many non-hi-fi listeners, even those of considerable musical erudition, can accurately diagnose the difference they hear in the tone of a famous violinist or pianist on your equipment instead of theirs? Play them a good disc by a personality they happen to know (a Perry Como for instance) and watch their reaction when a sizeable stereo system "brings him alive" in the same room with them. This disc does for Sergio Franchi what some of the better stereo releases have done for Como. Also very much on the plus side are the arrangements and conducting by Marty Gold. The orchestra is heard in lush stereo that takes you back to the days when just about every RCA Victor pop release made full utilization of the two-channel medium. The few novel touches in the arrangements are genuinely different. Note the tuned tympani used prominently in one song to achieve a brooding somber effect. In all, this is a highly successful sonic showcase for a popular singer of far more than average gifts. C.S.

Merv Griffin and Arthur Treacher in London

M-G-M SE 4381

The title of this album gives a slight clue but few record buyers will suspect what these well-known late evening personalities are really up to. Would you believe Arthur Treacher, late of movie butlering, as a singer of old-time hits of the British Music Halls? Or Merv Griffin as aider and abettor in some of the tunes? Yet a cursory examination of the Treacher background in show business will make this album seem less than far fetched. Born in Brighton, England, Treacher could hardly have missed the music hall influence in his country's entertainment world once he began to tread the boards in 1919. In this album he revives some of the comedy songs and tear jerkers that go back to a music hall era that gave us such familiar stars as Harry Lauder, Stan Laurel, Charlie Chaplin, and Beatrice Lillie. Merv Griffin's appearance as a vocalist will raise fewer eyebrows. Long before his emergence as a television host, Griffin gained his first nationwide fame as a singer with Freddy Martin's band. The tune that did the trick then is repeated here—*I've Got a Loverly Bunch of Coconuts.* C.S.

The Horn Meets "the Hornet." Al Hirt and Orch.

RCA LSP-3716 Stereo

The Hornet here is the green one of television. This is a collection of Hirt impressions of current television theme musics. There are themes from *The Green Hornet, Get Smart, Run For Your Life, Batman, King Kong* (that, I am told is a kiddy cartoon series), *The Monkees, Tarzan, T.H.E. Cat,* and *Run Buddy Run.* There are also two bands added that are not TV themes. One is called *Night Rumble* in an arrangement that is conducted by Dick Hyman. The second is called *The Hornets Nest;* this is arranged and conducted by Bill Walker. The *Green Hornet Theme* has been arranged and is conducted by Billy May.

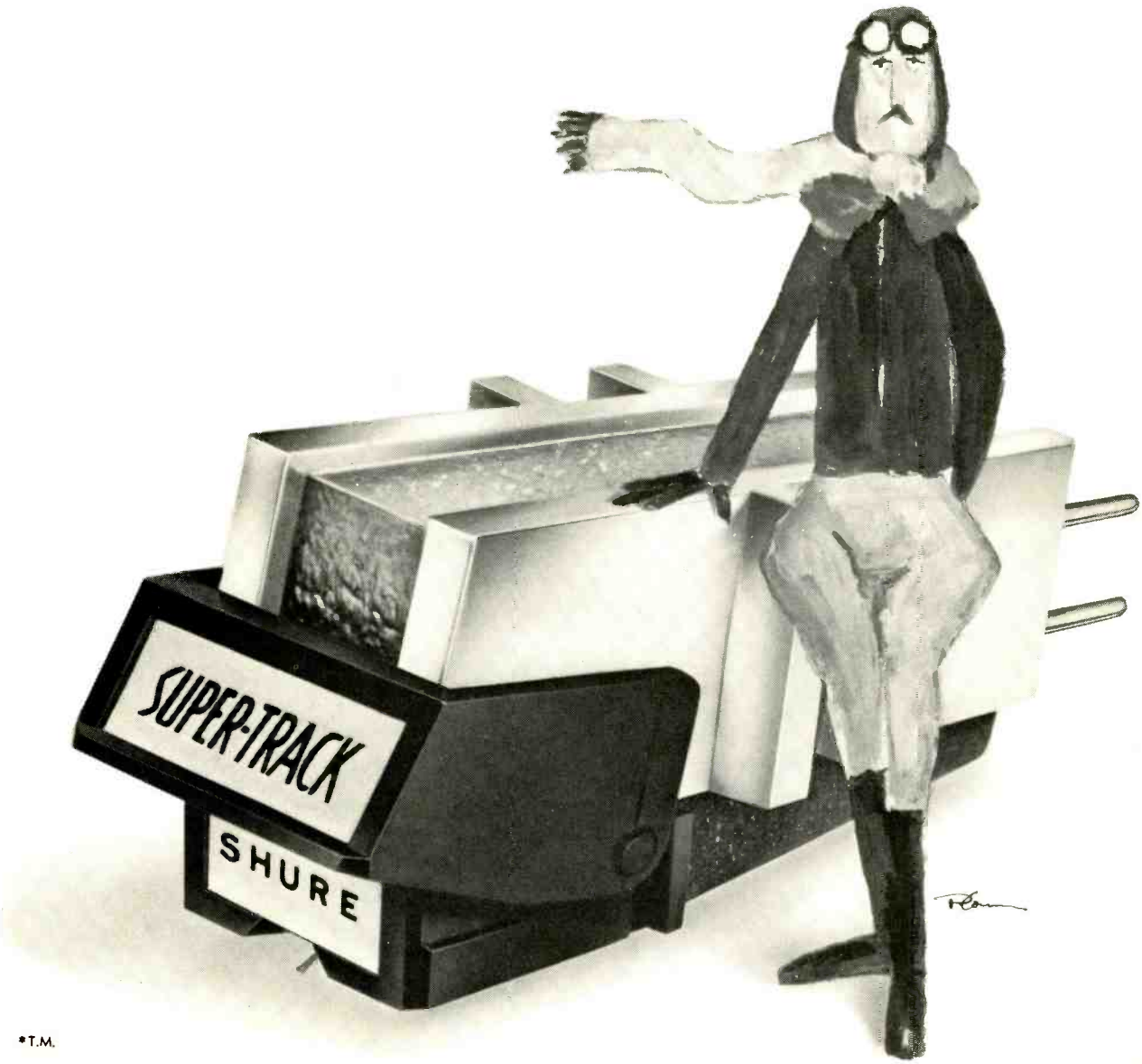
But it is the Al Hirt horn that is the star here. Fans of his will find much to revel about. He is in virtuostic form, pushing and tugging at that horn in a way in which its creators never imagined. I refer you to the *Tarzan* theme. The "wah-wah" sound is impressive. So is the rapidity of the Hornet theme. But it is the melodic line of the theme from *The Monkees* that steals this show. For one thing, it's the best piece of music here. For another, Hirt plays it straight. And a straight playing Hirt is a masterful trumpet.

RCA's sound is several cuts above the usual quality they give to popular discs. R.L.L.

LE MANS IS CHILD'S PLAY COMPARED TO "FOUR CONCERTOS FOR HARPSICHORDS AND ORCHESTRA"

The Shure V-15 Type II phono cartridge must be *much* more trackable than a Lotus Ford. This seemingly silly simile has significance, however, when one fully appreciates the importance of *trackability* in providing crisp, clear, distortion-free sound from *all* of your recordings. The ascents and descents, jarring side swipes, abrupt turns of a Grand Prix course are widely known. (Other analogies we might have used are the slalom, the steeplechase, the bobsled). Not yet as well known has been the curious fact that the grooves reproducing high level recordings of orchestral bells, harpsichords, glockenspiels, drums, pianos—through which the cartridge must wend its melodic way—are even more tortuous, more punishing. Thus, the much talked about "compliance" and "mass" of past evaluations are now merely parameters of design—whereas "trackability" is the true measure of performance.

For *your* entry into the era of high trackability, for an experience in listening you will find most astonishing, ask your Shure dealer to demonstrate the Shure V-15 Type II Super-Track* at $67.50, the Grand Prix elite among cartridges. It maintains contact between the stylus and record groove at tracking forces from ¾ to 1½ grams, throughout and beyond the audible spectrum at the highest velocities encountered in quality recordings. Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, Illinois 60204



*T.M.

Check No. 127 on Reader Service Card.

Twin Guitars—In a Mood for Lovers: Los Indios Tabajaras.

RCA Victor LSP 3611 (stereo)

The two Brazilian tribesmen who call themselves Los Indios Tabajaras have progressed over the years from authentic native chants to popular songs in folk style (*Maria Elena* has been their biggest hit to date). This time around, they have forsaken their cultural heritage altogether, and set aside their vocalizing in favor of instrumental (two guitars plus discreet percussion) settings of such less than ethnic pieces as *Make Believe, The High and the Mighty, Smoke Gets in Your Eyes,* and *The Third Man Theme.* The tunes are attractive enough, and the performances pleasantly easy-going, but the unchangingly languorous mood and the innocuous arrangements add up to a generally dullish outing.

R.S.

"Mod" Concert: Music by Alfven, Khatchaturian, Fischer, Felix, et. al., with the Pro Arte Orchestra conducted by Gilbert Vinter.

Capitol SP 8642 Stereo

If nothing else, this album deserves recognition for sporting the most outrageously misleading cover of the year. *Mod Concert,* it says. *A Jet-Age Survey of the World's Fashions in Melody,* it says. *A Good-Time Sound Spectacular,* it says. All this and a cover photo of a long-haired, short-skirted model, twisted into a frenzied go-go dance pose. Well, that would be fair enough if the musical content followed suit, but what do we find in this Mod, Jet-Age, Good-Time Spectacular? Pierné's *Entrance of the Little Fauns,* the languid Canadian folk tune *A la claire fontaine,* the gentle *Praeludium* of Armas Järnefelt. Abundant jazz rhythms (it says here) are provided by Ferde Grofé's *Mardi Gras,* the Latin beat comes from music by another renowned avant-guardist, Ernest Lecuona, and in a bravura display of Mod programming at its most daring, the disc leads off with the musical toast of 1923: Eric Coates' miniature Overture *The Merrymakers!*

Having duly noted that the old adage about telling books from their covers applies equally well to recordings, it must also be said that the present album does add up to highly agreeable listening. Much of the music is first class in its genre, some of the pieces (the Coates Overture, for instance) are new to disc, and even the lesser items (i.e., *Under the Linden Tree* by one Hugo Felix) are pleasantly melodious, skilfully orchestrated, and performed with good graces.

R.S.

Music of Lehar and Strauss. Anton Paulik conducting the Vienna State Opera Orchestra.

Vanguard Everyman SRV-205SD Stereo

The Editor sent this disc to me under the obvious uncertainty over whether it belongs in the CLASSICS or LIGHT LISTENING departments. I confess to an uncertainty myself. Certainly this is the popular music of its time, but then so was a lot of Mozart.

To compound things, this is thought of as a classic disc by Everyman. It is titled (though the heading has been altered on this review) *The Merry Widow and Other Music of Lehar and Strauss.* The Strauss part is Johann Jr. but with one work, *Furioso Galop* by Johann Sr. Other Strauss Waltzes here are the *Secunden Polka, Violetta Polka, Klipp-Klapp Galop, Studenten Polka, Waltz, Freut euch des Lebens,* and the *Demolierer Polka.*

Lehar is represented by the title work's waltz, several Waltzes from *Eva,* and the Waltzes from the *Count of Luxembourg.*

Paulik and the Vienna State Opera Orchestra know how to play this music and they get the most from it. (The VSOO is one of the real orchestras of Vienna; it is not a pickup.)

The Everyman sound is on the bright side, perhaps just a bit edgy in the strings. Although that is the sort of sound many European orchestras do make.

R.L.L.

Ray Noble

RCA Victor LPV 536

Several years ago Capitol Records brought out a reissue album featuring Ray Noble's original dance band in the British recordings that first brought him fame among American listeners. In this release, part of its decidedly worthwhile Vintage series, RCA Victor pretty much completes the Ray Noble story on records with a sampling of the records made by his American band. Anyone curious to know why Noble was a byword among record collectors in his day would be well advised to get the larger set on Capitol—if only for the distinctly better sound he got from the engineers who worked with him in his native land. In another sense, however, this Victor reissue will have more appeal than the Capitol. Those interested in the history of our better known dance orchestras will be fascinated by the list of musicians who worked for Noble as sidemen in his American orchestra. The appearance of the later-to-be-famous players on the Victor label is more or less coincidence. Victor recorded the band as a matter of course because, at that time, it held the domestic rights to the Noble band's British HMV records on 78-rpm pressings. Even without the unique warmth and "live" quality of the British sound, this disc, dating back to the mid '30's, will attract attention because Glenn Miller, Charlie Spivak, Will Bradley, Bud Freeman, and Claude Thornhill can be heard in this band. This particular group was organized in New York by Miller while the fresh-from-England Noble was waiting for a membership card in the local musician's union. Miller was already an established arranger when the band was formed. Four of his fast instrumentals on the record reflect his arranging style of the time. Al Bowlly, the fine vocalist in so many of the earlier Noble best-sellers, is heard in ten of the songs offered here. The value of discs such as this one cannot be fully comprehended by today's youngsters who never heard, as I did, the broadcasts of the Noble band from the august Rainbow Room atop Radio City in New York, the scene of its first and most important American engagement. Of course, any one familiar with the Fred Astaire-Ginger Rogers classic film musicals now on television will easily grasp the period of this record when Bowlly, a vocal group called the Freshmen and Noble himself swing into Irving Berlin's *Top Hat.*

C.S.

Old Heidelberg: Will Glahe's Chorus and Orchestra.

Ampex-London LPM 70017 (4-track stereo tape)

Listen with stein in hand, and *gemütlichkeit* in heart, and you'll enjoy these lusty mementos of Old Home Week at the Brauhaus. The men's chorus is suitably virile, Will Glahe's orchestra-cum-accordion accompaniments are light and lilting, and the songs themselves (some forty in all) are short enough not to overstay their welcome. Essentially, the tape covers the same ground as did the series of *German University Songs* on the Vanguard label some years back, except that the arrangements are homier (good), and Erich Kunz is missing (bad). Lively recorded sound is another plus.

R.S.

The Royal Highland Fusiliers. Regimental Band, Pipes, Drums, and Bugles.

London International SW 99425 Stereo

What a sonic blockbuster this is! There are two groups here, the Military Band and the Pipes and Drums of the Royal Highland Fusiliers. The term Fusiliers comes from the seventeenth century. Fusiliers was a name given to light infantry that fought with a flintlock musket called a fusil.

But to get back to the record at hand. This is for lovers of military bands and Scottish pipes and drums. Each are here featured both separately and in combined forces. The result is some stunning teamwork effects that must be heard to be appreciated.

But this disc is as much a sonic showoff as anything else. London International has provided us with a highly modulated disc that, given the music material, is a real challenge to track. But it can be done and the results are worth the effort. These are hall recordings, so there are none of the problems that seem to plague these recordings whenever they are attempted out-of-doors. The heavy cutting of the disc does, however, create a prominent pre-echo which, I am sure, carries into the music. Still, the sound remains quite clear.

But collectors will never mind because this is excellent band playing. And sound fanciers will never mind; they'll be too busy startling the neighbors. As for me, I would like to hear a good tape copy of the original master.

R.L.L.

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Russian Melodies. Emil Decameron and his Orchestra.

Vanguard Everyman SRV-201SD Stereo

This is an album for which you must be conditioned. These are symphonized versions of folk/ethnic melodies. Your conditioning must be two fold. You need to know and appreciate the Yiddish and Slavic works that have already been disked by Benedict Silverman. Then too, you must basically have had exposure to the music in its native form. As such you can appreciate the authority of these transcriptions. Emil Decameron captures to perfection the essence of these delightful songs. Even better, his orchestra fits right into the mood, serving the music well.

There is much that is familiar here. A dashing *Russian Sher, Meadowland, Dark Eyes,* the *Volga Boat Song,* and the *Red Sarafin.* And there are ten more.

It's all very pleasant nostalgia that has been well executed here. And if this is your cup of tea, then drink hearty. At the Everyman label bargain price this is a lovely disc. R.L.L.

Today's Great Popular Favorites: Richard Tucker, with Orchestra conducted by Franz Alers.

Columbia MS 6895 Stereo

Richard Tucker's operatic fervor is here focused upon a fine group of (mostly) show tunes, and the album is firmly recommended to anyone who likes show tunes sung with operatic fervor. Arias from *Kismet, Stop the World* and *On a Clear Day You Can See Forever* highlight the collection, and Mr. Tucker's clarion tenor likewise converts such once tender romances as *Sunrise, Sunset,* and *Somewhere* into thrilling bravura pieces. Of the non-Broadway material, the numbers which take best to this grandiose approach are *What Now My Love* (one of the really fine pop songs of the 60's), and a vigorous Israeli song-of-the-open-road type ballad, called *The Rover.* R.S.

Your Father's Mustache

RCA Victor LSP 3722

Your Father's Mustache is a chain of banjo nightclubs currently operating in nine cities scattered over much of the United States with several more scheduled within the next six months. With nostalgia a big drawing card in the entertainment world these days, the first throwback to the Twenties in this series of clubs opened its doors in Boston in September of 1962. This recording was made in the course of a typical evening's festivities at the Father's Mustache in New York City with the banjos in full cry in such beer-washed favorites as *Bill Bailey, MacNamara's Band,* and *Bye Bye Blackbird.* If primness in music making is not your dish of tea, a visit to the nearest record shop with this disc in its stock will have the most depressed individual on his feet in no time. C.S.

Jazz and All That

Bertram Stanleigh

Fats Waller: Fractious Fingering.

RCA Victor Bono LPV 537

This is the third platter of Waller reissues in the Vintage series. This means that nearly ten per cent of the more than 500 sides he recorded for Victor are now available in new high-quality transfers. The collection offers three piano solos from 1929, one of which, *Gladyse,* is a different take than that originally issued on 78's, and 13 sides from 1936 with a rhythm backing made up of Herman Autrey, trumpet, Gene Sedric, clarinet or tenor, Al Casey, guitar, and Slick Jones, drums. In addition to *Gladyse,* the reissues include *The Curse of an Aching Heart, S'posin', 'Taint Good, Nero, I'm Sorry I Made You Cry, My Feelin's Are Hurt, Floatin' Down to Cotton Town, Fractious Fingering, La-De-De La-De-Da, Sweet Savannah Sue, Bye Bye, Baby, I'm at the Mercy of Love, Please Keep Me in Your Dreams, Who's Afraid of Love?,* and *Swingin' Them Jingle Bells.* The transfers have been made with the same care as on previous Vintage reissues, and the resulting album is a treasure. B.S.

Astrud Gilberto, Walter Wanderly Trio: A Certain Smile, A Certain Sadness.

Verve Stereo V6-8673

Pairing Astrud Gilberto with the popular swinging Walter Wanderly organ trio turns out to have been a better idea than I would have suspected. With Bobby Rosengarden's colorful percussion, the group provides a supple, neatly balanced background for this flawless singer. From her first appearances in this country, only a couple of years ago, it was clear that Señora Gilberto was a perfectionist who was never likely to deliver a second-rate performance. She has never fallen below that standard, and if I report that her latest release is no better than her several earlier discs, it is simply that some things are beyond improvement. This album is an experience too fine to overlook. B.S.

Charles River Valley Boys: Beatle Country.

Elektra Stereo EKS 74006

Well, if the music of Lennon and McCartney is good enough for the Boston "Pops," Count Basie, and Gerry Mulligan, it's not surprising that it's also good enough for the Grand Old Opry circuit. Here, recorded in Nashville, are a dozen Beatle tunes performed in proper country and western fashion by a highly polished vocal and instrumental group. Both their individual names and their group identification are new to me—as a matter of fact, the only Charles River that I know is in Massachusetts—but their style is impeccably Nashville, and they cast an entirely new perspective on *I've Just Seen a Face, Baby's in Black, I Feel Fine, Yellow Submarine, Ticket to Ride, And Your Bird Can Sing, What Goes On, Norwegian Wood, Paperback Writer, She's a Woman, I Saw Her Standing There,* and *Help.* The Beatle material sounds so comfortable in country style that it may just wind up as standard blue-grass repertory. B.S.

Judy Collins: In My Life.

Elektra Stereo EKS 7320

That's right, the title of Judy Collins' latest release is yet another number from Lennon and McCartney. But it is only one aspect of the many-faceted collection she offers. Other selections from the broad gamut she covers include Bob Dylan's *Tom Thumb's Blues, Pirate Jenny* from the *Threepenny Opera,* Donovan't *Sunny Goodge Street,* and a group of selections from *Marat/Sade.* Recorded in a topnotch London sound studio, these performances augment Judy Collins' guitar with a variety of extra instrumentation. One of the special virtues of Elektra is its ability to get consistently good sound from commercial studios in various cities and countries. Most of the larger labels can't manage to achieve such uniform top quality with their own studios and engineering staffs. B.S.

Love: Da Capo.

Elektra Mono 4005

In addition to being a four-letter word, Love is the name of a seven-man West Coast group that sings, plays loudly amplified guitars, and makes some very modern, angry noises on flute and percussion. What it achieves sounds very much like the road out of folk-rock to someplace beyond. This is the same road that is being travelled by the Fugs and the Mothers of Invention, but Love is not simply one more group latching on to a new gimmick. It has a clear identity of its own, and its musicianship is of an especially high order. Most of the songs are written by Arthur Lee, a member of the group, who is a young man with ideas. He is worth remembering. B.S.

Fred McDowell, Volume 2.

Arhoolie Mono 1027

Arhoolie has made a specialty of seeking out and recording authentic blues

performers of the Texas and Gulf area. In Fred McDowell of the Mississippi Delta, they have one of the most eloquent of present day blues practitioners. Discovered in 1959 by Alan Lomax. McDowell has since gained an audience throughout the United States and Europe. His lean, economical manner of playing the guitar and singing is powerfully direct and deeply moving. For his second album he has reworked a number of songs that were not previously in his repertory and which are seldom encountered. In addition to performances by McDowell, the recording includes two songs by his former teacher, Eli Green, and a spiritual sung by the Hunter's Chapel Spiritual Singers. The recordings, made in Como, Mississippi and Berkeley, California, are of the "documentary" variety—adequate for preservation and appreciation, but hardly impressive for their technical achievement. B.S.

Tony Mottola: Guitar U.S.A.
Command Stereo RS 908SD

Not only does Tony Mottola include a Beatles number, *Yesterday*, in his latest, lively collection, he also doffs his hat in the direction of the popular Herb Alpert and his Tijuana Brass with a perky version of *Spanish Flea*. But it's a flea from a very different bag as Tony, on 12-string guitar, and Al Casamenti, on mandolin, carry the trumpet parts. In addition to a pleasant mixture of pop tunes and standards, the set affords an opportunity to note and compare a vast variety of guitar types. On the dozen numbers, Tony can be heard playing electric guitar, stereo jazz guitar, electric 12-string guitar, electric solid-body guitar, electric solid-body firebird, electric bass guitar, acoustic 12-string guitar, and classical guitar. Six top guitarists and a flock of notable sidemen are featured on this bright, fresh, crisply engineered platter. B.S.

Robert Shaw: Texas Barrelhouse Piano.
Arhoolie Mono F1010

Born in 1908, Shaw was a barrelhouse pianist during his twenties, and although he has since gone on to more legitimate and prosperous pursuits as the proprietor of a food market, he has continued to perform the music of his youth for his own pleasure. Arhoolie's claim that Shaw is the best of the Texas barrelhouse men still to be heard is probably no exaggeration for this pianist has a strong, sure technique with an attractive ragtime swagger. His program offers ten tunes, several of which recur frequently in traditional jazz with different titles and slight variations. In the liner notes, Shaw is quoted as saying, "When you listen to what I'm playing, you got to see in your mind all them gals out there swinging their butts and getting the mens excited. Otherwise you ain't got the music rightly understood." Shaw certainly has a talent for getting his idea across. The recording, made in 1963, is adequate; it was previously released by another label, but an accompanying note indicates that Arhoolie claims rightful ownership. B.S.

sound&sight

HAROLD D. WEILER

LAST MONTH'S SOUND AND SIGHT described the method of determining the vertical resolution of equipment employed in video recording and closed-circuit television. We continue with the use of a test pattern such as illustrated in *Fig.* 1, to determine over-all performance, compare equipment and to check and make adjustments.

In addition to the brightness gradations in the vertical direction, described last month, most scenes have brightness gradations in the horizontal direction. In consequence, the picture quality is also dependent upon the amount of resolvable detail from the left to the right side of the picture, which is termed the horizontal resolution.

Horizontal resolution is primarily dependent upon the size and shape of the pick-up and reproducing tube scanning beams and the bandwidth of the system. Horizontal resolution is usually expressed in the number of distinct vertical lines, alternately black and white, which can be perceived in a test pattern. The vertical wedges indicated as "C" in *Fig.* 1 are employed for this purpose. These wedges, like the horizontal wedges, each consist of two groups of four individual converging lines. The horizontal resolution is determined by locating the point at which the individual lines are no longer separately visible and then reading the calibration figure adjacent to this point.

If we assume optimum focus of the pick-up tube in a camera such as is illustrated in *Fig.* 2, and optimum focus of the monitor display tube, we would find the individual lines on the vertical wedges merge and become indistinct in the vicinity of point "D" in *Fig.* 1, indicating that the horizontal resolution of this particular camera is 500 lines at the center of the picture. The bandwidth of the system is then determined by dividing the number of lines by 80. In our example, 500 lines divided by 80 indicates that the bandwidth of the system is approximately 6.25 megahertz. As may be seen from Table 1, the broader the bandwidth of a system the higher the horizontal resolution.

Table 1.

Resolution in TV Lines	System Bandwidth in Megahertz
160	2.0
180	2.25
200	2.5
240	3.0
280	3.5
320	4.0
400	5.0
480	6.0
500	6.25
560	7.0
600	7.5
640	8.0
680	8.5
800	10.0
960	12.0
1000	12.5

The wedges in the four corner circles of the test pattern, indicated as "E" in *Fig.* 1. are, among other applications, also employed to determine vertical and horizontal resolution, as described for those in the center circle. These corner wedges, however, will generally display lower resolution than the center wedges for various optical and electronic reasons, to be discussed in detail in a later article.

The corner wedges provide an excellent means of determining the center-to-edge focus of the camera lens employed. Less expensive lenses will show a deterioration in the center-to-edge focus at or close to the maximum aperture. This characteristic results in a loss of detail in the corners of the test pattern. Should difficulty be experienced in obtaining good over-all focus, the camera lens should be used at a smaller aperture to provide improved focus. Reduced aperture, of course requires higher "on-scene" illumination.

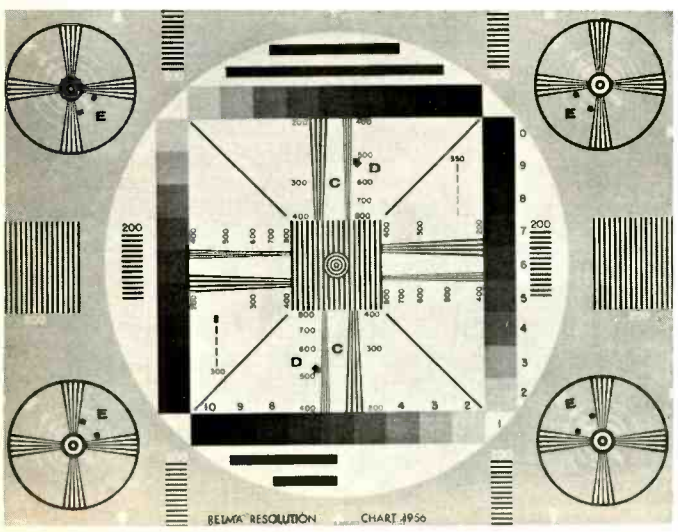

Fig. 1. The RETMA resolution chart.

The simplest method of providing the reader with some idea of the relationship between system bandwidth, resolution, and the quality of the picture which may be expected, is to analyze the image broadcast by a high-quality television broadcast station.

Studio facilities in a modern TV station are maintained to provide a bandwidth of approximately 8 MHz, which from Table 1, we can see provides a resolution of approximately 640 lines. Due to the limitation imposed by the line scanning rate of 525 lines, as explained last month, the vertical resolution is limited to approximately 350 lines. This is the quality of the picture which may be observed on the station's studio monitor, a quality not to be seen by the average viewer. The over-all system resolution slightly exceeds the resolution of most camera pick-up tubes employed in video recording and closed-circuit television, which is about 600 lines. This signal is then fed into the transmitter.

Bandwidth limitations imposed by the Federal Communications Commission limit the maximum video bandwidth of the transmitter to approximately 4.2 megahertz. In consequence, the maximum horizontal resolution which may be expected from the transmitter is 4.2 x 80 or 336 lines. The transmitter engineers observing the picture on an r.f. monitor will receive an image displaying a horizontal resolution of 320 lines, due to transmission losses. Thus the picture transmitted by a high-quality TV broadcast station displays a vertical and horizontal resolution which are about equal: 320 lines. This is the maximum resolution which can be obtained under optimum conditions from a broadcast signal when a high-quality r.f. monitor is employed at the transmitter location.

The vertical and horizontal wedges of the test pattern transmitted by TV broadcast stations for the use of TV service and installation men (in the alignment and adjustment of home receivers) is normally arranged to display a resolution of from 150 to 320 lines on the vertical wedges and a resolution of from 150 to 350 lines on the horizontal wedges. These values differ slightly with different TV stations since they depend upon the width of the wedge lines employed.

The quality of the received broadcast image is further dependent upon the location and the quality of the television receiver employed. "Higher Resolution" capability is one of the many reasons that monitor receivers are more expensive than conventional home television receivers.

The test pattern employed by TV stations incorporates many of the features included in the standard test pattern provided in *Fig.* 1. An analysis of this type of test pattern will be provided in a future article since many video recorders and an increasing number of closed-circuit television systems employ r.f. transmission of the video signal.

Further information on the use of a standard test pattern to evaluate, analyze, and adjust video equipment will be provided in our next issue. Æ

Tape Guide

HERMAN BURSTEIN

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

Q. My tape recorder has separate record and playback heads, but does not have separate record and playback amplifiers so that I can monitor the tape as I record it. Therefore I plan to add a playback amplifier; and it has been suggested to me that I might use one of the inexpensive stereo phono preamps such as made by Fisher and G.E., provided I install a switch to permit using it for tape playback. What is the purpose of the switch, and what kind should it be?

A. The phono preamp provides both bass boost and treble cut, while the tape playback head requires only bass boost, and of increased amount. Therefore corresponding equalization changes have to be made in the phono preamp for use with a tape head. The purpose of a make sure that your panel has room for more than the number you now believe are required. Over-design a little. It pays.

In the April 1966 installment of the Tape Guide there was a reference to a tape recorder whose metal plate became very hot to the touch. A similar problem was encountered and solved by Hans D. Schwethelm, 5639 Hawthorne St., Montclair, California. "My Concertone 801 did the same thing. The villain was a defective torque-motor resistor (variable resistor with four voltage taps). This heated the motor, which in turn heated the frontplate, which is designed to act as a heat sink."

Reader Schwethelm goes on to comment on another problem with his tape machine. "I also experienced a slowdown in the operating mode when the take-up reel was nearly full. I solved the problem by substituting a sand-blasted capstan (that's right) for the smooth capstan. At the same time I increased the pressure exerted on the capstan by the pressure roller, this by turning the adjustment nut on the capstan solenoid. The sand-blasted capstan was supplied by the factory."

Q. How often should 1½-mil tapes be played or rewound to prevent print-through? What about 1-mil and ½-mil tapes? What about polyester vs. *acetate tapes?*

A. The amount of print-through depends upon the recording level, upon the thickness of the tape base, and upon the storage time. Most of the audible print-through occurs within about the first week after recording. Theoretically, you would have something to gain by playing or rewinding a recorded tape every few hours in order to minimize print-through. Obviously this is impractical. Hence to minimize print-through you had best focus on proper recording level, upon suitable base thickness, and upon choice of a low-print tape if in practice you find print-through to be a real problem. Additional measures are to store recorded tape "tail out" (end of the program material at the outside of the reel) and to wind and rewind the tape one or more times prior to playback. ÆE

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