AUDIO

JANUARY, 1964
60¢

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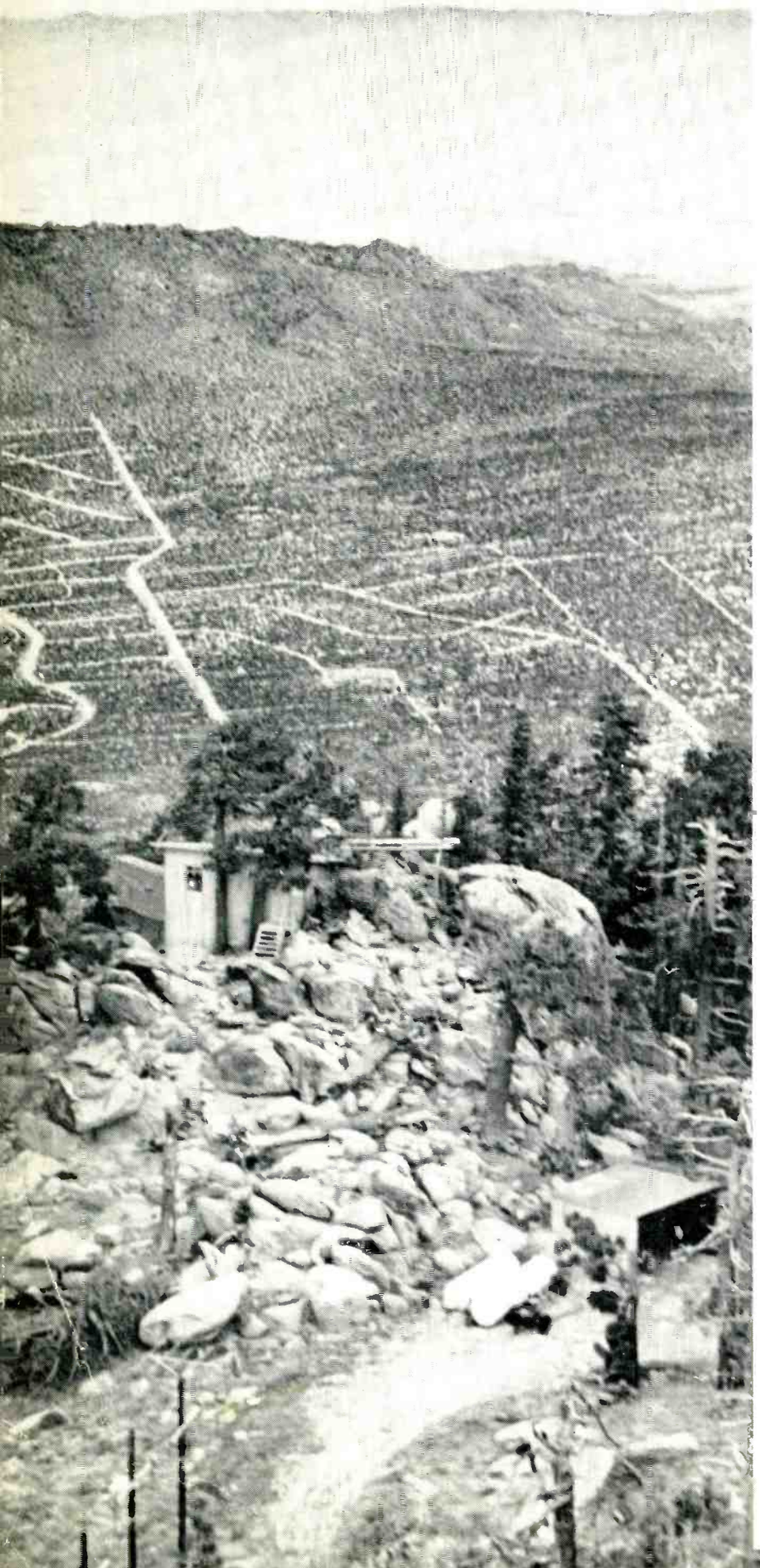

ON A DESERTED MOUNTAINTOP 10,000 FEET ABOVE THE CALIFORNIA DESERT THE SCOTT MONOPHONIC 310 IS ABOUT TO BE REPLACED... BY THE NEW TRANSISTOR 4312 STEREO TUNER

High atop Mount Santa Rosa, in California, the Palm Springs Television Company has been using monophonic Scott 310 broadcast monitors to relay FM programs from Los Angeles 105 miles away to the town of Palm Springs, directly behind the mountain. With the advent of stereo, new equipment was needed that would be as reliable as the 310, and provide the same performance . . . now in stereo. After an exhaustive study of available tuners, the brand new Scott 4312 transistorized tuner was selected for the job.

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Robert Beaman, Chief Engineer for Palm Springs Television Company, emphasized the two basic factors in the selection of the Scott 4312:

1. The radically new Solid State circuitry, designed by Scott, provides the optimum in stability and assures years of cool-running, trouble-free performance . . . a must for a remote location like Mount Santa Rosa.
2. New Scott transistor circuitry makes possible three-megacycle detector bandwidth which provides a new standard of stereo separation not previously achieved with vacuum tube tuners.

Here are the seven features that make the Scott 4312 the world's first truly reliable TRANSISTORIZED tuner.

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5. Sensitive tuning meter and antenna orientation indicator.
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7. Professional slide-rule tuning, with heavily weighted mechanism, and use of ball-bearings throughout. Assures true velvet-touch tuning. $365*

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AUDIO

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AUDIO Articles

AUDIO Reviews

AUDIO Profiles

AUDIO in General

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Coming Next Month

Construction . . .

● A Master Timer. W. G. Dilley details the construction of a metronome which can supply visual and audible signals, remotely or locally, in order to aid the recording of musical performances where the performers may be widely separated, or even isolated from each other.

● A Re-recording Filter. H. E. Riekels. A simple filter for use in re-recording tapes and records.

General . . .

● Reducing Distortion in Stereo Phonograph Systems —Part 1. J. G. Woodward. A description of research by the author, at RCA Laboratories, into the tracking-angle and tracing distortions produced when stereo records are played. One of the results of this research is the Dynagroove process. This part deals with the tracking-angle.

● Bad Sound From Great Composers. Lewis A. Harlow. Many times the distortion we hear on recordings is the fault of the composer.

and

Equipment Profiles . . .

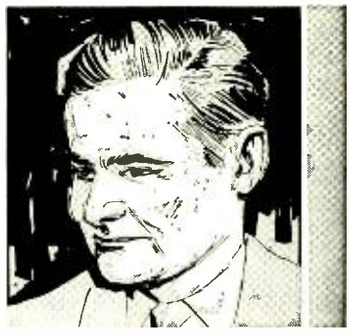
McIntosh MR-67 FM-Stereo Tuner
David Clark 100 Headphones

In the February Issue

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

AUDIO CLINIC

Joseph Giovanelli



Send questions to:
Joseph Giovanelli
2819 Newkirk Ave.
Brooklyn 26, N. Y.
Include stamped, self-addressed envelope.

Audio Time Delay System

Q. My question is about an unusual problem in a sound re-enforcement system in a local church. The equipment is primarily a sound distribution system to several rooms. The only speakers in the main auditorium are two fill-in speakers under the balcony. The problem is echo caused by the direct sound arriving under the balcony after the sound from the speakers. Most people scarcely notice this. Others find it very annoying.

Do you know of any method, not too expensive, for introducing a delay in the amplified signal to eliminate the echo? The delay needed is about 0.05 second. W. J. Stiles, Kirksville, Missouri.

A. I know of no inexpensive commercially available arrangement which will do what is required for your church installation. However, the procedure to be described uses an idea originally found in a commercial reverberation unit.

Assume we have the microphone picking up the sound of the speaker's voice in the normal manner. Assume that this microphone ultimately feeds a small speaker fitted to the end of a tube or hose. Another microphone is placed at the far end of this hose. The output of this second microphone is fed to the public address system in the normal manner.

The length of the hose is dependent upon the time delay required. It can easily be calculated. To make this computation, remember that sound travels at a speed of approximately 1100 feet per second. The time delay you require is approximately 0.05 second. Therefore, the hose length required will be equal to the distance that sound will travel in 0.05 second, or 55 feet.

Fortunately, the hose can be coiled, thereby eliminating the complications attendent on installing 55 feet of straight hose.

The quality of the final result will be degraded over what it was in your original installation. Therefore, use tubing having the largest possible diameter.

Fusing Loudspeaker Systems

Q. I have a three-way speaker system. I wish to fuse this system but I do not know how to go about this.

The midrange and tweeter have less power-handling capacity than does the woofer. Does the crossover network protect the smaller power-handling capacity of these speakers or must each speaker be protected separately?

I would like to fuse each system at a slightly lower level than the maximum which the system is rated to withstand because the systems are quite efficient. Are the fuses used cartridge type, similar to those used in amplifiers? D. Schmit, Milwaukee, Wisconsin.

A. In my work with speaker systems, I have found that the crossover networks protect the tweeter and midrange units to such a degree that there is no reason to fuse them separately even where their wattage ratings are less than that of the woofer. Rather, it is only necessary to fuse the over-all system.

The type of fuse is not critical as to shape. It is important that a delay type of fuse be used. This type prevents small transient peaks from blowing. These peaks will not harm the speaker. You will have to experiment with the fuse to find the best current-carrying capacity.

One thing is important and that is that you provide some kind of an alternate load resistor which will come into play if the fuse blows. If this protection is not provided, the amplifier will be unloaded when the fuse blows. This, in turn, can result in damage to the output stage of the amplifier.

My experience has shown that a resistor having a value of about ten times the impedance of the speaker provides a suitable alternate load. This resistance value is not so low that it will rob significant power from the amplifier. A one ampere fuse will serve as a starting point for your experiments.

In my speaker systems which are 16 ohms at 30 watts, I use a 150-ohm alternate load resistor and 0.8-amp delay type fuse. If the impedance is 8-ohms or lower, with the same power-handling capacity, the current rating of the fuse must be increased. If the power rating is less than 30 watts, the size of the fuse will have to be reduced.

The rating of the fuse does not double when the impedance is cut in half, assuming the same power requirement. The size of the fuse must be increased approximately 1.25 to 1.50 times its value at 16 ohms.

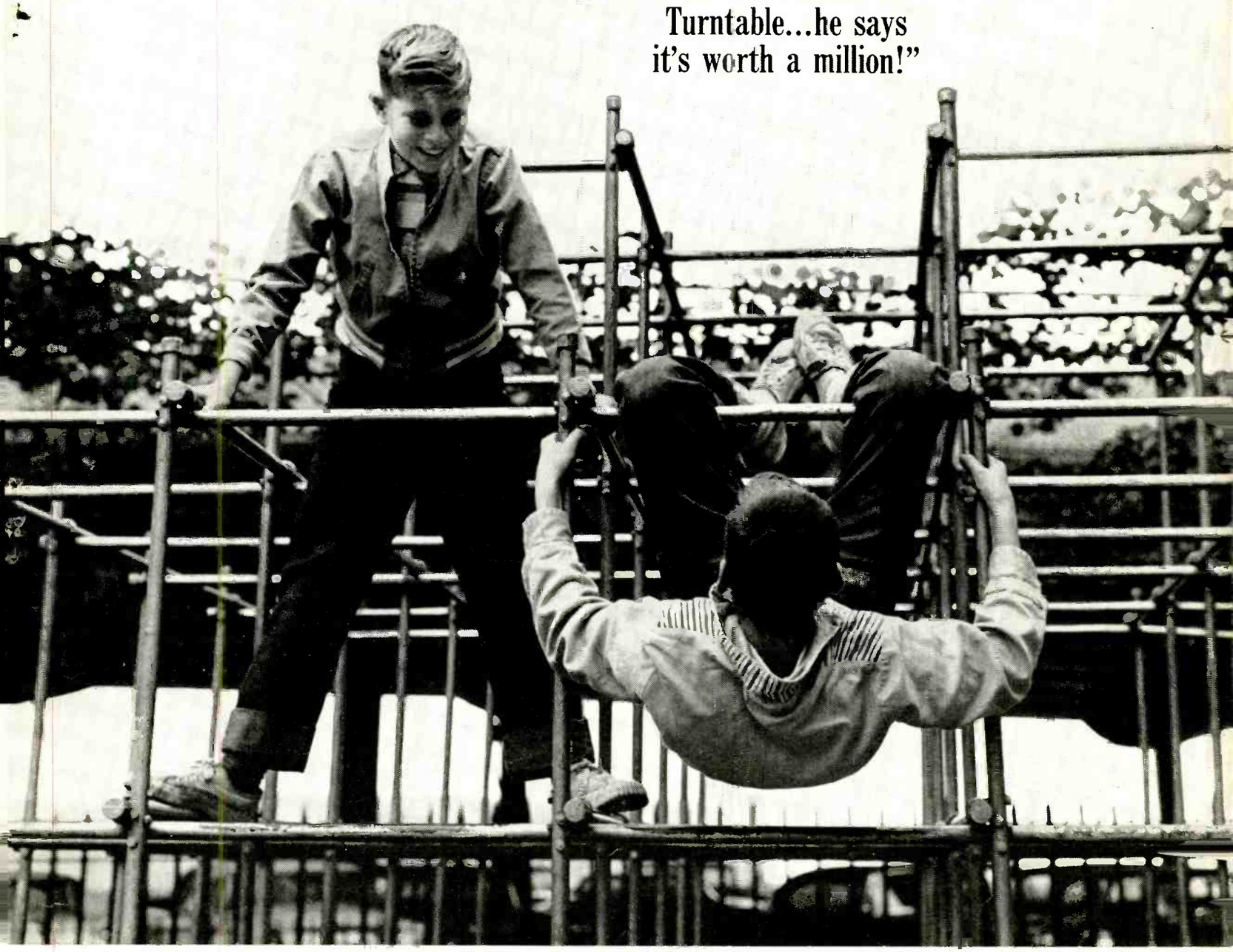
Voltage Breakdown of Capacitors

Q. What would be an optimum voltage rating for an electrolytic capacitor used as a bypass to ground in a voltage divider which is providing 30 volts of B-plus to the heaters of the tubes in my pre-amplifier?

I tried a 40 μf, 10-volt unit and it exploded. The B-plus supply for my preamplifier provides 250 volts. This is connected to one of the arms of a potentiometer, the other end being grounded. The arm of the pot is adjusted so that the smaller resistance, or some 25 k of the 250 k potentiometer, appears between the arm and ground. The voltage between the arm and ground is some 30 volts as measured with a VTVM. This arm is attached to the arm of a po-

"my daddy bought us a new car... he says it's worth $7000"

"my daddy bought us a Garrard Automatic Turntable...he says it's worth a million!"



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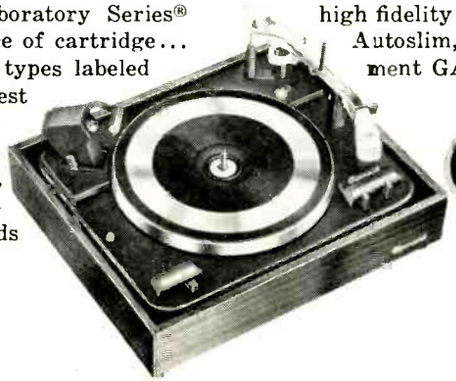

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WORLD'S FINEST

tentiometer which, in turn, is connected across the heaters. The capacitor bypasses, or shunts, the 25 k to ground. Wilfred Bell, Sedalia, Missouri.

A. If you do need a bypass from the arm of the potentiometer located in the B-plus portion of your power supply, the voltage breakdown for this capacitor must be higher than the voltage to be applied across its terminals. When any capacitor is rated at a particular voltage, this rating indicates the maximum voltage which can be placed across the capacitor without causing it to break down. For instance, if you have 30 volts which is to be placed across the terminals of a capacitor and if you use a capacitor rated at 10 volts, the applied voltage will be three times higher than that which the capacitor is capable of withstanding. You saw the results of this experience for yourself.

For your application, you must use a capacitor having a rating of 50 volts or better. There is no adverse effect if you happen to use a capacitor having a voltage rating somewhat higher than the actual applied voltage. In fact, there must be some leeway for safety if the equipment is to operate in a trouble-free manner for a long period of time.

This is true only within limits. If you use a capacitor rated at 450 volts, for instance, the capacitor would function and would probably possess more capacitance than it would if it were operated closer to its rated breakdown voltage. If this capacitor was operated in that manner for a long period of time, the voltage breakdown rating would decrease and, therefore, could not be placed across the full 450 volts until it had undergone restoration on a forming rack.

At this point you might wonder what happens when a capacitor breaks down. What can break, you may well ask after all, there are no moving parts.

The capacitor is constructed with two elements insulated from one another. It is essential to the proper operation of the capacitor that this insulation be maintained. The thickness of this insulating material is not great, possibly 0.1-mil in some instances. When voltage in excess of a certain level is applied between these insulated plates, the insulating film is incapable of withstanding the strain caused by the force between the two plates. The insulation is punctured and the two plates touch and form a short circuit. The capacitor will now act like a continuous piece of wire.

The thicker the insulating layer, the greater its ability to withstand the voltage applied across the plates it separates. Thickness of this material is not the only criterion of voltage breakdown. The type of material used has a considerable effect upon the voltage breakdown for a given thickness of material.

The ability of the material to withstand voltage applied to the two plates which it separates is a measure of its *dielectric strength.* **Æ**

A Troubador is a Troubador is a Troubador

TROUBADOR
TABLE OF CONTENTS

Empire 3-speed "silent" turntable; 980 dynamically balanced playback arm with sensational Dyna-Lift*; 880p mono-stereo cartridge featuring the virtually indestructible Dyna-Life* stylus. 488 complete with walnut mounting board: $192. Walnut base optional ($15); 398 complete with handsome walnut base: $210.

*Patent Pending

When Empire first built the Empire Troubador 398 it was strictly for professional and studio use—The thought of a highly technical, precision company, kept busy with industrial and laboratory products 24 hours a day, entering the consumer field was unreal. However, as the Troubador was seen and heard, the demand became quite great, and a new consumer product came into being. Now we had a professional record playback system, second to none — too handsome to hide behind cabinet doors, too technically perfect for a whisper of distortion. And its components, used by more FM Stereo Stations than any other brand. "But what about my cabinet . . ." came the cry of a new breed. Enter the Empire 488—no larger than a record changer . . . every inch a Troubador. Same motor . . . same belt . . . same arm . . . same cartridge . . . same weight platter, only the size has changed.

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LIGHT LISTENING

Chester Santon

Together! with the Buffalo Bills
Warner Bros. WS 1520
The Phoenix Singers in Concert
Warner Bros. WS 1522

These new stereo releases from the Brothers Warner are sure to cheer the audiofan who has become disenchanted with the present sound available on some of the major labels. To the credit of Warner's engineering staff, there is no lopping off of top or bottom segments of the frequency spectrum in order to accommodate the deficiencies of cheap playback equipment. Dynamics are left relatively unharmed to work out their natural rise and fall on a sound system that can handle them. With adequate provision in the budget to incorporate decent material in the pressings, surface noise of these discs is down to the level of the industry's current minimum. Any grade-school economist can figure out that it's cheaper to mask disc surface noise with the higher signal made possible by a dynamic limiter than it is to foot the expense of top-grade materials in the disc itself.

Warner Brothers have not stinted on sound in either of these releases recorded, by coincidence, during appearances of the Buffalo Bills and the Phoenix Singers in Washington, D.C. Prior to their 1957 Broadway debut in the cast of "The Music Man," the Buffalo Bills had already established themselves as a vocal attraction by winning the coveted International Championship of The Society for the Preservation of Barber Shop Quartet Singing. Following the 1,350 New York performances of "Music Man" and the film version of the show, the quartet is now busy packing in customers at supper clubs such as the one that provided the live acoustics for this recording. Anyone with a good stereo setup will have a field day following the four tightly interwoven strands of their close harmony in unaccompanied ballads, show tunes and novelties that only a barber shop quartet would tackle. The orchestra of Bill Cross is heard in some of the numbers but the spotlight is brightest on the quartet. We all have our favorite recordings when it comes to demonstrating the virtues of good stereo to listeners whose interest in the subject doesn't quite match our own. I think you'll find this full-range disc by the Buffalo Bills a more arresting item for demo use than nine tenths of the channel-hopping stuff.

The album by the Phoenix Singers, recorded at The Shadows in Washington, D.C., reflects the successful first year this male trio has enjoyed in show business. All three members of this group are graduates of the famous Harry Belafonte Singers, bringing a polish and rhythm propulsion to their folk songs that can be traced back to their parent body. There is an easy virility in the approach to all their songs (gospel, work tunes and ballads) that is most refreshing in today's crowded field of folk singers whose voices seldom rise above the puny.

Here's Love (Original Broadway Cast)
Columbia KOS 2400

The first major musical of the new season is ready for home appraisal but it's a moot point whether every homestead will decide it has to have a copy of the original cast album. "Here's Love," Meredith Willson's latest musical, has all the trappings of an important show. Unfortunately for the home listeners, "Here's Love," like so many productions of the past season or two, depends on the nature of its spectacle rather than the caliber of its songs to keep the customers from fidgeting in their seats. In terms of wholesomeness, the story surpasses even the "Sound of Music," the previous contender for top honors in the right-for-the-whole-family category. In "Sound of Music," Rodgers and Hammerstein had only Mary Martin; in this show Meredith Willson has Santa Claus under contract. A real live Santa Claus right on the stage of New York's Schubert Theatre. The show, as you've probably guessed by now, is based on the old movie "Miracle on 34th Street" which featured Edmund Gwenn as Kris Kringle. In his libretto and lyrics Willson has merely brought up to date the classic struggle between the Macy's and Gimbels department stores while preserving as much as possible of the original story's message of love at Christmas time. To supplement love in the abstract, more or less standard romantic leads have been worked out to keep busy the stars who share top billing with Laurence Naismith, the Kris Kringle. A production as predictable as this one does manage one surprise. The leading man making his Broadway debut is Craig Stevens who projected Peter Gunn into a prominent place in television listings as long ago as 1958. Janis Paige is the leading lady, returning to Broadway after an absence of seven years. Playing the part of a brisk lady executive at Macy's, hers is the easiest voice to recognize in a so-so set of songs. There isn't a single musical item in the show with the initial impact of the tunes Meredith Willson turned out for "The Music Man" and "The Unsinkable Molly Brown." The closest link to his earlier Broadway successes is the hearty music for the marchers in the Thanksgiving Day Parade. The single exotic touch in the score is a short carol sung in Dutch by Santa and a little Dutch girl. The rest of the songs may not go down in the annals of show business but "Here's Love" will probably carry the ball for the rest of the season as The Wholesome Show for the entire family. The stereo version is the preferred one if you insist on savoring the motion of the parade.

Robert Goulet in Person
Columbia CS 8888

It takes only a minute or two of "auditorium level" listening to determine that this is no ordinary Goulet recording. Most of us are quite aware of the fact that the average recording artist usually turns in a better performance when taped before a paying audience. Record labels with artists still capable of drawing a crowd have also been aware of this factor and have tried to take advantage of the phenomenon whenever possible. Anyone who has followed the musical fortunes of a favorite singing star through a succession of recordings is equally aware of the differences that can show up in a series of recorded personal appearances. As luck (or hard work) would have it, everything worked out splendidly at the concert Columbia taped for this recording. So many studio recordings these days are turned out almost mechanically with the singer running through a bunch of songs with one eye on the music stand before him and the other on the clock on the wall telling him he's already late for his next appointment. This Goulet recording, on the other hand, puts the listener in the audience that spent its good money to attend his gala concert at the Chicago Opera House. What we are attending is a performance polished to jewel-like precision by weeks of rehearsal and, more important perhaps, repeated exposure to a series of audiences. Lyn Duddy and Jerry Bresler created the special material Goulet uses in the concert: the incisive uptempo *Wake Up* that opens the show as well as the ballad *Melinda*, the breezy *Concentrate on One Thing at a Time* and the compelling *Blues Are Marching In*. Jerry Bresler is also in charge of the large orchestra that gives Goulet magnificent backing throughout the show. Highlights of the album are the medleys, one devoted to outstanding venerable tunes, the other to great Lerner and Loewe classics from "Paint your Wagon," "Gigi" and "Brigadoon." Unlike the average pop album which runs about 13 or 15 minutes to a side, this Goulet concert offers 40 minutes of top entertainment.

Patachou at Carnegie Hall
Audio Fidelity AFSD 6109

Patachou's typically exuberant appearance at Carnegie Hall gives the Audio Fidelity label another opportunity to remind us that France is far from poor in personality singers even with the great Piaf gone. It is hard to believe that a decade has gone by since Patachou made her first real mark in this country with a smash fourteen-week engagement at the Empire Room of the Waldorf Astoria Hotel. A typical collection of Patachou favorites has been miked at close range, encouraging the listener to forget that the singer and the small assisting combo are really working in a large hall. The only reminder of the locale is to be found in the reaction of the audience heard across the footlights as Patachou explains, in her unique way, the meaning, intent and significance of the songs she is about to sing.

Gordon Jenkins: In a Tender Mood
Columbia CS 8809

The recordings of Gordon Jenkins demonstrate the advantages that can come the way of conductors who choose not to stay put on one label. While many band leaders may testify to the convenience of working for one label decade after decade, Jenkins has been able to prove that playing the field is an excellent way to keep a conductor-arranger from going stale. In the current LP catalog are to be found Gordon Jenkins releases on the labels of Decca, Capitol, Warner Bros., Everest, Time and C.G. as well as the latest stuff on Columbia. The stimulus of working with a wide assortment of recording crews is clearly evident in his latest release. Combined here are the far from inconsiderable virtues of Columbia's low-distortion process and the solid musicianship of a conductor-arranger who has consistently refused to be swayed by fads in sound or the vagaries of the musical market place. In the Jenkins treatment of orchestra and chorus in this stereo recording you never lose the melody in such evergreens as *Begin the Beguine, Paradise* or *Gone with the Wind*. The freshness of the album lies in the way Jenkins introduces his ideas. He doesn't hit you over the head with a phrase for shock effect. Each pattern, whether for voice or instrument, grows out of the basic design the composer put into the song. When the tune happens to be a Jenkins composition, as in the case of the moody *Blue for Beverly*, the task is easier but the important point is that he handles most tunes as though he had collaborated in their composition. AE

LETTERS

Is Stereo Necessary?

SIR:

I agree with Mr. Hancey ("Letters," March, 1963) but I will be more specific about the unreasonable attempt to bring the concert hall into the living room. The most predominant example of this trend is the steadily growing large-scale change from monophonic to all-stereo equipment.

Certainly stereophonic reproduction is a step toward "realism," but unless a person wants to take the time to sit in his living room and pretend he is really in the concert hall—perhaps even trying to locate the positions of the instruments, he is wasting his money on a lot of extra equipment. The person who really enjoys good music for the entertainment and inspiration it conveys will not be listening for *effects*, and will be just as satisfied with a monophonic system of good quality.

During much of the time while most of us have our hi-fi equipment operating we *wouldn't even notice* whether the recording being played at the time is stereo or monophonic. We don't often pay that much attention.

PAUL T. GIHRING
5615 Lisette Ave.
St. Louis 9, Mo.

A Poke at Pike

SIR:

I must object to the tone of some of the remarks by Mr. Winthrop S. Pike, concerning organs and organ music, in the October 1963 issue of AUDIO.

I'm afraid Mr. Pike, and other "purists" like him, overlook a good many practical factors. Most of us, for example, are: (a) lovers of the organ—organ "sound" if you like; (b) interested in playing for our own amusement, rather than to impress someone else; (c) not organists in the classical sense; (d) not rich, either; (e) not owners of cathedrals in which to plug the pipes of a pipe organ.

Mr. Pike seems to take a very dim view —in fact, the tone of his remarks becomes quite sarcastic at times—of the ". . . 'simplified' arrangements of timeworn old chestnuts," and of electronic organs in general, for that matter. Maybe, if Mr. Pike could, or would, look around, he might just discover that there are a lot of people like me who don't claim to be organists, but who like to play *what they are able to play* for their own enjoyment.

H. E. BRYAN
9175 San Juan Place
La Mesa, Calif.

"Fluid" vs. "Solid-State"

SIR:

Edward T. Canby brought out an interesting point in his comment on "fluid" vs. "solid-state" high fidelity (November AUDIO). He contends that the main concern should be whether any advancement in technology forwards the "high" of the fidelity and contributes to lower distortion, less hiss or hum, and so on. The argument over the relative merits of a "transistor sound" should be secondary.

An analogy might be drawn to the characteristic sound of a pipe organ with regard to that of its electronic counterpart. Few will deny that such a differentiation exists, but are we more concerned with comparing a Baldwin to a Steinway grand, or a harpsichord to an upright?

E. Power Biggs (Notes to accompany "The Art of the Organ," Columbia SL-219) brings up an interesting observation in his comparison of electric and mechanical pipe organs (the analogy follows to electronic organs). The system of mechanical linkage affords the organist the ability to control the rate of buildup of pipe wind pressure simply in the manner by which he presses on the key. The movement of the mechanical linkages may be heard in the background. The electrical and electronic organs, however, have "instant" touch and, in general, are completely void of extraneous noise. Mr. Biggs relates that this so-called imperfection adds a vital factor in making the sound of the organ "lively" or, better, not monotonous after the first movement.

Mr. Canby's attitude is the only attitude for the purist. A tube is no more a transistor than is a pipe a speaker.

ROBERT W. MILLER
2336 Bancroft Way
Berkeley 4, Calif.

He Wants Individuality

SIR:

You have hit a nerve in your November Editorial. You are absolutely correct in your assumption that the FM band has been degraded. Technically, however, there should be absolutely no problems with wireless microphones which definitely fill a need to the public in the most straightforward way. In fact, I see no reason why the output of these devices shouldn't be at least 100 μv/m at 50 feet since they are easily tunable. (*The problem is interference with an already licensed service—technically and ethically.* ED.)

Yes, the FM band has been degraded. However, the contributors to the vast FM wasteland are FM stations and unfortunately the good music image that a few (like your magazine) groups present as the music for the majority. For example, here in the Decatur area we can receive 10 or so FM stations and without exception they are broadcasting good music. All is the same. They could, in fact, exchange tapes and no one would be the wiser. I like mood music, the classics, and good orchestras, but not the same all the time. FM here as well as everywhere else I have been presents a mechanical image of goodness. I want individuality and personality with radio stations (total image, of course) as well as with people. Otherwise why have more than one radio service to a community or even a nation?

CHARLES E. KOONTZ
Room 404
Y M C A Hotel
151 West Prairie Avenue
Decatur, Illinois 62523

Want to Visit?

SIR:

I have been actively interested in "Hi Fi" for at least 20 years and have by now accumulated a large collection of all types of records (non-classical) and some tapes.

I like to think my equipment is unusually good and would be interesting to others.

I would like to get in touch with a few people with similar interests who might like to exchange visits, do some listening and exchange ideas about our mutual hobbies.

I would welcome calls from anyone interested at Freeport 8-1118.

R. M. HOLT
126 New York Avenue
Freeport, L. I., N. Y.

MORE CLEAN, UNDISTORTED POWER, BANDWIDTH AND FEATURES THAN FAR COSTLIER INTEGRATED VACUUM TUBE STEREOPHONIC AMPLIFIERS

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The new Award A700 puts out a big, clean 70 watts of audio power. That's more than enough to drive any speaker—regardless of efficiency. No matter what speaker you use, chances are the A700 will be coasting most of the time.

Now consider the frequency response of the A700—12 – 70,000 cps ± 1 db! No other integrated vacuum tube amplifier—regardless of price—can approach it! What makes the difference? The A700's solid state power supply, plus its specially designed grain-oriented steel output transformers!

The A700's bandwidth superiority can be demonstrated visually with test instruments. More important, it can be heard in your living room! It is this extended bandwidth—octaves above and below the normal range of hearing—that assures flawless reproduction within the audible range... and at all power levels!

Run through the gamut of conventional controls on any fine integrated stereo amplifier—individual bass and treble tone controls, tape monitor switch, separate high and low cut filters, balance control, contour control, blend control—you name it, the A700 has them all and more!

But where the A700 really moves "out front" is where it counts—performance! For final proof, ask your dealer to demonstrate the A700 against other costlier amplifiers. Even against some of the so-called "world's-best." For anyone with highly critical standards—and a modest budget—the A700 is the only logical choice. Write Harman-Kardon, Dept. A-1, Plainview, N. Y., for more information on this superb integrated stereo amplifier.

The A700—$199.95. Prices slightly higher in the West.

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AUDIO ETC.

Edward Tatnall Canby

THIRD CHOICE IN TABLES

This is a time of rapid change, they say. Even phono tables are changing. That is—almost any phono table except the kind I've been trying out recently. This type couldn't change a fly, let alone an LP record. But it is changing the turntable market quite radically, breaking up consumer habits that date back to the very beginning of home hi fi.

I refer to the minimum-powered, lightweight manual tables, driven by the tiniest of clock-like, low-torque motors and sold at a very "reasonable" price, for high performance in fundamental aspects. They have already become a major Third Choice for most hi fi shoppers.

From the engineer's viewpoint these tables are interesting but not exactly spectacular. There are many ways to skin this particular cat, the design of a moderate-priced high-performance turntable, and the clock-sized motor drive system is merely one of them, as anybody can see at a current hi fi show. Most of the features in these tables are familiar already; individually, we have seen them in one form or another in many earlier playing systems.

And yet nevertheless, after a couple of months' personal experience with a table of this minimum-power variety, I've come to see why the type has generated what might seem a disproportionate popularity for itself. The obvious answer would seem to be quality—high performance at a modest price via design and manufacturing ingenuity. Very possibly true; but there is more to it than that, I think, and the further differences are worth a good look.

Alternative

You see, since as far back as the first days of the home hi fi business a strictly two-way choice has been offered the prospective home buyer in the turntable area; before he could get anywhere at all he had to jump positively, one way or the other. It was a deep and significant division, too, for it reflected no less than the entire larger structure of the new home equipment market. Moreover, it involved price contradictions that to this time continue to bewilder the newcomer. Don't tell me no. I hear it every day.

On the one hand, you were told, you could buy a changer. Now today there are many varieties of changer and the prices would seem to vary widely enough. Yet no matter how you slice it, the changer still is a changer. Changers have everything. They play every known speed, accommodate any old disc, 7-inch, 10-inch (what happened to *them?*), 12-inch, big holes, little holes, inserts; they change, they stop automatically and return to rest, they even turn off your system for you. And of course they have arms, built-in, and often enough a cartridge too, ready to play. They even mute the sound during changing cycles.

All this and hi fi too, and for the whole business the price is remarkably low. Back in the old days it might be something like $29.99 with only a handful of speeds; lately it's more, but the fi is higher and so is the number of features. Things haven't changed too much—again from the buyer's point of view.

A dozen years ago it was almost always a Webcor changer that tempted the hi fi purse (in the days before world-wide competition had set) and it could be had with the fabulous GE variable reluctance magnetic cartridge, and usually was so had. Now, it's variety, all-out. But whether recent or early, the changer has always looked like a mighty fine bargain for the modest hi fi installation.

Ah, but then along comes—along came—a real hi fi addict. He told you, innocent you (he still does), that the only *right* thing to do was to acquire a real "component" table, the best. Just a table. Period. No arm, no cartridge attached, no changing, no automatic stop, maybe only one speed. No muting, no switching, no wiring, no nuttin'. *And it cost a lot more than the changer.* Plus astronomical extras for the rest of the gear and its installation.

And yet, over the years, how many of us have gone and done just this! If you rejected the old Webcor, then you most likely aimed high, say for the Rek-O-Kut T-12H with the deluxe hysteresis motor, a whopping monster of a 12-inch manual table no one of which, to the best of my knowledge, will ever wear out. Tank-style construction. Others soon appeared of the sort, maybe less massive but still oh-so-definitely in the component-manual category, to put all mere changers to shame. We kept on buying them, through the years of progress, until eventually the changer people in their desperation began advertising their changers as "manual." No better compliment was ever paid the component industry!

Needless to say, hi fi evolution has edged steadily away from these two violently opposite alternative positions, towards the middle ground that would offer the best of both. Of course the presently available component tables are removed by years of designing from the respectable early models of the type, and changers are similarly different—both types would seem to have spread out to the point where no intelligent hi fi buyer could possibly find a crack in the coverage between them. And yet, oddly, the old pattern has persisted. You will still find that the first question a new buyer must face is the same old one: *do I want a changer or do I buy a manual table?* It simply won't go away.

But now there is a Third Choice. How about one of those new little tables with the clockwork motors (well, those *electric* clockwork motors . . .)? Don't they give you pretty high performance—maybe it's worth giving up the changer, after all? So it goes. Ask any dealer. How come so sudden?

Third Choices

It isn't that we have had no Third Choices until now. There have been many worthy attempts to fill in that middle ground, and many of them have had modest success, too. Not enough. Not enough to establish a new way of "positive thinking" among the dealers and consumers. The trouble has always been, as I see it, that each piece of new middle-ground equipment to reach the market has found itself in the same slippery situation, precariously balanced on an impossible height. After a bit of frantic lurching, model after model has hurtled ignominiously down one side or the other, into the same old two camps.

The changers have grown de-luxer and de-luxer; their tables are splendidly silent, their arms light as a feather, their cartridges impeccable. Yet in the face of every improvement the public has gone right on saying, it's a changer, isn't it! You couldn't break the changer psychology, it seemed, short of charging so much for your machine that you could buy a half dozen component tables for the same price.

And on the other hand, the numerous and varied attempts over the years to launch modestly priced manual tables inevitably slid the other way. Each one seems somehow to have ended up as a sort of undesirable "junior" edition of a more respectable senior components line. An economy model. In the component field that is a kiss of death, and of NO SALE on the cash registers. Alas, it hasn't helped a bit that many of these models were well worth considering as improvements on changer performance.

Into the Middle

And yet in all these years the plain fact is that technical progress *has* aimed steadily towards the central position, from both sides, and with steadily less compromise in essential performance. As I see it, the mainstay of the component table's steady progress has been in one over-all idea, explaining lots. *Get rid of bulk mass;* substitute, in new, lighter, cheaper formats, *mechanical ingenuity.* Not only in careful mass-machining to higher, but no more expensive, standards; but also in newly ingenious dynamic balances, new materials, new systems for isolation of the wows and flutters inherent even in small moving parts, in new drive systems—the belt drive, for instance; in new supports—like the Stanton magnetic bearing. In a thousand details this sort of improving has been going on steadily. It was only a matter of time until in the purely engineering sense a range of tables could be offered which would perform in top fashion at a virtually changer-like price. (The changers have obligingly inched upwards in price.) All that remained was to sell the idea to the hi fi know-nothing. Ugh. What a job.

It has been done. And the turning point, like it or no, has come with the little minimum-powered manual table. That table is no more than a very ingenious collecting-together of a number of ideas for improvement which have, as I say, been seen before in various forms. But this particular assemblage has turned out to be the magic formula. In the whole, in the package, it has finally hit a sort of jackpot and no denying it. The customers have at last found a real Third Choice, a turntable system that really semes different, that is utterly unlike any changer, at whatever cost, and yet is not really like the accepted image of the component table, either, in price, bulk or in "feel."

I can hear all the old arguments that prove this is unreasonable and unlikely—

An FM tape stereo system of comparable quality would cost up to $850

you can build it from Eico kits for only $445

You can build a complete, high quality FM tape stereo system from the new Eico Classic Speed Kit package for only $445. This system includes the Classic 2400 stereo/mono 4-track tape recorder; Classic 2536 FM MX stereo receiver and two HFS-8 2-way high fidelity speaker systems.

Completely wired you'd save nearly $300 on this system over other makes of comparable quality—factory wired price $570. You can also select any individual component at a remarkably low price.

Here's why it's so easy to build these superb components. The 2400 tape recorder comes with the transport completely assembled and tested—only the electrical controls and amplifiers need be wired. The 2536, is without doubt the easiest-to-build receiver ever designed. The front end and the IF strip of the tuner section are supplied completely pre-wired and pre-aligned, and high quality circuit board and pre-aligned coils are provided for the stereo demodulator circuit. Speaker systems are completely assembled in fine oiled finish walnut cabinet.

EICO CLASSIC 2400 STEREO/MONO 4-TRACK TAPE RECORDER Performance on a par with recorders selling at twice the price. 3 motor design enables each motor to be optimized for its particular function.

□ 3 heavy-duty 4-pole motors, capstan motor with integral fan □ DC braking of reel motors □ Standby operation between all transport modes prevents tape spillage, provides slur-free starts, permits easy cueing & editing □ Automatic end-of-tape switch & digital counter □ Jam-proof belt shift mechanism selects 7½ or 3¾ ips speed. □ Requires no head wearing pressure pads □ New combination erase and record-play 4-track stereo head □ Equalization selector provides uncompromised equalization on both speeds. □ Mixing mike and line level controls □ Dual electron-ray level indicator tubes □ Made in U.S.A. □ Oiled finish walnut base incl. in price of both semi-kit and wired versions. Semi-kit (transport assembled & tested) $199.95; wired $269.95.

EICO CLASSIC 2536 FM-MULTIPLEX STEREO RECEIVER Makes every other stereo receiver seem overpriced. Combines stable sensitive FM stereo tuner *plus* a virtually distortion-free 36-watt stereo amplifier with remarkable overload, transient and regulation characteristics.

AMPLIFIER SECTION □ all program sources—magnetic phono, adapted ceramic phono, tuner, tape □ Full control facilities—bass, treble, blend and balance □ Tape monitor switch □ Distortion at 10-w/channel 40 cps—0.5%; IHF, power bandwidth at 1% distortion, 30 cps—20 kc.

TUNER SECTION □ Low noise, shielded & temperature compensated front-end for drift-free performance □ 4 amplifier-limiter stages & ultra-wide-band ratio detector. □ Electron-ray tuning bar & stereo program indicator □ Velvet-smooth rotary tuning □ IHF usable sensitivity 3 μv (30db quieting); 1.5 μv (20db quieting). □ IHF distortion 0.6%; IHF capture ratio 3db. Kit $154.95; wired $209.95 (Incl. FET)

EICO HFS-8 2-WAY SPEAKER SYSTEM Compact 2-way speaker system in handsome oiled finish walnut cabinet. Full transparent bass; clean, smooth middles and highs. Two speakers: 8″ high-gap energy woofer-mid-range transducer, and matched 2″ tweeter. Wired only, $44.95.

OTHER NEW EICO CLASSIC SERIES COMPONENTS 2036—36-watt stereo amplifier. Kit $79.95; wired $109.95. 2200—FM/MX Stereo Tuner. Kit $92.50; wired $119.95 (Incl. FET.) 2050—50-watt stereo amplifier. Kit $92.50; wired $129.95. 2080—80-watt stereo amplifier. Kit $112.50; wired $159.95. Optional oiled finish walnut cabinet for the 2536, 2036, 2200, 2050 and 2080 are available for $19.95. Add 5% in West

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EICO

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they don't alter the fact of a sudden and widespread acceptance. And so there you are. The deed is done; all that remains is for everybody who has a good table to get in on the act—quick. You see, there is a golden lining to it all, and not fool's gold either.

The good news is simply in the fact that at last the old order changeth, in the public mind! Now that the deed is done, suddenly the perilous in-between ground is going to offer much safer footing for a lot of varied development ideas that heretofore have been unjustly damned via too-faint jingles in the cash register. Now there is not only a Third Choice, securely established at this point, but there is a whole new Third Potential, opening up for the asking. Go ahead, boys, pile right in. The public awaits you.

* * * * *

I've hardly mentioned the Third Choice table itself as it has impinged on me personally—in my role as an observant consumer-type. Yes, it did strike me at once as something really different, novel enough in the sheer feel to arouse any consumer's interest. That is its secret—if you can call it a secret at this point. It remains merely for me to qualify this "feel" for those who may wonder why it has had such an impact on people in general. The "feel" is by no means all pleasurable, and thus its significance is the greater—for these are sacrifices the common hi fi buyer seems ready to make, in favor of high basic performance at a pleasant price. Maybe you wouldn't have believed it.

Squishy

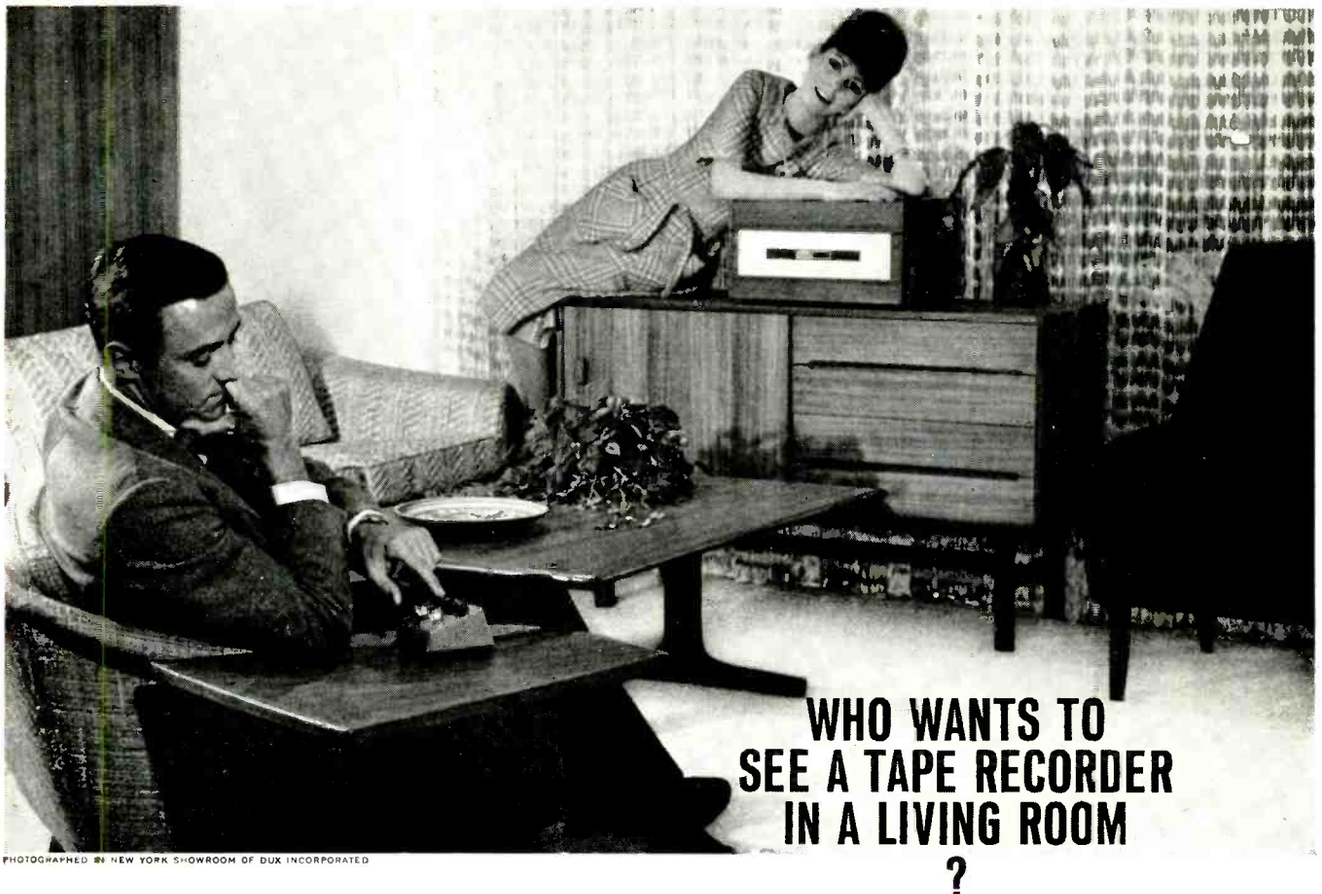
Two things hit your senses at once when you first try the Third Choice type of table. First, its slo-o-w, slow start. Second, the squishy touch, sort of soft and rubbery, with nothing to get a firm hold on. The whole thing feels as if it might begin to pour in a liquid sort of way. Inevitable, of course. First, if you use a slightly oversized clock motor to turn your table, it isn't likely to start on a dime, (it may if the table is light enough), or even a silver dollar. It starts up with deliberation, like a Pullman moving out of the terminal. Not like a city subway. (For opposite reasons, of course.) It takes off like no table the wary buyer has ever seen before. And it stops easy. Just brush a finger on the record and it obligingly quits.

No split-second fullspeed here, no holding-back with the hand, no cueing-in of midband grooves. Just try that and see what happens—the most dismally prolonged wow you've ever heard. RrrrrOOOOWW, like the old wind-up phonograph when you cranked it while the record was playing.

Few people object. Just give the little motors a few seconds to get their breath and your minimum-powered table is running true and exactly at speed. It'll stay that way through any conceivable playing condition, just so long as you don't stick your big, oafish hippopotamus hands in its way. It may take about three seconds for such a table to get started. Keep in mind that a changer that starts to play *five* seconds after you push its lever is a miracle-changer. Most take a lot longer.

If you want instant-start like you want instant coffee or instant rice (cooks instantly in 13 minutes), then you'll need a more potent drive. I do, for radio programs and the like. Otherwise, why bother. What's three seconds in a hi fi day?

As to squishiness, the rubbery ingenuity of these tables' mounting system is half of the battle won towards high performance.



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WHO WANTS TO SEE A TAPE RECORDER IN A LIVING ROOM ?

YOU DO

(if it's Miranda®!)

Two magnificent new stereo tape recorders featuring major electronic advances...plus the beauty of genuine teakwood cabinetry!

MIRANDA Sorrento Sophisticated solid-state circuitry, comprising an impressive array of 21 transistors and 19 diodes. Electronic matrix-type push-button switching positively and instantaneously controls every mode of tape transport. Tape-handling mechanism includes automatic tape lifters and tension bars. Other features include: built-in 4″ x 6″ full range dual speakers, automatic shut-off for motors *and* amplifiers, three motors plus servo motor for remote control, illuminated VU meters, pause switch, electronic switching delay, 3¾ and 7½ ips., records and plays 4-track stereo. *Priced at $400.00*

MIRANDA Nocturne Hysteresis synchronous motor assures unfailing constancy in tape movement. Smoothly operating push-button controls make it a pleasure to operate. Each channel is provided with individual volume and tone controls, VU meter, two input jacks, output jacks for external speakers. Single switch allows the Nocturne to be used for either stereo or mono playback. Ten clean actual watts of audio power (5 per channel) plus matched 4″ x 6″ speakers give rich, full-bodied reproduction. The Nocturne records and plays 4-track stereo and mono in 1⅞, 3¾ and 7½ ips. *Priced at $250.00*

SORRENTO REMOTE CONTROL: All tape transport controls plus separate channel volume controls, and 16 ft. cable. Priced at $35.00

At last . . . the first truly practical design in tape recorders. Miranda is housed in genuine teakwood cabinetry that blends with and enhances any decor. No glaring chrome trim . . . no jagged outline disturbs its simple, classic elegance. More than a fine tape recorder, Miranda is also a fine piece of furniture that you can display with pride. Write for free literature to Dept. A-1.

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You don't feel it if you keep your hands where they belong. It's only when you try to rush things, say by giving the table an extra twist, that you find your stylus rudely jumping the record as the table bends down to the left an inch or so, and squishes back. Quite startling the first time it happens to you. You can't stop the record suddenly, either, by hand. If you try, the same thing happens. Off flies the arm. Just don't try, then. No reason to. What you pay for isn't starting and stopping, but plain going.

Floorboard

Vibration? In spite of the rubbery feel, these new tables are dynamically designed so that most heavy vibrations are neatly absorbed. You can put them on top of a big speaker and there won't be any feedback. You can stamp up and down next to them and they won't jump. However, mine had a spectacular encounter with my famous Loose Floorboard that for awhile seemed disastrous. The arm jumped an inch every time I walked by.

It turned out that the cartridge I was using, with a very high and rather undamped compliance, coupled up neatly with the arm resonance to jiggle at around 3 cycles, just right for ye Floorboard. I put in a different cartridge, with a better control of its less compliant stylus (and a better sound too, naming no names)—lo, the Floorboard was conquered. There was no more than a tiny gulp in the sound as I walked past, and the stylus kept its groove.

(Keep in mind, whatever your arm, that such an arm-stylus coupling can play havoc in all sorts of machines. Just in case you have jumping stylus trouble).

It seems, too, that my Floorboard jumps *laterally*, a type of vibration that's more difficult to cope with than the ordinary up-and-down kind.

Retrograde Music

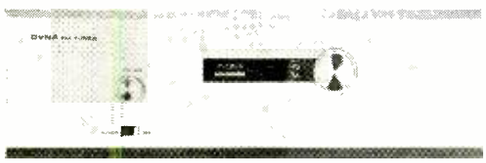
A final Third Choice comment. Most of these tables, you'll find, will play backwards, given a good nudge. Remember, many years ago, the old newspaper-promoted Music Appreciation records, 78's of course, and the little record player that came with them, and was sold too by Sears Roebuck and even, if I remember, by RCA Victor? Well that table had the same type of reversible synchronous motor that is used in the new miniature-motor tables—you twisted that one to start it. Either way. In those pre-tape days, we found backwards music or speech a new and novel sensation. I used to try everything backwards. Great fun.

It's not quite so easy with the new Third Choice tables but you can generally do it with a careful nudge of the table in the retrograde direction, if you really want to.

Now *there's* a feature that neither changers nor hi fi component tables offer! Maybe that's what's back of all the fuss. New and totally different. **Æ**

THE STEREOMATIC DYNATUNER
INCOMPARABLE VALUE

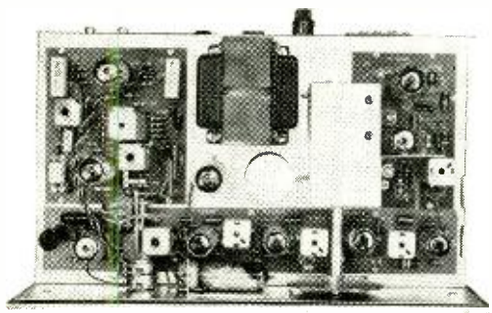
LOOK OUTSIDE



Assembled $169.95 Kit $109.95

- Fully automatic electronic transition from mono to stereo. Just tune the station. STEREO lights up to signal a stereo broadcast. No switches, relays, clicks or pops.
- Reference-grid tuning eye for precise tuning of every station, weak or strong. Positive indication of the tuning point which has lowest noise, minimum distortion, and maximum separation. This eye is more costly, but far more precise than a meter.
- Front panel volume control with a push-pull switch to lock out the stereo circuitry if desired.
- Effortless enjoyment of FM with Dyna's advanced, automated design, which eliminates old-fashioned stereo-mono switches, AFC controls, local-distant switches, sub-channel filter controls and signal strength meters.
- Sophisticated modern styling blends with every decor. The Dynatuner readily mounts in a cabinet or stacks attractively with the Dyna PAS-3 preamplifier. And the cover is included at no extra cost.

LOOK INSIDE

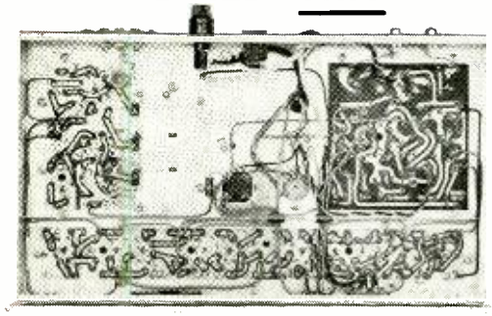


- Cathode coupled RF stage for lowest cross-modulation and high sensitivity.
- Four IF stages, all of which act as limiters—so effective that they limit on noise alone, and reduce interstation noise by 10 db.
- Exclusive wide-band (900 KC) symmetrical discriminator for exceptional AM suppression, maximum pulse-noise rejection, and reduced multipath effects.
- Multiplex doubler, phase-locked to pilot signal, avoids free-running oscillators which cause beats or whistles, provides perfect synchronization, and maintains lower background noise.
- Unique gated-bridge synchronous multiplex detector for lower noise and full separation on all stereo signals—the key to the Dynatuner's superior stereo performance on weak signals.
- Feedback audio stage with unmeasurable distortion and low impedance outputs.
- Finest quality parts, plated rugged steel chassis, top-grade XXXP and fiberglass etched circuit boards.
- Precision planetary tuning—no backlash, no cords to break, no pointers to slip.
- MOST IMPORTANT OF ALL—every stage of the Dynatuner from the RF "front end" through to the multiplex integrator is alignable by YOU, with no test facilities, with the accuracy heretofore achievable only in the finest test laboratories.

THEN LISTEN

- Transparent, lucid sound—the best of FM—without hum, noise or distortion. Full separation on every stereo signal; complete freedom from beats when tape recording off the air.

IT'S FUN TO BUILD THIS KIT!



- It's fun because it's so easy to build; you learn by doing and save money too.
- Three etched circuit boards speed assembly, accurately define parts placement, and provide exact reproducibility from unit to unit, lab model to production kit.
- Clean, uncluttered, easy-to-work-on chassis.
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- **Simplest by design.** Complex assembly instructions are completely avoided.
- Packaged for protection and convenience. In conformance with the Dyna policy of supplying equipment of highest quality and appearance without the expense of useless trim, we use a simple, functional package rather than include the cost of a point-of-sale display in each unit.
- **Dynakits build your confidence.** Error-free, obsolescence-proof Dyna designs, backed by an unprecedented one year kit guarantee, and many thousands of satisfied Dynatuner customers (most of whom built their own) assure your success.

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EDITOR'S REVIEW

IT HARDLY SEEMS POSSIBLE . . .

BUT HERE WE SIT, in the same time- and seat-worn chair we use to confront our typewriter, faced with writing another New Year's editorial. It seems as if we just finished the editorial introducing 1963. Oh well, it certainly wasn't a dull year.

Anyhow, looking back, it seems that 1963 did highlight certain previously discernible trends.

First of all it became obvious that almost every high-fidelity electronics manufacturer is seriously toying with transistors although tubes have not, as yet, been supplanted. Not by a long shot. However, most knowledgeable people are predicting a significantly larger number of transistor products in 1964. We were pleased to note the caution with which most manufacturers approach these potentially pesky devices. Also we have heard, and seen, far fewer references to the "special sound" of transistors. Good sense begins to prevail, as usual.

The second trend which became better defined is the one towards all-in-one units. Some people call them receivers, others call them tuner-amplifiers. Call them what you will these devices are undoubtedly the most popular items in the marketplace. A parallel trend is the move towards a complete system in a cabinet, commonly referred to as a console. The obvious explanation for this trend towards convenience packaging is that the sound quality of components is appealing to more and more people, people who aren't necessarily interested in the technicalities or flexibility of separate components. In fact, this explanation is substantiated by the entrance of several large department stores and mass merchandisers into this field. Unquestionably their patrons wanted this kind of merchandise or they wouldn't bother.

Another trend, which we believe is related to the previous one, is the reduced attendance at audio shows. In our opinion, this seeming lack of interest is really a lack of communication on the part of the show operators. We believe that the increased interest in high-fidelity sound, coupled with reduced (percentage) interest in the technicalities, calls for a different type of show aimed at a slightly different audience. Certainly the large number of concertgoers in this country would love to have equipment which would faithfully reproduce their favorite music—without having to take an electronics course in order to be able to purchase intelligently. Certainly they would be interested in a show where they could learn about reproducing equipment in their own terms. Anyhow, we think they would.

Another trend we noted is the other side of the coin of improved packaging, the tendency to oversimplify. Apparently we are getting ever deeper in that quagmire of needing to own "the best," or "the biggest," or "the loudest," or what have you. The number of people who indicate these inane desires seems to increase rather than diminish. We don't mean to single out audiofans in this trend, certainly it extends into every nook and cranny of American life, but they do fit in, judging from the questions we get asked. Perhaps we should all assign ourselves the task of repeating 5k times, "There is no 'most'."

ARTICLES WE WOULD LIKE TO READ

Looking over the crop of articles we harvested last year makes us realize that we could have had more high-quality construction articles. Not that we didn't have many good ones, but there was still room for many more. In our estimation, most readers of AUDIO are interested in constructing parts of their audio systems themselves. Also, we believe, you are interested in high-quality sound reproduction rather than merely good quality.

The area we found least satisfactory was in projects for transistor amplifiers. Apparently, not too much original work has been done in this area. Or is it that the devices are too expensive? Perhaps the reason is a scarcity of adequate transistors. We don't know the answer, but surely some adventurous audiofan must have experimented with the Class-D amplifier idea presented by George Fletcher Cooper? If any of you have, please send us the results of your efforts so that all audiofans can share—and perhaps improve. Or if any readers have succeeded in putting together a transistor amplifier which solves some of the problems we have heard about, let us all share.

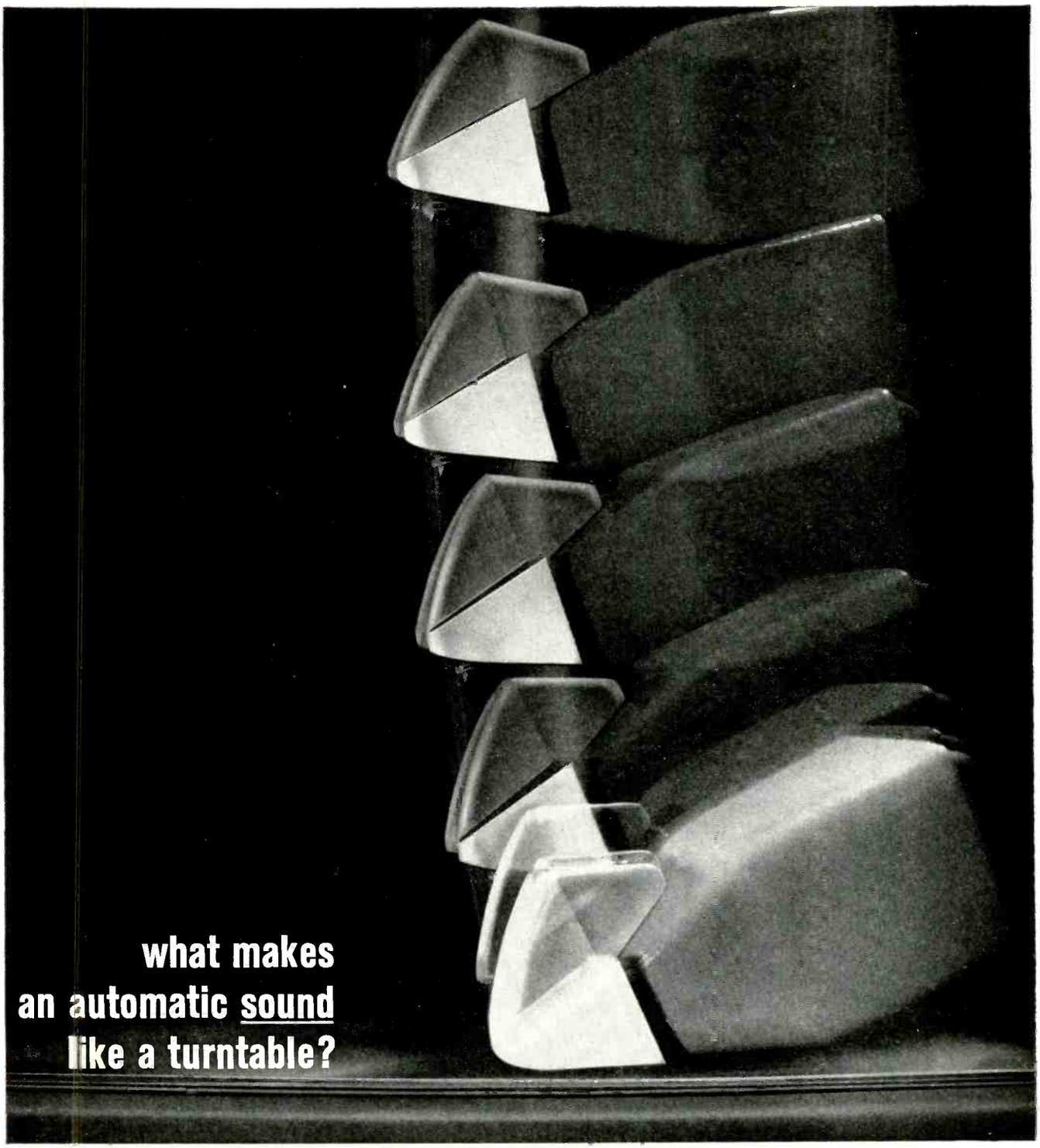
Another area which was relatively uncovered, is in relation to electronics to go with tape recorders: recording amplifiers, preamps, a variety of mixers, and so on. Also ignored, by-and-large, was recording techniques. We do have a few articles ready for publication in this area, but hardly enough considering the very large interest in this field. Come on you recording engineers, record it on paper.

Of course, by calling attention to specific areas we don't mean to discourage audiofans who are interested in loudspeaker projects, or building microphones, or in fact any area that catches the fancy of one of our readers. We certainly need all the worthwhile articles we can get. Our aim was to highlight relatively neglected areas which might be of great interest.

. . . . . TOMORROW, AND TOMORROW, AND TOMORROW

There are several editorial projects we have started in the past year or so that we would like to see resolved in 1964. First of all we would like to see the vertical tracking angle problem resolved *and put in perspective*. We have presented several articles on this subject, another is presented this month, and in succeeding months we will present one more viewpoint. Hopefully, we will then be in a position to make a balanced judgment as to how important is the disparity between vertical cutting angle and playback angle. Actually, even at this stage of the game we begin to suspect attention has been focused on the wrong place. But we will wait until more evidence is in before making judgment.

Another editorial undertaking we were involved in last year related to adequate methods of informing readers as to the virtue of several types of high fidelity equipment. For example, we did mention previously the need for standards for FM-stereo equipment. Meaningful standards. Another area we feel needs clarification is transistor amplifier standards. Hopefully, answers will be promulgated in 1964. We will do all we can to help.



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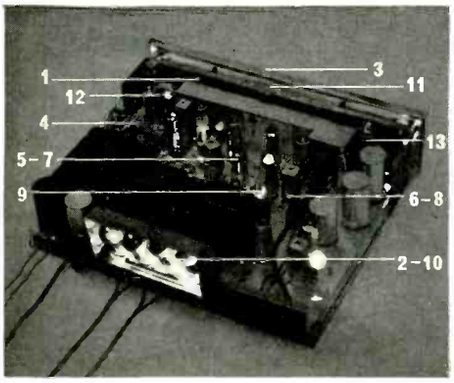

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COVER STORY

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Each system of this stereo pair weighs over 1200 pounds—totalling about a ton-and-a-quarter. The weight results from the use of concrete as the horn material in order to eliminate spurious radiation from the horn itself.

WALTER WYSOCZANSKI*

A PROPERLY DESIGNED HORN speaker system is capable of exceptionally fine sound reproduction. However, in most cases the design is compromised in several ways, thereby yielding results considerably inferior to that which is possible. The design described in this article is intended for home use, however the usual compromises involving space and weight (and time and effort), have been somewhat relaxed in order to more closely approach ideal performance. The results of following such an approach have indeed been gratifying.

The design of this horn system was not a sudden conception, but was the outcome of many experiences, experiments, and considerations involving several different horns and drivers. Some of the important conclusions leading to the final system will be related. Sufficient information is presented to enable an experienced concrete worker to duplicate it.

Generally, the finest examples of sound reproducing systems are still found in motion picture theaters. Thus it seemed that the desired objectives could be achieved by starting from this source, with its wealth of engineering experience. Also, the necessary components are available.

The typical motion picture theater uses a two-way horn system with the crossover at 500 cps. The low-frequency channel uses two 15-inch drivers on a horn with taper cutoff frequencies from about 50 to 110 cps and the range below this cutoff usually being supplemented by bass reflex loading. The high-frequency channel has one or more drivers coupled to multi-cellular horns. For larger theaters, or auditoriums, these basic systems are used in stacked or multiple arrays for greater power and wider distribution. The basic system unit is designed to deliver high-level sound, at low distortion, to volumes very much larger than the typical large living room. An immediate advantage of using theater components in the living room is the extremely low distortion for the loudest-listening levels. A common characteristic of transducers such as speakers is that the distortion generated has an inverse relation to the amplitude of motion of the diaphragm.

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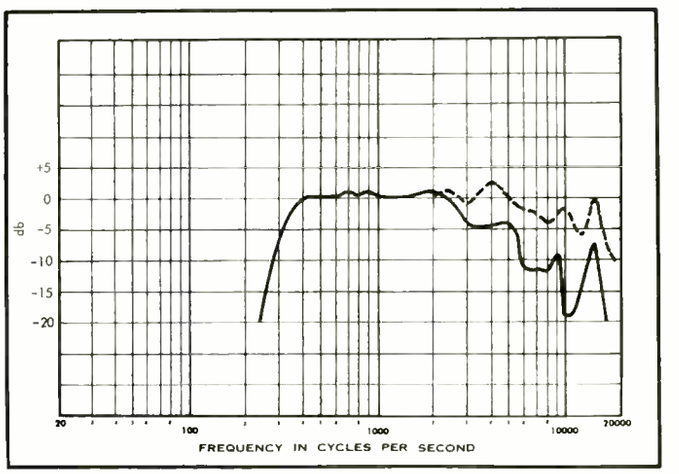

Fig. 1. Axial frequency response using Altec Lansing 288B driver with 30210 coupler and with 1005 multicellular horn (——) or without the horn (----). Measurement made one foot from horn mouth with Sony C-37 microphone.

From acoustics literature it was determined that certain rules should be followed for the best results: The system should have but two channels (one crossover point). The problem of effectively integrating two channels is difficult enough; for three or more it is extremely difficult. Therefore, a two-channel system was decided upon, divided at the most typical crossover frequency of 500 cps and with a bandwidth (half-power points) of 40 to 16,000 cps. This bandwidth may seem narrow, but systems (any kind) that actually can cover it with high quality are extremely rare.

It was also deemed important that all the voice coils, or all the diaphragms, lie in a common plane close to each other—the next best situation to the impossible requirement that they occupy the same space! This provides for smoothest crossover and a minimum of transient distortion due to different sound path lengths.

Both the horn axes should be straight in order to avoid the many difficulties introduced by bends in the horn.

The High-Frequency Horn

Tests were begun using an Altec 288B with an Altec model 1005 multicellular horn for the high frequencies. At first, listening tests showed discouraging performance in the upper frequency ranges.

The response from 400 to 2500 cps was perfect (*Fig.* 1). However, the need for considerable improvement above 2500 cps was quite clear. Close inspection of the driver (the diaphragm voice coil assembly is readily removable and replaceable) led to the conclusion that it should be capable of good response to at least 12,000 cps. This made the horn suspect. Fortunately a quick and simple test was possible: The driver is joined to the horn by a flared 6-in. long coupling (Altec 30210) whose area on one end is sufficient to act as the mouth of a horn, when used alone, for good loading to a little below 2500 cps. The 1005 multicellular structure was removed leaving the 288B with 30210 coupler, and another response curve, starting at 2000 cps, was run. The same reference level was used, and this time the upper response proved to be acceptable up to about 16,000 cps. Thus it was concluded that the multicellular structure was somehow interfering with the full capabilities of this excellent driver, yet only multicellular horns were available for it. A different and better type of horn would have to be constructed.

A horn with good polar distribution was sought. It should have a distribution equal to or better than that produced by a multicellular type. Study and comparison of the polar patterns for different horn types showed that a horn having two straight sides and a

curved mouth (also known as a sectoral horn) should give excellent results. Altec Lansing manufactures a smaller version of the 288B, the 802D, which has curved-mouth horns available for it (models 511B and 811B). An Altec 802D-511B combination was obtained and it was soon confirmed from listening to it, and comparing with several horns, that this type of horn has the most ideal polar pattern for the objectives at hand. The sectoral horn did not interfere with the high-frequency performance of the drivers as did the multicellular type. It was also noted during the various tests that certain coloration was introduced due to the horn material according to whether it was of wood, aluminum, or Fiberglas.

The Altec 288B driver produces, essentially, a plane wave pressure front at its 1.4-in. diameter output opening. The problem is to properly couple this high-pressure source into the listening volume. This involves expanding and reshaping the wave front.

The expansion can be made to follow any of several mathematical shapes. The two most efficient and useful for this problem are the hyperbolic and exponential flares. There are two important characteristics for deciding which flare type to use. The hyperbolic flare has superior loading (flatter frequency response) near cutoff, while the exponential flare introduces less second harmonic distortion. In the initial volume, or throat, of a horn the pressures remain quite high, so much so that the air behaves in a much more non-linear fashion than it does when driven at lower pressures. For sinusoidal pressures, this non-linearity can be detected as second harmonic distortion. This distortion is proportional to the sound intensity at the throat; that is, for a given acoustical output, the horn with a larger throat cross-sectional area will introduce less distortion. The Altec 288 is a good choice in this respect since it couples to a larger throat than most drivers designed for a similar frequency range. The faster the expansion of the horn, the faster the intensity is reduced, and therefore the smaller the distortion. A faster expansion means a higher horn cutoff frequency. For the same cutoff frequency, the exponential horn expands faster than the hyperbolic and therefore will introduce less distortion. And for a given intensity, the distortion increases directly with frequency. But, fortunately, the peak intensity content of typical program material above 1000 cps falls off at about the same rate, thereby mitigating this effect. The exponential flare was chosen mainly because of its lower distortion, while still retaining good response near its cutoff.

The cutoff frequency of 250 cps was selected to provide good loading for the driver for about an octave below the crossover frequency.

The next parameter to be determined would be the horn length. This also fixes the mouth area. But the length also affects the polar pattern. The polar pattern is closely related to the shape of the wave front being radiated at the horn mouth. Let us examine this.

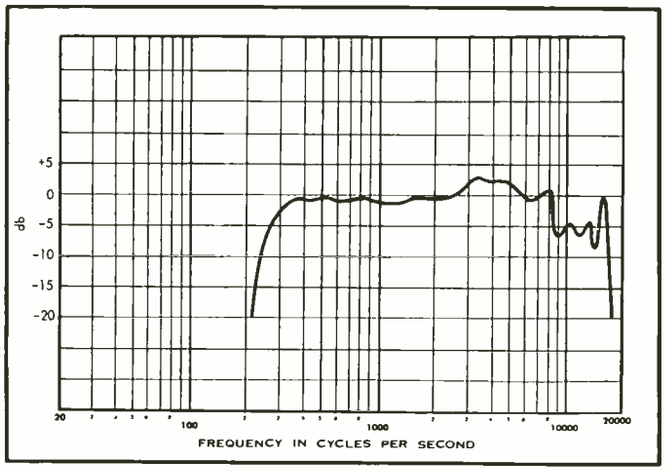

Fig. 2. Axial frequency response using Altec Lansing 288B driver with a concrete sectoral horn having a cutoff frequency of 250 cps and mouth area of 654 sq. in.

The majority of horn designs are what may be called plane-wave horns, that is, they tend to preserve the plane-wave shape from the driver to the horn mouth. This means that the polar pattern for such a horn at a given frequency is the same as that of a vibrating piston of a certain diameter. But with a horn, the effective diameter of the equivalent piston is a function of frequency and the horn constants. This factor can and is used to advantage. For example, with a given piston radiator the polar pattern becomes progressively narrower with increasing frequency. But with a horn the polar pattern can be made essentially independent of frequency. It can be said that a horn does this by reducing the diameter of the equivalent piston with frequency. Or, to put it another way, a horn keeps the ratio of equivalent piston diameter to wave length constant for different wavelengths. The requirement that the polar pattern be relatively independent of frequency is met by extremely few speakers. With a horn this independence is governed mainly by the mouth size and improves proportional to its magnitude. With typical horns designed for hi-fi use, the mouth is usually made small to give wide high-frequency dispersion, but the dispersion is much more frequency dependent than for a larger mouth. However, all is not perfect with the large mouth; it gives a uniform frequency-independent dispersion, but this pattern is quite narrow. A faster flare rate (higher cutoff frequency) can help slightly by broadening the pattern. Also a multicellular type structure is a good choice for wide coverage. For a single high-frequency horn, about a 30-deg. angle of coverage can be obtained with a mouth dimension of at least 15 inches. For home use a 30-deg. angle is certainly adequate for the vertical coverage; however, it is unsatisfactory for the horizontal coverage.

In a horn, starting at the throat, if a plane wave front could be re-shaped into a curved one as it progressed so that it resembled a section of a sphere, and if this spherical shape could be maintained until the surface was large compared to its wavelength, then the frequency response would be independent of position for a listener anywhere in the solid angle determined by that surface. The multicellular horn is designed to accomplish this. Actually, some such curving takes place in simple single plane wave horns, but better results are possible when the horn is particularly designed to promote such curving. The sectoral type of horn efficiently curves the wavefront. But it does this principally only in, say, the horizontal direction if the curved mouth lies in the horizontal plane. On the vertical axis the radiation is still essentially a plane wave. Consequently, the sectoral horn can be said to radiate a cylindrical wave front. The angle of radiation in the horizontal plane will be almost equivalent to the angle between the two straight sides bounding the curved mouth. The vertical polar angle is governed by the same considerations as that of a plane wave horn. The longer the straight sides of the horn, the more perfect the polar pattern for this axis. Also the greater the vertical mouth dimension, the more uniform the vertical pattern. Therefore, a very good design is a sectoral horn with the required horizontal angle and which is long and has a large vertical dimension. Fortunately, these length and height requirements are of the same nature: they both mean a larger mouth. With a sectoral horn, one can obtain wide horizontal coverage, with a vertical coverage of about 30-deg., and be assured of excellent frequency-indepen-

dent uniformity in the resultant solid listening angle.

Any partitioning of a sectoral horn will cause it to approach multicellular behavior according to the extent of the partitioning. The partitioning of a sectoral horn is, ideally, undesirable.

All the preceding considerations resulted in an exceptional sectoral horn for the Altec 288B driver. The angle between the straight sides was set at 100-deg. and the horn length at 26-in. The radius of the curved mouth was set at 24-in. The throat of the driver is 1.4-in. in diameter. The mating circular horn throat changes, in a short distance, to a square cross section with 1.7-in. sides. With a 250 cps cutoff the 26-in. length results in a mouth area of 654 square inches. The arc length at the mouth is 41.9 inches and the height is 15.6 inches. The cross-sectional dimensions were calculated and recorded in tabular form, for every half inch of length up to the mouth. Note that the cross-sectional surface at each value of radius is a section of a cylinder.

Fabrication

The design was now complete. Fabrication was next. Now we must decide which material is best for horn construction.

For any loudspeaker the vibration of the diaphragm is ideally transmitted directly to the air only. That is, the radiation from the material forming the boundaries (i.e. baffle, horn, and so on) should be zero. Otherwise an undesirable double or multiple radiator situation arises. The boundary being in intimate contact with the driving source can readily absorb sound from the driver, and conduct and redistribute this absorbed energy to a large surface area with good coupling to the air. In other words, the material itself behaves somewhat like a very poor direct radiator. Consequently, various colorations, distortions, and resonances become apparent due to the characteristics and contributions of this second radiator. The velocity of sound in most boundary materials is considerably greater than that in air. This factor alone tremendously complicates and deteriorates the resultant sound reaching the ear. Another factor is that the frequency response of most boundary materials is not flat. There are other coloration factors. Of course these factors are of great importance for musical instruments where pleasing effects are obtained when the boundary materials are encouraged to contribute to the total sound. But, these effects should be strongly avoided for speaker systems. A speaker is not a musical instrument; it is a reproducer!

The boundary material should be very rigid, non-absorbing, and have high internal damping. Wood does not meet these requirements very well, nor do, in fact, most materials. Bracing of the boundaries helps suppress gross resonances, thus easing one of the problems. Applying damping material to the surface helps. However it is better if the desired properties are inherent in the material itself, thereby requiring a minimum of external correction or compensation. The absorption and conduction of the material must be negligible while its internal dissipation is high.

Concrete appears to be about the best material for boundary surfaces of horn speaker systems. The standard engineering texts strongly recommend its use. However, it has rarely been used in sound systems. Where it has been used, the results have been outstanding. Perhaps the biggest objection to its use is its weight. But, note that concrete is actually "lighter" than aluminum. The specific gravity of concrete is 2.6; whereas for aluminum it is 2.7. It is the quantity used that makes the end result heavy.

An exponential sectoral surface is rather complex when compared to the simpler typical horn surfaces. It cannot be formed by bending flat sheets. Casting techniques are preferred. This requires making only one good model and constructing a mold from it. Once the mold is completed, its life is long, permitting many identical units to be cast in it. Of course concrete is a natural media for casting.

A model, mold, and two horns were constructed.

Another frequency-response curve was made with the Altec 288B driver, but this time with the newly completed concrete sectoral horn. The test set up was identical to that used for the multicellular horn tests. The curve is shown in *Fig.* 2. Notice the greater output above 2500 cps for the sectoral design. The slightly extended low response is due merely to a lower effective cutoff frequency for the concrete horn. All the design expectations were fully confirmed.

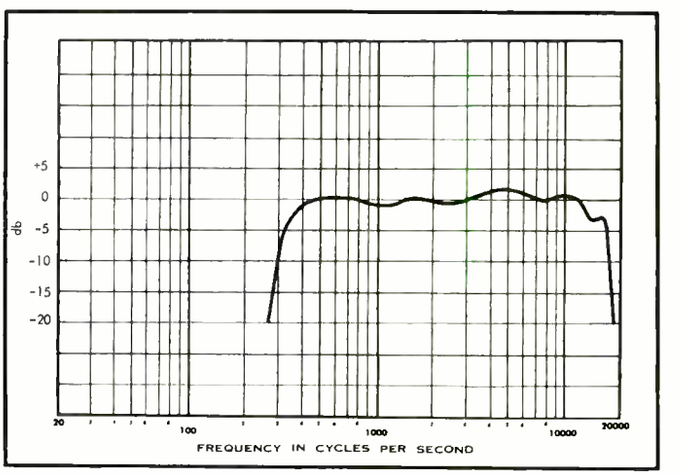

Fig. 3. Axial frequency response using an Altec Lansing 288C driver with a concrete sectoral horn having a cutoff frequency of 300 cps and a mouth area of 552 sq. in. as in Fig. 4.

As a matter of interest, the second-harmonic distortion was calculated for 1-watt (acoustic) input at 1000 cps for this combination. In the listening room where this horn is located, this power produces a level of about 110 db. At this level the second-harmonic distortion is 2.2 percent. To obtain the distortion for other frequencies one must simply remember that it increases directly with frequency for a given level. The per cent distortion for a given frequency is proportional to the square root of the acoustical power input to the horn.

About a year after the completion of two of these concrete horns. Altec Lansing began marketing an improved driver: the Altec 288C, which has a flatter response out to 16,000 cps (see *Fig.* 3). A new horn was designed for these newer models based on past experience. This is the unit which appears on the cover and is shown in detail in *Fig.* 4, and results in slightly less horn distortion. The new horn cutoff is set at 300 cps. Its length is 21 inches, with a radius of curvature of 20-inches. The mouth area is 552 square inches with a 34.9-in. are length and a 15.8-in. mouth height. With the construction of these new horns and their testing, the high frequency part of the system was considered to be successfully completed and to be the best possible for some time to come.

The Bass Horn

With an excellent high-frequency end for the system accomplished, efforts were next directed towards the design and construction of a complementary bass horn section. It was decided to use concrete for the bass horn in spite of the fact that its weight would be very great. The sand shielding tests and the good experiences with the high-frequency section were the initial justification for its use again.

The exponential sectoral type of horn was selected again as it permitted good matching in many respects with the

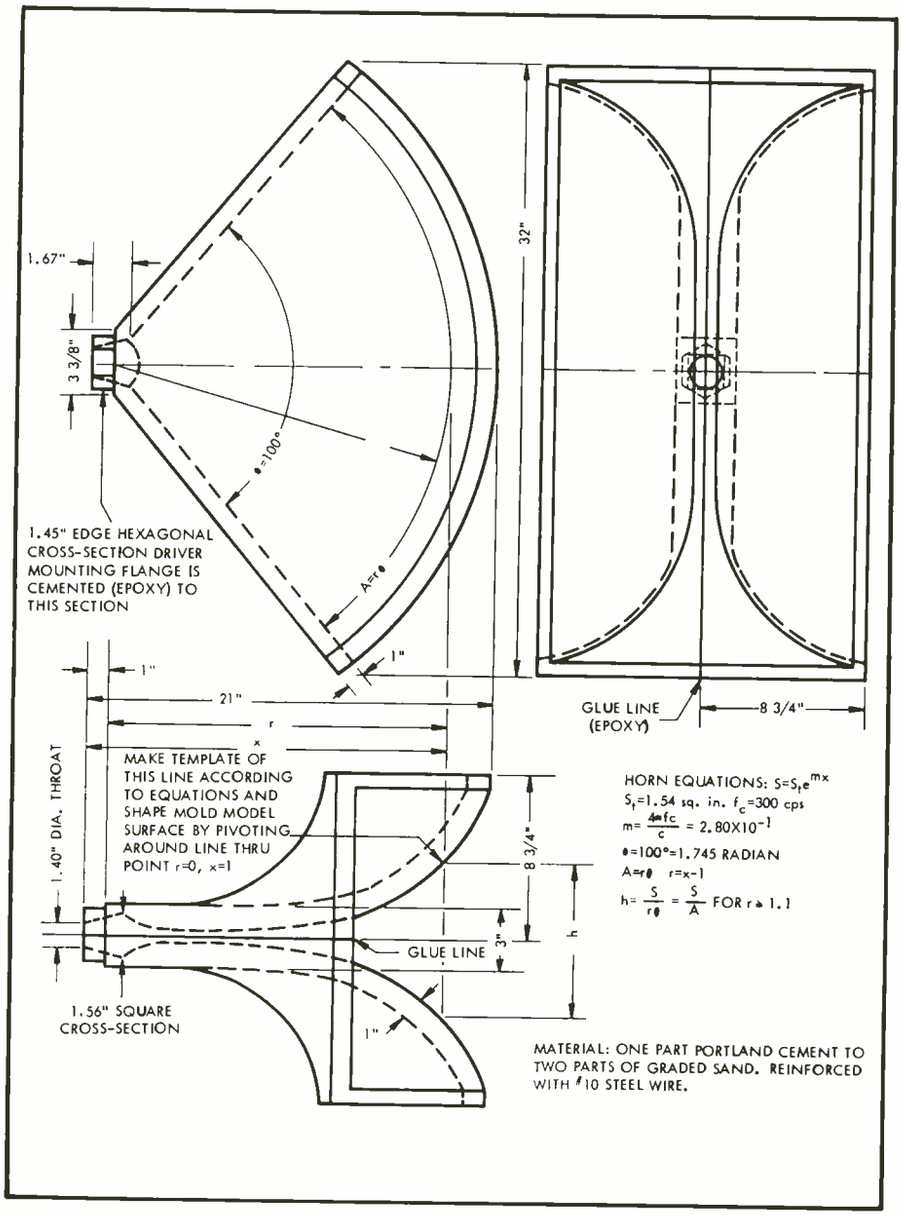

Fig. 4. High frequency concrete exponential sectoral horn for Altec Lansing 288C driver. Horn consists of two idential castings cemented together and a hexagonal flange for mounting the driver. Flange is made from two pieces of 1/16-in. sheet steel and is not shown in this drawing.

high-frequency section. Not only acoustical, but also, appearance matching was thus obtained.

It was again noted that most theater bass systems are not pure horn, but use the bass reflex principle to extend the low-frequency response below the horn cutoff frequency. In such cases the horn is straight and shorter than the longer folded horns.

The typical use of two close-spaced 15-in. drivers for practically all theater systems appeared to be a good procedure to follow. This has several advantages: The efficiency is almost doubled, driver distortion is decreased, horn distortion is decreased, power handling is increased, and the horn itself can be much smaller for a given performance. The main disadvantage of multiple drivers is the possibility of irregular frequency response in the upper range. But for a pair of close-spaced 15-in. drivers these interference effects begin to become serious only above 500 cps where the power input to the drivers is already 3-db down.

Experiments were conducted with a short straight 1-in. thick plywood corner horn having a cutoff of 110 cps and bass reflex loading below. This unit used two 15-in. drivers vertically stacked. Tests were made using a proper bass reflex porting with different values of damping. A closed box condition was also tried. The best overall fidelity was obtained only with the ports closed and cavity completely filled with an absorbing material. With port loading, the lower bass was better, but among other things, there appeared to be some sacrifice in quality in the upper bass ranges. From this it was learned that it is better to have a good response over a narrower range, than a compromised response over a wider frequency range as from hybrid combinations. Therefore, it was decided to use the radiation from only one side of the driver diaphragm. The design procedure was to go as low as possible with pure horn loading, while retaining reasonable proportions.

For best loading with maximum efficiency, the throat area is highly dependent on the driver motor efficiency. For a given diaphragm diameter, the best throat area will be inversely related to the motor efficiency—higher motor efficiencies requiring smaller throat areas. For a typical high-efficiency 15-in. driver the optimum throat to diaphragm ratio is about 1:2. But by sacrificing 1 to 2 db in over-all efficiency, the throat area can be made equal to the effective diaphragm area. This will help keep the horn size down. Another advantage of a large-throat short horn is a more gradual low-frequency cutoff. On the other hand a maximum efficiency loss of 3 db at the higher frequencies (above 500 cps for 15-in. drivers) may occur with a 1:1 throat to diaphragm ratio. Also, the range over which the driver must have good linearity must be greater in order to compensate for the greater diaphragm excursions due to this lighter loading.

For optimum response near the bass horn cutoff, it is quite standard practice to balance out the horn mass reactance at frequencies below the diaphragm resonance. This is done by having a suitable total compliance for the driving system. Once the horn and driver is determined, the required compliance can be calculated. This compliance is made up of two principals: the diaphragm suspension compliance and the compliance of the air in the enclosing back cavity. The driver compliance is fixed by its design. And, in turn, in most cases a definite volume of air will contribute the necessary compliance for a given driver. For a given horn, the driver with a lower free-air resonance will demand less volume in the back cavity. The importance of a low free-air resonance can be demonstrated by calculating the many fewer pounds of required construction material.

Eight different makes of 15-in. drivers, all intended for woofer service only, were obtained and tested before deciding on the best driver. Of the eight types tested, three involved at least four samples of that particular type. Most of the drivers for this test were obtained on loan from friends.

A simple optical setup was used to accurately measure diaphragm displacement. This facilitated the measurement

of several important factors: B_1 factor (or the product of gap flux density with the length of conductor in the gap), the compliance of the suspension system, and the linearity of the driver. These in combination with other simple measurements yielded about 20 points with which the drivers were compared and rated.

The linearity test became important since a number of the drivers possessed what was judged to be poor linearity for the application in mind. The linearity test was the plotting of the diaphgram displacement verses the current through the voice coil. In some cases the poor linearity was due to design limitations and in others, poor manufacture. Predominately, the voice coil lengths were either much longer or much shorter than the magnetic air gap depths. The short type of coil is capable of much better conversion efficiency with good linearity. However, unless the voice coil is accurately centered axially (radial centering is of little consequence in this matter) in the uniform region of the magnetic field the linearity will be poor. In one make of speaker with a short voice coil, only one unit of four had proper axial centering of the coil in the magnetic field. On the other three units, it could even be visually observed that some of the voice coil turns were outside the air gap when the speaker was in a vertical plane and with no electrical connection to the voice coil. And all these units were brand new! The same fault was observed on another make of short coil speaker also. On the other properly centered short coil type speakers the linearity was found to be good, but over a smaller range than that observed for the types with the long voice-coil design. Therefore, a long voice-coil speaker seemed a better kind to use for this design in spite of the fact that its efficiency would be lower than that of the short types. Actually all the long-coil types tested showed acceptable linearity. Good short-coil types are made but there are risks involved in getting one that is properly assembled.

Four units of the Jensen P15-LF were purchased after very encouraging data were obtained from the manufacturer. All four of these units tested practically identical in agreement with the manufacturer's claims.

The Jensen P15-LF has a free-air resonance of about 19 eps. It is capable of peak excursions of ±0.5-in. with excellent linearity over a range of ±0.20 in. from neutral. This is more than adequate linearity for horn loading with several acoustic watts output at 50 eps. In spite of the necessarily long voice coil it still has good motor efficiency. The cone is heavy, straight sided, and the front is completed sealed from the back. It probably was never intended for horn use, however it was judged to be the best all-around unit for this horn design.

Using a 1:1 throat-to-diaphragm ratio permitted a horn throat area of 250 square inches for a driver pair. A maximum over-all depth for the bass horn was set at 50 inches, of which 10 inches was allotted to the driver. All the system drivers were to be vertically stacked. It was desirable to keep the high-frequency horn axis not much above ear level when seated. This meant that the low-frequency section height had to be minimized. A 33-in. over-all height was selected and permitted a 32-in. height at its mouth. The axis formed by the origin of the radii of the bass horn was made to coincide with that of the high-frequency horn. The radius was made to be 38 inches for this reason. This results in all the driver voice coils lying in the same plane with

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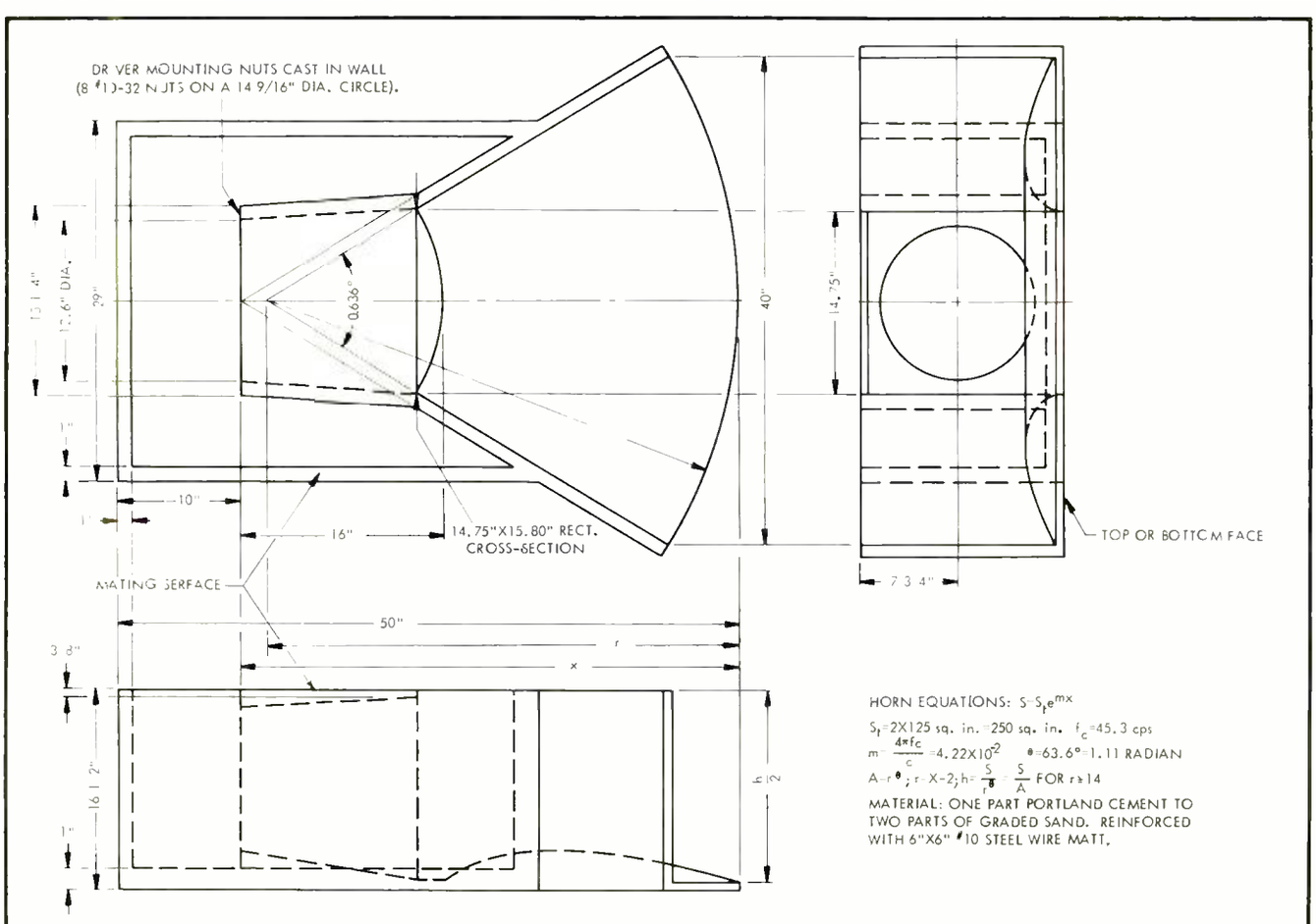

Fig. 5. Low frequency concrete exponential sectoral horn for Jensen P15-LF driver. Complete horn consists of two identical castings, one stacked over the other. Seam is packed with a non-hardening caulking compound.

Transient Performance of Loudspeaker Dividing Networks

Based on a theoretical analysis, this author demonstrates that one dividing network can do the work of two, and better. In areas the explanation requires a knowledge of advanced mathematics—but the schematics are easily understood by all.

ROBERT M. MITCHELL*

THE LOUDSPEAKER DIVIDING NETWORK has been an essential component of high-quality audio reproduction since the early days of sound motion pictures. In fact, the "bible" of loudspeaker dividing network designers, the well-known book "Motion Picture Sound Engineering," was published in 1938. This book set the standard for such designs, and there has been little change since.

The designs in this book followed classical steady-state theory, and the major consideration was to split the given spectrum into two channels, so that the total sound power remained constant over the frequency range. A secondary consideration was to achieve a design which did not react on the amplifier adversely by changing the frequency response or increasing the harmonic distortion.

Two major types of dividing networks were evolved, called the m-derived and the constant-resistance types. The former gave faster rolloff away from the crossover point, but was more complex. The second gave a more gradual rolloff, but had the advantages of presenting (theoretically at least) a constant resistance to the amplifier, and being simpler to make. Both of these types met the criterion of permitting constant sine wave power from the two loudspeakers over the frequency range.

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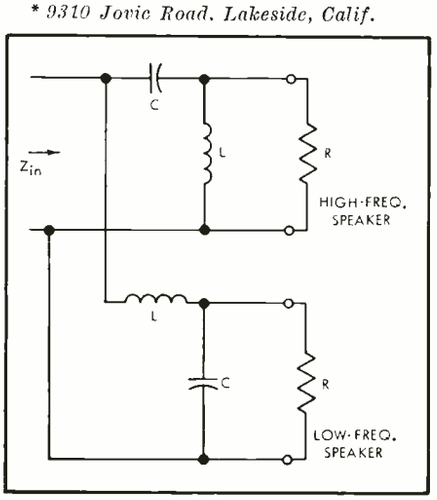


Fig. 1. Two element constant-resistance network.

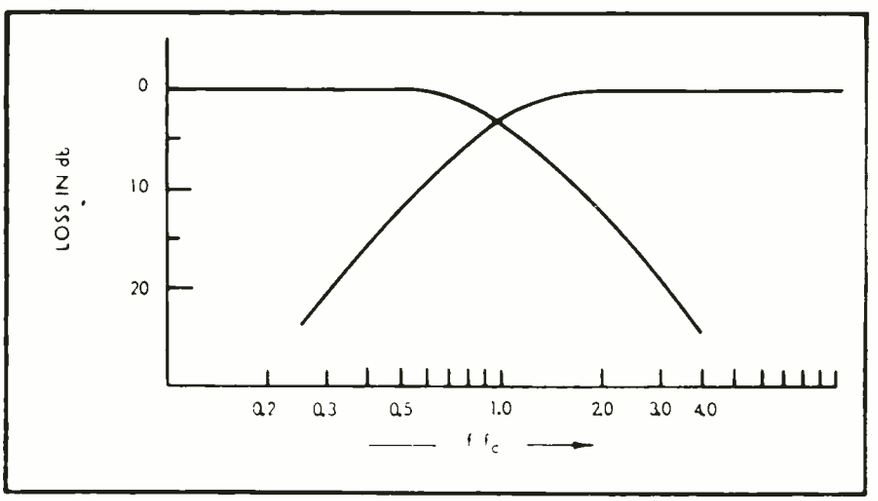


Fig. 2. Steady-state response of network shown in Fig. 1.

The two types have been universally employed since that time, and indeed there is virtually no other to be found in use today. Strange, therefore, that although they work correctly for steady state, they are inherently incapable of reproducing a transient signal (step function) without distortion! This is a rather startling state of affairs, so let's see how it comes about.

Let's look first at the constant-resistance type of network. The configuration of elements is the same as in the m-derived network, but the relationship between L and C is a simpler one, allowing a corresponding simplification in the applicable formulas. A two element, parallel-type, constant-resistance network is shown in *Fig.* 1, and the resultant steady-state response is shown in *Fig* 2. In *Fig.* 2 we have a typical "frequency response" curve.

It is important to keep in mind that this is a graph of the logarithm of one quantity (voltage out) versus the logarithm of another (frequency). In network analysis when we deal with the response of networks to sine wave inputs, we talk about their response in the "frequency domain." When we discuss the transient response of networks, we describe their behavior in the "time domain." In the time domain we usually do not use logarithmic plots. Instead we use linear plots, with the actual magnitude (instead of the log of the magnitude) of the voltage plotted against time. In the time domain, we are not concerned with such concepts as "rms" since frequencies (in the sine wave sense) do not enter into consideration. We keep this in mind specifically so that when we add the powers contributed by the different channels of a network, we do not attempt to do so on the basis of "half-power points." The addition of powers is obtained from the algebraic sum of the squares of the instantaneous voltages.

To investigate any response (steady-state or transient) of the dividing network of *Fig.* 1, we first find the transfer functions of the high- and low-frequency channels. We write these functions in terms of the complex frequency

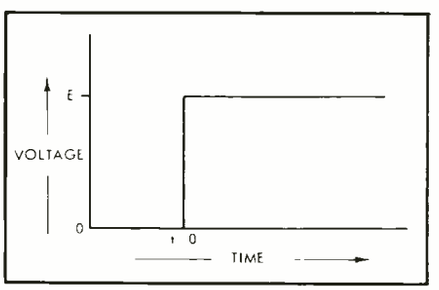


Fig. 3. Simple step function.

The sound from this new Shure cartridge is awesome in its vitality & clarity

A NIGHT-AND-DAY DIFFERENCE

From the very first prototype, the sound from the new Shure Series M44 Stereo 15° Dynetic Cartridge was incredible. Even skeptical high fidelity critics have expressed unconcealed surprise at the audible increase in brilliance, clarity, transparency, presence, fullness and smoothness of this amazing new Shure development. A close analysis of its performance reveals startling differences in this cartridge—although not extraordinarily improved in the "usual" areas of frequency response (still a virtually flat 20-20,000 cps) or in compliance (25 x 10^{-6} cm/dyne)—rather it is in the distortion measurements where Shure engineers have achieved a highly significant and dramatic reduction of *75% to 90%* in IM and harmonic distortion from even such admirably distortion-free cartridges as earlier versions of the Shure Stereo Dynetic. Further, cross-talk between channels has been effectively negated in the critical low frequency and mid ranges . . . providing superior channel separation throughout the audible spectrum.

SCRATCH-PROOF RETRACTILE STYLUS

And, as if that were not enough, the new 15° cartridge incorporates a totally efficient retractile stylus that momentarily retracts whenever excessive forces are applied to the tone arm. This feature protects your records and prevents annoying "clicks."

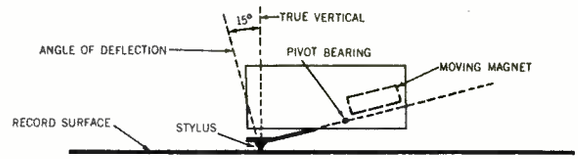
PERFECTION IS A MATTER OF DEGREE

It has been known for some years that a difference between the angle used to cut stereo records and the angle of the stylus of the cartridge used to play them would result in an increase in IM and harmonic distortion audible on certain records. With widely different cutting angles employed by the record companies, the effective angle of the playback cartridge stylus had of necessity to be a compromise so as to provide the best possible results from records of all makes.

Recently, industry attention was focused on this problem by a series of technical articles ascribing the difference in effective vertical angles between the cutter stylus and the playback cartridge stylus as a cause of distortion and urging the adoption of a standard effective angle to which records would be cut.

Major record companies have now begun to use an effective cutting angle of 15°, which is the proposed standard of the RIAA (Record Industry Association of America) and EIA (Electronic Industries Association.)

With the emergence of the single standard effective vertical tracking angle for cutting records, Shure engineers immediately began what seemed on the surface the seemingly simple but in actuality the arduous and exacting task of converting their formidable Stereo Dynetic cartridge to the 15° effective tracking angle. It couldn't be done. So Shure designed this radically new moving-magnet cartridge that will track at an effective angle of 15°. Graphically, this is the kind of cartridge geometry involved in the new Shure Series M44 15° Stereo Dynetic Cartridge:



THE ULTIMATE TEST

You must hear this cartridge to appreciate the totality of the sound improvement. It will be instantly recognizable to the ear without the necessity for elaborate test instruments or A-B listening tests—although we assure you, instruments and A-B tests will more than substantiate our claims.

M44 SERIES SPECIFICATIONS

	M44-5	M44-7
Frequency Response:	20-20,000 cps	20-20,000 cps
Output Voltage at 1000 cps (Per Channel, at 5 cm/sec peak velocity):	6 millivolts	9 millivolts
Channel Separation (at 1000 cps):	Greater than 25 db	Greater than 25 db
Recommended Load Impedance:	47,000 Ohms	47,000 Ohms
Compliance:	25 x 10^{-6} cm/dyne	20 x 10^{-6} cm/dyne
Tracking Range:	¾ to 1½ Grams	1½ to 3 Grams
Inductance (Per Channel):	680 millihenries	680 millihenries
D.C. Resistance (Per Channel):	650 Ohms	650 Ohms
Stylus:	.0005" diamond	.0007" diamond
Stylus Replacement:	N44-5	N44-7

Monophonic Styli Also Available:
Model N44-1—For monophonic LP records, with .001" diamond
Model N44-3—For 78 rpm records, with .0025" diamond

SHURE

Stereo 15° Dynetic®

SERIES M44 SCRATCH-PROOF CARTRIDGE
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LITERATURE: Shure Brothers, Inc. 222 Hartrey Avenue, Evanston, Illinois

Manufactured under U.S. Patents 3,055,988; 3,077,521 and 3,077,522. Other Patents Pending

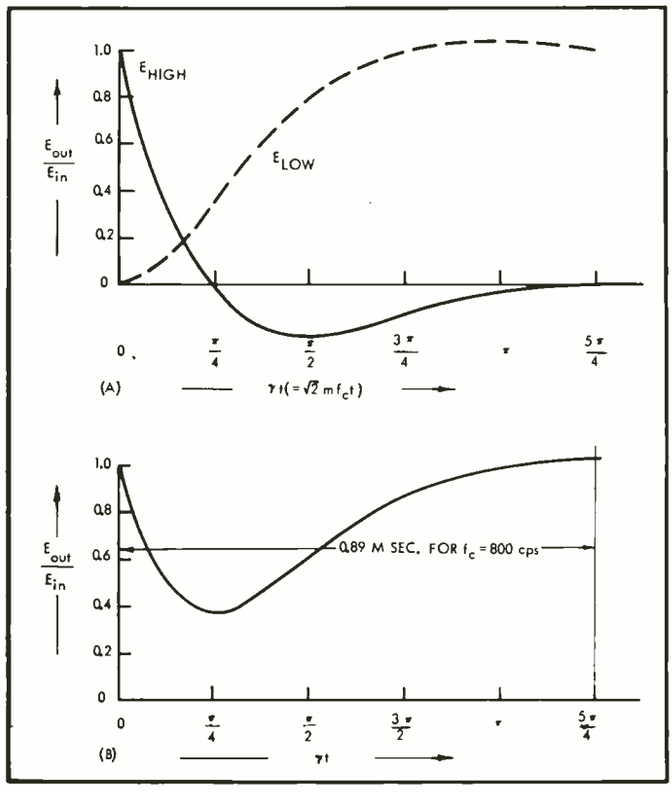

Fig. 4. (A) Plot of Eq. 2(A) and 2(B); (B) Plot of sum of the two equations.

variable "*s*," since this provides us with a form suitable for calculating the steady-state response (by using the imaginary part $j\omega$ of the complex frequency s) or the transient response (by using the real part σ of s.)

The transfer function of the low-frequency channel will be indicated by the notation $G_{lo}(s)$, while that of the high-frequency channel will be indicated by $G_{hi}(s)$. We find for the network *Fig.* 1:

$$G_{lo}(s) = \frac{1/LC}{s^2 + (1/RC)^2 + 1/LC} \quad Eq.\ 1(A)$$

$$G_{hi}(s) = \frac{s^2}{s^2 + (1/RC)^2 + 1/LC} \quad Eq.\ 1(B)$$

The usefulness of the transfer function lies in the fact that if we multiply the expression for the input voltage by the transfer function, we automatically obtain the expression for the output voltage.

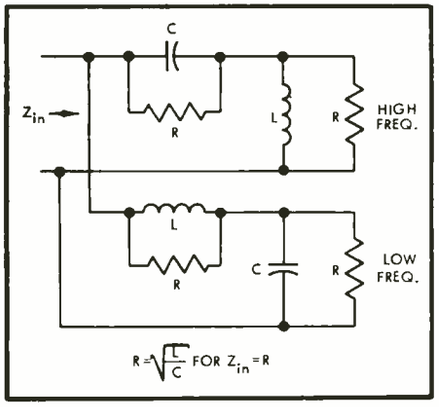

Fig. 5. Network of **Fig.** 1 with resistor, R, across the series reactance.

If we recombine the outputs of the two channels linearly, we should have and exact replica of the input signal if there has been no distortion. In an actual circuit this could be done by feeding the two outputs into a distortionless mixing amplifier, for example. In this way we effectively achieve the ideal situation through resistive mixing—a linear addition process.

A simple signal which will permit display of the complete transient response of any network is the step-function. This is shown in *Fig.* 3. As will be recognized, this is nothing more than half of a square-wave, which has long been used as a transient testing signal. In complex-frequency notation the step function is represented by E/s, where E is the amplitude of the voltage. To obtain the output expression of a network, knowing its transfer function and the "*s*" form of the input signal, we need only multiply them. We then look up the resultant expression in a table of LaPlace transforms. The table will give us the response expressed as a function of time. Doing this for the above network we find that

$$E_{lo}(t) = E[i - e^{-\gamma t}\ (cos\ \gamma t + sin\ \gamma t)] \quad Eq.\ 2(A)$$

$$E_{hi}(t) = E[e^{-\gamma t}\ (cos\ \gamma t - sin\ \gamma t)] \quad Eq.\ 2(B)$$

$$\text{where } \gamma = \sqrt{2}\,\pi\, f_c$$

These two voltage outputs are plotted in (A) of *Fig.* 4. It would seem that adding these two responses would not recreate a step function (which would be necessary for perfect response). The sum itself is shown in (B) of *Fig.* 4, and it certainly is not a step function.

It is now apparent that the conventional dividing network cannot respond properly "transient-wise" to a step input, and as a matter of fact generates a new component which Fourier analysis will show has components covering a wide range of the audio spectrum. This transient distortion would not be too objectionable if it were produced only upon the application of an occasional step function. It can be easily shown, however, that a similar distortion results from the sudden application of other signals also (square waves or switched sine waves, for example). Furthermore, this failing is present not only in the particular parallel constant-R network chosen for the example, but in all conventional (constant-R and m-derived) networks, since they differ only in the ratio of their impedance values.

With this somewhat discouraging state of affairs at hand, let's see if we can find another type of network, which will have acceptable cutoff characteristics, but will also have perfect transient response. We start our search by adding a resistor R (equal to the load) across the series reactance, as shown in *Fig* 5. Upon examining the transfer function we find

$$G_{lo}(s) = \frac{s/RC + 1/LC}{s^2 + 2(s/RC) + 1/LC} \quad Eq.\ 3(A)$$

$$G_{hi}(s) = \frac{s^2 + s/RC}{s^2 + 2(s/RC) + 1/LC} \quad Eq.\ 3(B)$$

Multiplying these by E/s as before, and converting to time-domain response we find the transient response is perfect!

Those extra series resistances are very wasteful of power, however, so we consider moving the dividing network into the amplifier, and feeding the network output to two separate power amplifiers as in *Fig.* 6. The values of R, L, and C can now be chosen almost *ad libitum*,

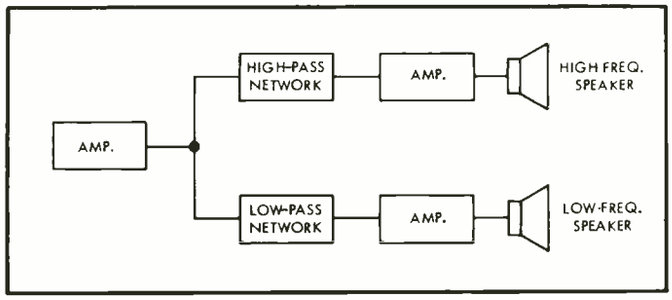

Fig. 6. Driving the network with an amplifier.

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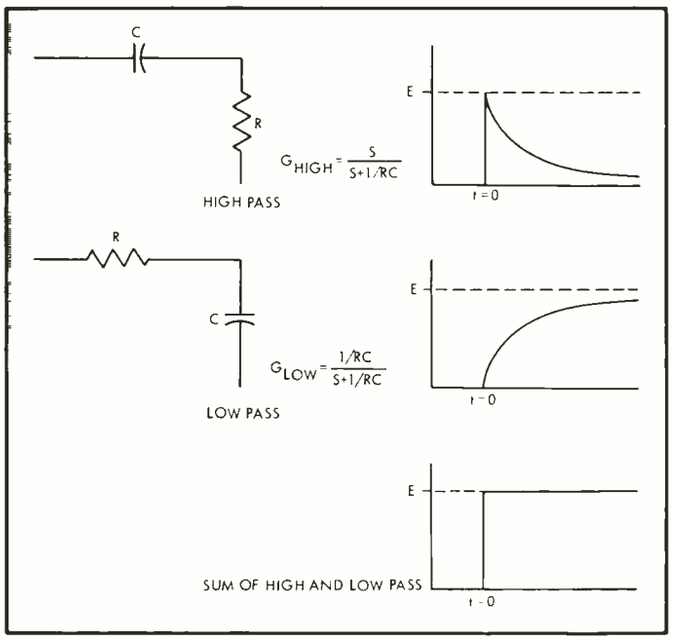


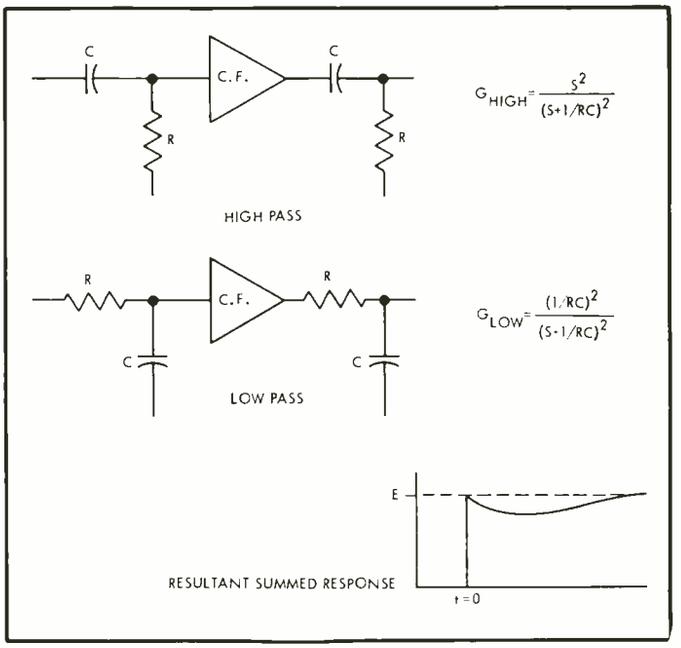


Fig. 7. (Left) Old standby R-C network. Fig. 8. (Right) Stacking one R-C network on top of another isolated by a cathode follower.

since power dissipation is no problem. This greatly eases the problem of finding suitable components, and the cost of the network can be considerably reduced.

Upon taking a second look at our transfer functions, however, we find that we have been kidding ourselves a bit. If we substitute $R = \sqrt{L/C}$ in G_{hi} we find it reduces to

$$G_{hi}(s) = \frac{s}{s + 1/\sqrt{LC}} \qquad Eq.\ 4(A)$$

and that G_{lo} reduces to

$$G_{lo}(s) = \frac{1/\sqrt{LC}}{s + 1/\sqrt{LC}} \qquad Eq.\ 4(B)$$

These are transfer functions for 6 db/octave networks (since the denominator is linear, and not quadratic as before). Consequently although we have gained in transient response, we have lost in rolloff characteristics. However, if a 6-db network is suitable, why not consider an *R-C* network, rather than a *R-L-C* network, since the cost can be reduced many fold. We therefore look at the old standby configurations of *Fig.* 7 and find that their transient response is indeed perfect. This looks encouraging. All we have to do now is stack one 6-db *R-C* network in back of another one (isolated by a cathode follower) and we will have it made—or will we? Let's see. (*Fig.* 8.) Not very helpful, after all. It begins to look as though only 6-db networks have perfect transient response. This hardly seems likely, so let us make a more thorough examination of the basis of the band-splitting concept.

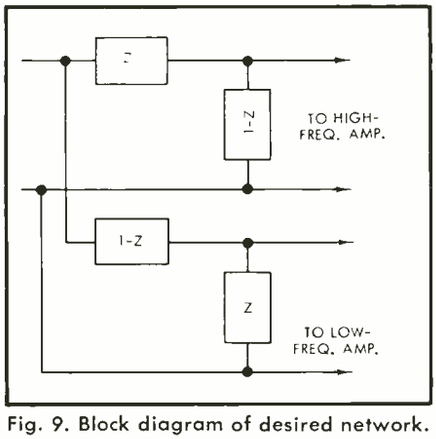


Fig. 9. Block diagram of desired network.

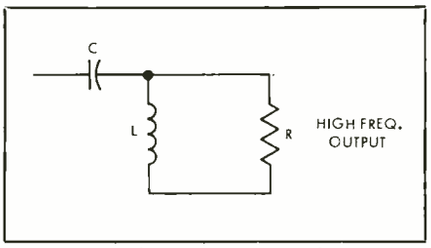


Fig. 10. High-pass section of constant-resistance network.

If we examine the transfer functions of those networks that have perfect transient response, we notice one common feature—the sum of the two functions G_{hi} and G_{lo} is always a constant (in our examples the constant is 1). Upon a little reflection this seems reasonable enough. For if the answer is a constant, then the variables does not appear in the answer. Since the variable s is the complex frequency variable, (representing both the transient frequency" and the periodic frequency) its absence means that the result is independent of frequency in both these senses. In other words, both the transient and the steady-state frequency response are perfect. If we illustrate this schematically we find that our desired network should have the arrangement shown in *Fig.* 9.

This gives us a very important clue towards the general construction of such networks since it shows that we need only one network (either high-pass or low-pass) and that the complementary channel will use the same network in the inverted configuration. For example, if we take our original constant-R network and use the high-pass section 1 (*Fig.* 10), we can construct a dividing network by using this section two times—once in its normal arrangement and once inverted. (See *Fig.* 11.) As we anticipated, the transient response of this network is perfect.

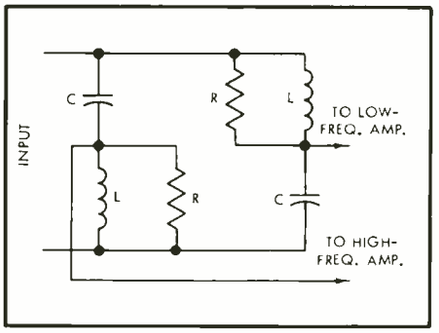


Fig. 11. Dividing network consisting of two high-pass constant-resistance networks, one inverted.

(*Continued on page 60*)

Stereo Disc Recording Comes of Age

DUANE H. COOPER*

At the recent Convention of the Audio Engineering Society, new theoretical and experimental findings related to distortion in stereo disc recording and reproduction were reported. This article gives a broad survey of the present situation and discusses the implications of the new findings.

DISTORTIONLESS STEREO DISC RECORDING and reproduction is the prospect signalling a new maturity for the recording industry. During the past year or two, a new understanding of the relationships between the ancient problems of tracing, tracking, and tip-mass distortions has emerged. These insights[1] point the way toward means for the independent control of each of these sources of distortion. It is the mastery of such techniques that will actually inaugurate the mature era.

Tracing versus Cutting

In the cutting of a master disc, a chisel-shaped stylus is used. The purpose is to so concentrate the stress at the cutting edges as to cause rupture of the acetate lacquer material. In playback, rupture of the groove walls is to be avoided; indeed, the goal is to keep the groove wall deformations to the smallest values consistent with other requirements.

Avoiding the distortion due to groove-wall deformation requires (1) the use of small dynamic bearing forces, (2) the use of rather large bearing or contact areas between stylus and groove wall, and (3) the use of stiff materials for the manufacture of the pressings derived from the master discs. Not all of these measures can be freely invoked. At the very least, some minimum force is necessary to push aside the dust particles that will inevitably be found residing in the groove. Again, the record material must possess, also, those properties which allow an economical process for making pressings and for handling the resulting product; glass, as an extreme example, wouldn't do as well as the present vinyl.

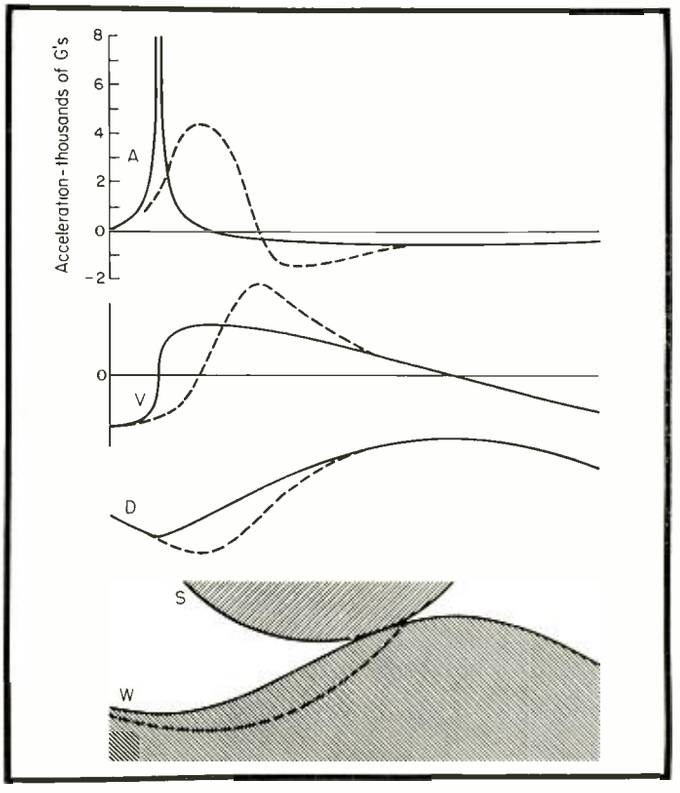


Fig. 1. Plots of acceleration, **A**, velocity **V**, and displacement, **D**, waveforms resulting from tracing the groove wall modulation, **W**, with the curved stylus tip **S**. The dashed curves show deviations resulting from a possible groove wall deformation. The deviation softens the demand for acceleration.

For a given record material, and for dynamic bearing forces greater than a certain minimum, measures (1) and (2) have played a complementary role, so that a compromise was always necessary. It has never been feasible to arrange for bearing forces so slight that the sharp edges provided in the cutting stylus could also be used in the reproducing stylus. Because of this, a rather blunt reproducing stylus has been the rule. The disparity in shape between the two styli causes an error in tracing the modulation cut into the groove wall.

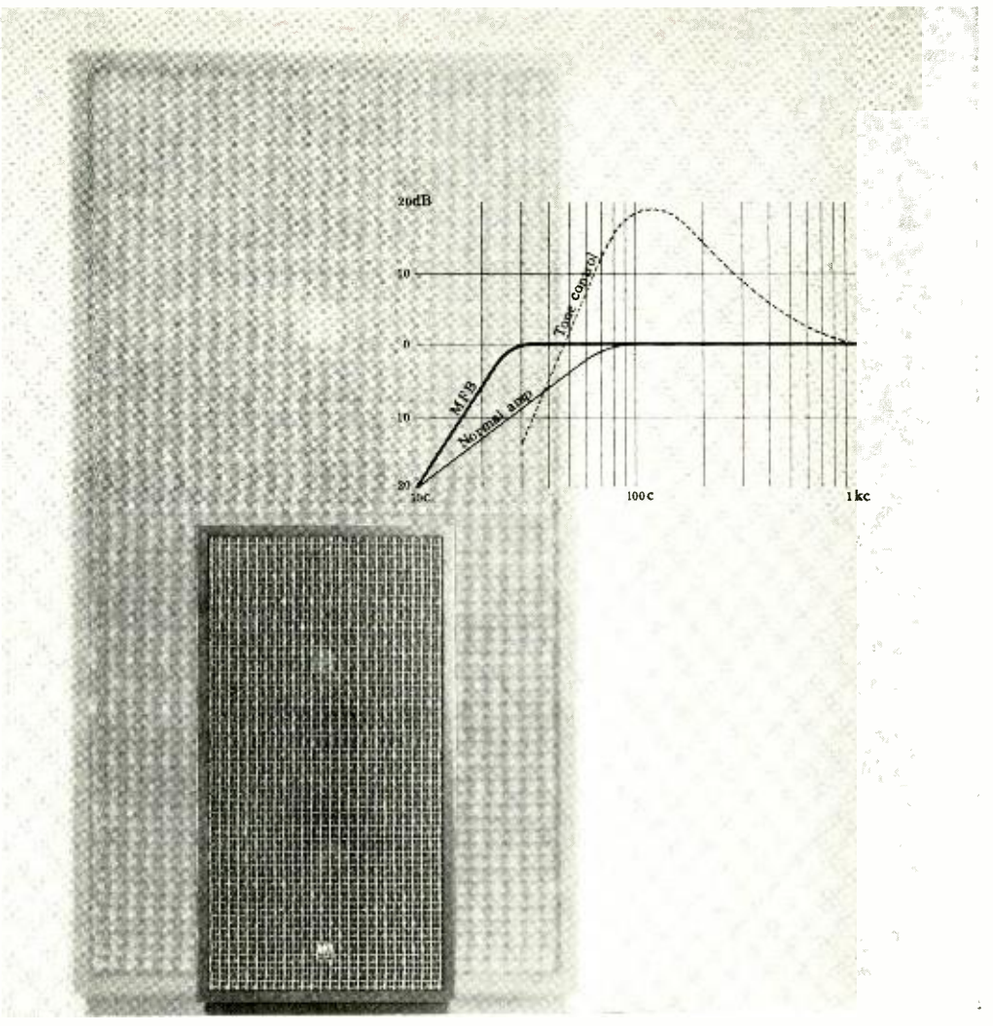
The Role of Tip Mass

The compromise comes down to one between distortion arising from excessive, if not permanently destructive, groove wall deformations, on the one hand, and distortion arising from excessive tracing error on the other. The key factor in this compromise has been the effective tip mass of the reproducing stylus.

The word "effective" means here that all inertial effects presented by the moving parts of the reproducing cartridge, in opposing accelerations of the stylus tip, are to be included in this one parameter. Many advertising copy writers seem content to speak of only the mass of the tip itself. The total effective tip mass is difficult to measure, so that apart from some confusion over definition, precise estimates are not usually known. The best cartridge designs at present seem to exhibit an effective tip mass near 1 milligram. It would appear that only radi-

* *University of Illinois, Urbana, Illinois.*

[1] A mathematical discussion of some of these new insights may be found in the paper "Integrated Treatment of Tracing and Tracking Error," by the present author, in the January 1964 issue of the *Journal of the Audio Engineering Society.* The paper includes an extensive bibliography.



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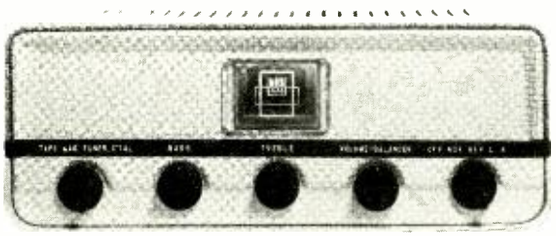

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cally new approaches to cartridge design will allow effective tip masses much below this value. In the fairly recent past, however, effective tip masses have ranged from several to dozens of milligrams.

It is not difficult to see why effective stylus tip mass should be such a key factor. In tracing groove-wall modulations whose sharpest curvatures come close to matching the curvature of the stylus tip, several thousands of G's of acceleration are demanded for the upward accelerations. For effective tip masses of a few milligrams, the required forces have peak values of dozens of grams. For styli so sharply pointed as to have a tip radius of a half or 0.7 mil, the groove wall is unable to supply such peak forces, so that it suffers indentations which are often permanent.

On the other hand, the ideally sharp stylus is required, for the same modulations, to suffer hardly more than one thousand G's of acceleration, up-or downward. At the same time, the reduced dynamic bearing forces are distributed over such a small area that even more severe groove wall deformations, or even rupture, may occur. The exact relationship between the deformation (indentation) and sharpness of tip curvature still seems to be a matter of some controversy, but there is no doubt that the two go hand-in-hand.

The problem of indentation would be of lesser importance if one could guarantee that the elastic limits of the record material were not exceeded, and that the indentations were linear functions of the dynamic bearing force. Unfortunately, even when the first is true, the second is not. Indentation by a sliding contact with a curved indenter may not be expected to be a linear function of the bearing force in the first place, and, in the second place, the apparent stiffness of the surface would depend upon the local curvature of its unindented surface.

The linear component would lead only to a high-frequency loss, but the nonlinear component would lead to tip-mass distortion with the generation of in-band intermodulation products. Tracing distortion aggravates the problem, because the demand for greater acceleration excites additional tip mass distortion.[2] There is some comfort to be found in the fact that these two distortions tend somewhat to cancel one another, though usually at the cost of dangerously large indentations.

The static bearing force, also present, is needed to drive the downward accelerations, so that the stylus will not lose contact with the groove wall. These downward accelerations range from only a few hundred G's for the blunter styli to a thousand G's for the excessively sharp ones. The required force is developed by the static load upon the compliant stylus suspension. A very compliant suspension is of no particular advantage here. If the needed static load is developed by some nominal deflection a little larger than the amplitude of the groove modulation—5 or 10 mils should leave ample margin—the requirement is met. It is clear, however, that the greater the effective tip mass, the less compliant should be the suspension, if the static deflection is to have only such nominal values. At the same time, it is possible, by allowing for quite large static deflections, to provide a very compliant "loose-tooth" stylus suspension, and thereby gain some temporary advantage in the market place.

Some of these ideas are illustrated in *Fig.* 1. The bottom part shows a longitudinal section of a groove wall, *W*, contacted by a rounded stylus tip, whose profile is the curve *S*. The peak curvature of the sinusoidal modulation just matches the curvature of the stylus (curvature limit). As the stylus moves, say from left to right, along the groove axis, its center of curvature traces the displacement curve *D*. The sharpened turning point is characteristic of tracing distortion. The corresponding slope or velocity waveform is plotted as the curve *V*. At the place where the displacement curve sharply turns, the velocity changes rapidly from a negative to a positive value. This waveform is strongly skewed in a manner like the skewing of the displacement waveform in tracking distortion.

The waveform showing the instantaneous acceleration values for the tracing is the curve marked *A*. The scale is calibrated in thousands of G's. This calibration holds for peak curvatures matching a 0.7-mil stylus, with a groove speed of 17.3 inches per second, or a 0.5-mil stylus at 14.5 ips. The positive or upward accelerations would have to be provided by forces developed in the groove wall, while the negative or downward accelerations are to be supplied by the prestressed stylus suspension. Where the displacement curve shows a sharpened curvature, there is a short but infinitely tall "spike" in the demand for acceleration. This would present a violently hard jolt to the groove wall.

It is impossible for such a jolt to be sustained; it must be softened by a yielding of groove wall. In this way, the groove wall can develop reduced forces, corresponding to only a few thousand G's, forces which, depending on effective tip mass and tip curvature, it could conceivably sustain. The deformation of the groove wall means that the displacement curve, *D*, will not be followed exactly. Instead a deviation like that shown as the dashed curve will be followed.

The exact form of such a deviation may not be predicted at present with any accuracy. The dashed curve represents a conjecture in reasonable agreement with the deformation photographed by Walton.[2] The deformation calculated from the deviation is the dashed curve shown for *W*. Since photographs of only plastic (i.e., irreversible inelastic) deformations exist, no attempt is made to represent elastic deformations in these plots. The asymmetry of the deformation is typical of the photographs.

Once a particular deviation is assumed, not only is the shape of the groove wall indentation determined, but the revised shape of the velocity and acceleration waveforms may be calculated. These are

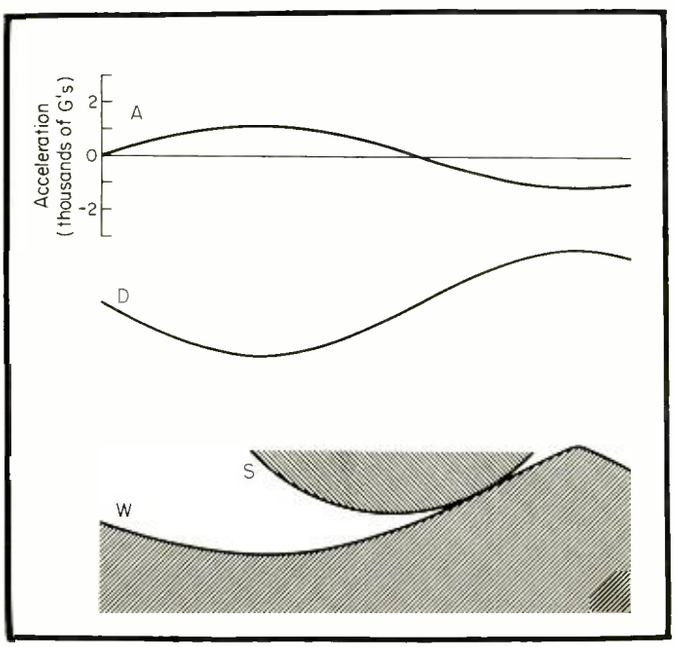

Fig. 2. Plots of acceleration, A, and displacement, D, waveforms resulting from tracing the specially shaped groove wall modulation, W, with the curved stylus tip, S. The modulation, W, of Fig. 1 is shaped to simulate the effect of recording with a blunt stylus whose curvature matches that of S. The displacement waveform, D, is a faithful reproduction of that sinusoid. The acceleration demand, A, is modest.

[2] A recent discussion of tip mass distortion has been given by Walton, "Stylus Mass and Reproduction Distortion," in the *Journal of the Audio Engineering Society* for April, 1963.

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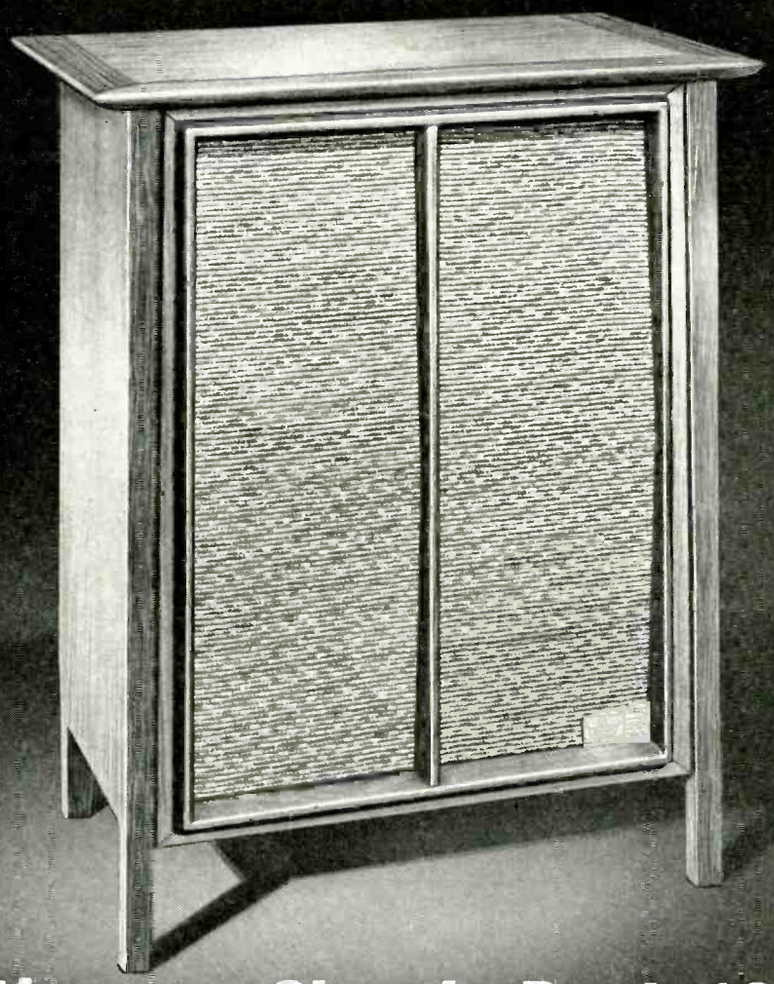


the new Classic Dual-12

the three-way system with two 12" speakers—plus!

From the first moment of its appearance, the Classic Mark II won instant and unanimous acclaim as the most exciting new instrument in the world of music reproduction. Its range, its presence, its spaciousness and dimension are truly outstanding, even when compared with the so-called "world's bests." Its reputation, however, posed this immediate challenge: Could University now create a speaker system with the essential qualities of the Mark II, but in a more compact size... and at a more moderate price? Could University now bring the pleasure of uncompromising big system high fidelity to a broader range of music lovers?

The challenge has been answered with the new Classic Dual-12, created by a totally new approach to the design of speaker systems. Instead of the conventional 3-speaker arrangement, University's Dual-12 incorporates two 12" speakers...plus the Sphericon Super Tweeter! One 12" speaker is a woofer specifically designed for optimum reproduction of the ultra-low frequencies (down to 25 cps); the other, a woofer/mid-range, reinforces the woofer, removes the peaks and valleys that cause harsh, strident sounds in ordinary systems and provides flawless mid-range performance. The renowned Sphericon is included to assure silky, transparent highs soaring effortlessly up to 40,000 cps! Power Requirements: 10 watts. Size: 23¾" x 31¼" x 15½". Oiled walnut finish. **$229.95** Hear it at your hi-fi dealer, or write: Desk R-1.

LTV UNIVERSITY
9500 West Reno, Oklahoma City, Oklahoma

the dashed curves associated with V and with A. The velocity waveform shows an overshoot, and the acceleration waveform shows a major reduction in acceleration demand but one which is sustained for a longer interval. This reduction in peak acceleration demand explains the stability of such deformations, once formed, against further change upon repeated playings. Walton finds such extensive damage to be characteristic, for 0.7-mil styli, of effective tip masses near 3 milligrams.

The effective tip mass is a key factor in another way. It largely determines the frequency of the resonance with the groove-wall compliance, although the groove wall appears stiffer to the more bluntly curved stylus tip. In general, the resonance comes at the higher frequencies for the smaller effective tip masses. At such a resonance, very large groove wall deformations tend to develop, and separation between the stereo channels all but vanishes. Obviously, such a resonance should be well-damped and placed well outside the audio band, if possible. The higher the resonant frequency the less the need for viscous damping, so that there need be developed smaller forces in opposition to stylus velocity (rather than to displacement or acceleration). This factor determines the dynamic bearing forces for the middle frequencies near the so-called free resonance of the stylus suspension.

This sketch of the relationship of all these dynamic factors to the key one of effective tip mass does leave out consideration of the possibility of beam resonances within the stylus cantilever, or within a transducer element, such as a ceramic or crystal bar. The relationship of these factors to effective tip mass is more complicated. If such complications may be left aside, as they often can, then the one factor of effective stylus tip mass is seen as controlling the others. More to the point, it is the complementary role of tip mass and tip curvature that is dominant.

In each instance, if it weren't for tracing error, the effects of a large effective tip mass could be reduced by the use of a blunter stylus. The presence of tracing error, however, has tended to promote the use of more sharply pointed styli, so that tip mass distortion and tracing distortion were kept in some kind of compromise balance. Refinements of design leading to reduced tip mass, and reduced distortion on that account, have tended to be exploited by sharpening the tip curvature, reducing tracing distortion and increasing tip mass distortion, to restore the compromise.

The over-all result is not quite a stalemate. There has been a net improvement. Some present-day cartridges, even with half-mil styli, show reductions in both tracing and tip mass distortion in comparison with their 0.7-mil ancestors. Even so, the day of the 0.1- or 0.05-mil reproducing stylus would not seem to be in the near future, even for elliptical stylus shapes with their slightly sharpened edges, nor can so much be promised with predictable reductions in effective tip mass.

The New Shape in Groove Walls

Now, at last, it is possible for the near-stalemate, between improvements via sharpened stylus tip curvature and improvements via reduced effective tip mass, to be broken. This is to be achieved by a more correct shaping of the groove-wall modulation, to provide a direct compensation for tracing distortion, independent of any hampering tip-mass considerations.

It should be remembered that tracing error arises because of the disparity between cutting and reproducing stylus shapes. Attempting to remove the disparity by sharpening the reproducing stylus leads only to endless difficulties, because the effective tip mass remains obdurately non-vanishing. The other way to remove the disparity is make the other stylus—the recording stylus— more like the blunter reproducing stylus.

In the bottom part of *Fig.* 2, there is shown a groove wall, W, formed by a shaped waveform, simulating the effect of using a blunt recording stylus, whose tip curvature matches that of the playback stylus, S. The waveform prior to shaping was the curve W of *Fig.* 1. The displacement waveform traced by the center of curvature of S is plotted as the curve D, which is a faithful reproduction of the unshaped waveform. Such a faithful reproduction requires the acceleration demand, plotted at A, to be met. The demands are relatively modest, and probably may be met by only elastic and nearly linear wall deformations.

It should be noted that at the sharpened projection in the groove wall, the acceleration is to be supplied only by the stylus suspension. A large part of the static bearing force is taken up with this acceleration, and thus, the groove wall is partially shielded at these points against the full bearing force.

Blunt styli can be used to form record grooves by a process known as embossing; it is used in certain dictating equipment. This way, apparently, lies the abyss. The noise problems are severe.

The effect of a blunt recording stylus can be simulated electronically, however, by proper waveform shaping prior to recording with a conventional stylus. This shaping may be done in an electronic analog computer, such as the *Dynamic Stylus Correlator* developed at RCA.[3] The design of this machine, or any other simulation device, derives from the recent realization that tracing error is much more like tracking error than had been hitherto thought, in that the error in each case derives solely from phase perturbations.

The use of such machines allows the noiseless recording possible with modern sharp, heated styli, but with the modulation shaped as if a rounded stylus had been used. In this way, the effect of using a recording stylus, whose radius of curvature matches that of the reproducing stylus, may be achieved. One may anticipate that a matching to within 0.1 mil or even 0.05 mil will one day be maintained. Thus, one could have the small tracing distortion previously associated with the impossible 0.05-mil stylus, together with the small tip-mass distortion possible with a 0.7-mil stylus. Again, achievements in reducing effective tip mass need not be largely dissipated by yielding to any temptation to sharpen tip curvature.

The Compensation Controversy

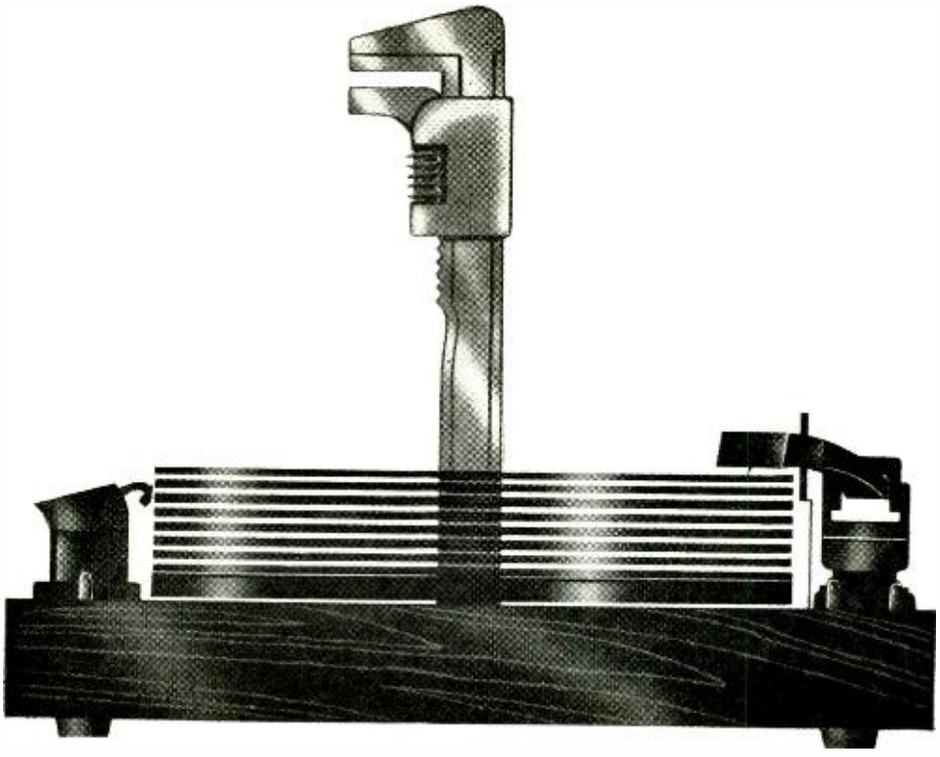
Already, in the brief history of its use, the *Dynamic Stylus Correlator* is the subject of rather intensive controversy. Because its use is a part of a battery of innovations known collectively by the trade-name *Dynagroove*, the controversy partly derives from the one of larger scope concerning those innovations. The relative merits in such a controversy is a matter which the present author is in no position to appraise, at least not on its full scope. The use of the *Dynamic Stylus Correlator*, or other such compensating devices does, however, fall squarely within the range of this paper.

One may hear objections that the device merely pre-distorts the groove in an effort to make up for the deficiencies of inferior reproducing equipment. There are enough half-truths in this statement to make a strong appeal. From what has been explained in the foregoing, however, it is seen that this objection represents a short-sighted view of the problems of the stylus-groove interaction.

For example, one appeal of this objection rests upon the identification of the less sharply pointed stylus with "inferior equipment." Such an identification overlooks the important engineering advantages entailed in the gently-curved stylus tip, and presumably sees the only excuse for a blunt reproducing stylus

(*continued on page 61*)

[3] The *Dynamic Stylus Correlator* has been described by Fox and Woodward, "Tracing Distortion—Its Cause and Correction in Stereodisk Recording Systems," in the *Journal of the Audio Engineering Society* for October, 1963.



do you have a monkey wrench in your automatic turntable?

Any spindle that permits the stacking of records on a turntable throws a monkey wrench into the entire system.

The stacking of records varies the stylus angle – increases the load on the motor – creates flutter and wow – wears records – diminishes your listening pleasure. IS IT WORTH ALL THAT JUST TO CHANGE RECORDS?

If you want a transcription turntable *plus* a changer . . .
working together properly . . . see the Thorens TD-224.
There's no other instrument like it in the world.

THORENS

If your dealer can not qualify for a Thorens Franchise – go to another one! ELPA MARKETING INDUSTRIES, INC., Dept. A-1, New Hyde Park, N. Y.

Very Low Voltage Relay Operation

Using d.c. to operate a low-voltage a.c. relay can save the day when the exact a.c. voltage is not available.

RONALD L. IVES*

IN A WIDE VARIETY of equipment, including high-fidelity installations, the need recurs for a method of controlling a remote device, such as an amplifier, from an input device, such as a tuner. This device must be simple, automatic, and trouble free. It should not be excessively costly, and it must be constructed of easily buyable components.

The common heat-reducing expedient of replacing a thermionic power rectifier by a solid-state rectifier, adopted by many audiofans, as well as by a large percentage of industrial equipment users, frees a five volt, two ampere transformer winding which was previously used to power the rectifier filaments. This is usually controlled by the power switch on the actuating device, and is completely isolated, electrically, from the power line.

Quite obviously, this can be used to control the remote device, the only needed components being the connecting line and a relay at the far end. This idea usually falls flat on its face when it is found that 5-volt a.c. relays are not standard, and require "120 days for delivery, on D. O." A 6-volt a.c. relay can sometimes be used, and occasionally works, but performance of most 6-volt relays on 5 volts less line drop is considerably less than satisfactory. In fact, a.c. relays in audio equipment are prone to give the user acute new algia, due to hum, buzz, leakage fields, and the difficulty of controlling flybacks.

All is not lost, however, for an a.c. relay will usually operate most satisfactorily on about one quarter its rated voltage, d.c. This means that a 6-volt a.c. relay needs only about 1.5 volts d.c. for satisfactory operation. Most happily, a 5-volt a.c. winding will produce much more than 1.5-volts d.c. when rectified and filtered.

From these basic facts, the circuit of *Fig.* 1 was developed. Constants found satisfactory are shown. If other components are used, some adjustment of values may be in order. None of the values are extremely critical, and ample margins of safety are allowed. Although the filtering is somewhat skimpy, relay operation is smooth and humless, in part because of the shading ring with which most a.c. relays are equipped. This shading ring, in conjunction with the 1000 μf. filter capacitor, effectively absorbs the flybacks occurring when the circuit is broken, so that relay operation does not produce a loud "blop" in the speaker.

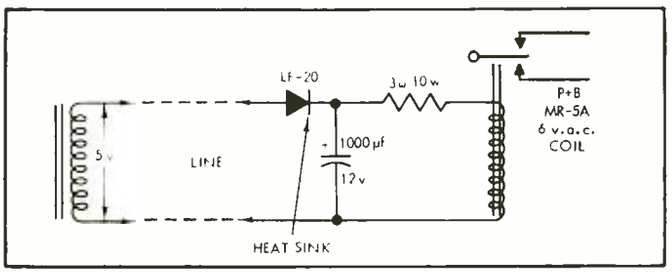


Fig. 1. Very low voltage relay circuit.

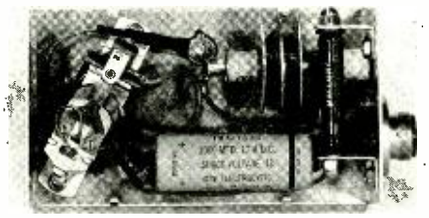


Fig. 2. Very low voltage relay assembly. Note heat sink on rectifier.

The filter capacitor is connected across both the relay coil and the dropping resistor, for maximum effectiveness. This is the optimum position because the energy storage of a capacitor ($Q = CE$) is highest at maximum voltage; and because the time constant of the circuit ($T = RC$) is at a maximum when resistance across the capacitor is highest.

Appearance of a working relay circuit, in which an a.c. relay is operated with the aid of a rectifier and filter, is shown in *Fig.* 2. Construction is simple and straightforward except for one important factor. In the manufacturer's catalog, the Sarkes-Tarzion type LF-20 rectifier here used is rated at 5 amps "with adequate heat sink." In this circuit, the rectifier will last about 20 minutes without a heat sink; and is still functioning perfectly, after more than two years of service, with the heat sink shown. This heat sink, which conducts heat away from the cathode of the rectifier, is made from three copper disks, each 1/16-in. thick and 1½-in. diameter, separated by ⅜-in. diameter brass spacers, ⅜-in. long. The whole is held together, and under tension, by the center screw, which also is the mounting screw. Anode connection to the rectifier is made with a ¼-in. vacuum tube grid cap.

The specific unit shown is an automatic antenna switch, which connects the antenna when the receiver is turned on. Similar units are used to automatically connect the speaker to the amplifier in use. As constructed and used, the relay assemblies will probably outlast the equipment with which they are used, and apparently need no maintenance, although the relay contacts are cleaned, as a matter of course, every six months. Æ

* *2075 Howard St., Palo Alto, Calif.*

Mr. Peter Pritchard, President and Chief Design Engineer, Audio Dynamics Corporation.

THIS IS NOT A REFINEMENT THIS IS AN INVENTION...

The Induced Magnet Transducer

Can a new magnetic cartridge be *that* different? The ADC Point Four Stereo Cartridge is. It embodies a concept sufficiently unique to establish a new type of playback head. We call the Point Four an "Induced Magnet Transducer". But that is not the only reason for putting it in a class by itself. We also believe it to be the most advanced cartridge available anywhere today.

Although there are many "magnetic" cartridges, the term embraces a wide variety of variable reluctance, moving coil, moving magnet, and moving iron designs. Each is a distinct type, with advantages and disadvantages unto itself. Much hard thinking has gone into ways of wedding the virtues while skirting the drawbacks. The result, in this case, was something more than the best balance of compromises and reconciliations. The "Induced Magnet Transducer," in achieving new and impressive goals, goes about the business of reaching them in its own way.

The cold specifications are here. Proof of what they mean is up to your own ears. Some of the points, however, to which we'd like to call special attention are the significantly reduced mass of the moving system, the optimum tracking angle of 15°, the extremely low distortion, and the high compliance.

As to the mass, let's remember that the first duty of the stylus is to track the shape of the recorded groove as accurately as possible. To the extent that it falls short here, we cannot have complete fidelity. Unfortunately, to finish its job, the stylus must also push a load that will ultimately produce an electrical signal. Whatever the load – it may be a magnet, a set of coils, or a bit of iron or steel – it has mass. And this mass must inhibit the freedom of the stylus to track the groove. Mass of the moving system in the Point Four is reduced to half or less that of systems previously regarded as low-mass designs.

How was this done? Consider the usual load on the stylus. Sometimes the cantilever or stylus arm is itself the heavy, steel armature that must be moved. Sometimes the arm is a desirably light, aluminum tube – which must nevertheless, in turn, move a heavy magnet or set of coils. The Point Four stylus is mounted at one end of the desired aluminum tube – but the other end extends into a light armature of soft, magnetically permeable, iron tubing.

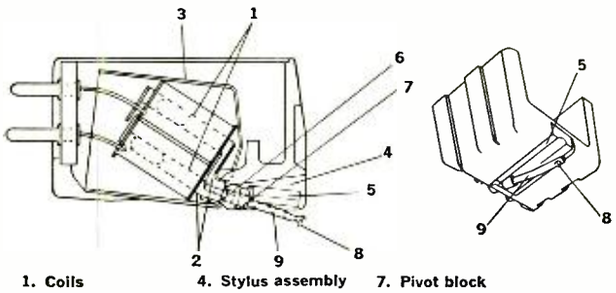
A heavy magnet is on the premises, but it has no physical connection with the moving system. It is completely outside the cartridge body. In fact, it is mounted on the easily replaceable stylus assembly, and positioned to induce high density of magnetic flux in the armature. The efficiency of this method actually assists in permitting armature weight to be reduced.

The end of the pivoted armature away from the stylus is near the pole pieces of the pickup coils, with the coils being well back into the cartridge. The remote position of the magnet with respect to the main structure, including the coils, ensures freedom from saturation and hysteresis distortion – serious effects that are beyond control by conventional shielding.

The physical configuration of the stylus assembly yields another important advantage. With the pivot point brought close to the record surface, obtaining the now established tracking angle of 15° is no problem. This requirement may seem simpler than it is, at first. But the pivot point of the stylus assembly is often high above the surface, because the assembly must move something well up into the "guts" of the cartridge. It is well understood that the most important factor in the tracking of a tone arm is the location of its pivot point. The analogy holds true for the pivot of a stylus arm, as well.

Its angle of vertical motion is not the only feature of the stylus. We use a nude diamond, which we grind and polish to a radius of .0004 inch. We have found this radius optimum for all modern recordings, both mono and stereo.

On the practical side, the stylus assembly is exceptionally easy and convenient to replace. The stylus itself is retractable to protect itself and your valuable records. As to the quality of the sound, we have already said that it is up to you and your ears. We can only hope that you try it with equipment that will do it justice.



1. Coils
2. Pole pieces
3. Mu-metal shield
4. Stylus assembly
5. Magnet
6. Armature
7. Pivot block
8. Stylus
9. Aluminum cantilever tube

ADC Point 4 Specifications

Type	Induced Magnet
Sensitivity	5 mv at 5.5 cm/sec recorded velocity
Channel Separation	30 db, 50 to 8,000 cps
Frequency Response	10 to 20,000 cps ±2 db
Stylus Tip Radius	.0004 inch
Vertical Tracking Angle	15°
Tracking Force Range	¾ to 1½ grams
IM Distortion	Less than 1%, 400 and 4,000 cps at 14.3 cm/sec velocity
Minimum Compliance Vertical and Horizontal	30 x 10^{-6} cm/dyne
Price	$50.00

ADC AUDIO DYNAMICS CORPORATION
PICKETT DISTRICT ROAD, NEW MILFORD, CONNECTICUT

Intermodulation Distortion—Pros, Cons, and Hows

MANNIE HOROWITZ*

Intermodulation distortion tests more closely approximate operating conditions of an amplifier than do harmonic distortion tests, and are thus more significant. Intermodulation tests have been standardized in practice although there are more stringent tests available.

THE NON-LINEAR characteristics of audio amplifiers are measured in various ways, the most common is to check the harmonic components. Unfortunately correlation between harmonic content and listening quality has been poor. Intermodulation distortion measurements are now used with the hope of better matching measurements with the subjective tests.

The test for intermodulation distortion is straight-forward. Two frequencies are simultaneously fed to an amplifier. If the amplifier is linear, only these two frequencies will appear at the output. If there is non-linear distortion, other frequencies will be present at the output of the amplifier, along with the two signals which comprise the input. The presence of newly created frequencies in a non-linear system can readily be determined from a mathematical analysis.

If vacuum tubes (or transistors) are driven into non-linear operation, the current at the plate (or collector) follows the well-known expansion

$$i = a_1 e + a_2 e^2 \qquad Eq.\ (1)$$

where i is the plate current, e is the signal voltage, and a_1 and a_2 are contants. Higher order terms in *Eq.* (1) (such as $a_3e^3 + a_4e^4 + a_5e^5 + \ldots$ etc.) have been omitted from the calculation. Although they may be significant in determining all components in the distortion, that exact an analysis is not required here. *Equation* (1) is sufficient to calculate the type of frequencies present in a non-linear amplifier, when two signals, E_1 and E_2, are fed simultaneously to such a device.

Denote the sinusoidal signals fed simultaneously to an amplifier by the equation

$$e = E_1 \cos \omega_1 t + E_2 \cos \omega_2 t \qquad Eq.\ (2)$$

where E_1 and E_2 are the peak voltage of signal 1 and signal 2 respectively. ω_1 and ω_2 are the frequencies of each of these signals. Squaring *Eq.* (2) gives

$$e^2 = E_1^2 \cos^2 \omega_1 t + E_2^2 \cos^2 \omega_2 t + 2E_1E_2 \cos \omega_1 t \cos \omega_2 t \qquad Eq.\ (3)$$

Substituting *Eq.* (2) and (3) into equation *Eq.* (1), shows i to be

$$i = a_1(E_1 \cos \omega_1 t + E_2 \cos \omega_2 t) + a_2(E_1^2 \cos^2 \omega_1 t + E_2^2 \cos^2 \omega_2 t + 2E_1E_2 \cos \omega_1 t \cos \omega_2 t) \qquad Eq.\ (4)$$

From trigonometry, it can be shown that

$$\cos^2 \omega t = \tfrac{1}{2} + \tfrac{1}{2} \cos 2\omega t \qquad Eq.\ (5)$$

It can also be shown that

$$\cos(\omega_1 t + \omega_2 t) = \cos \omega_1 t \cos \omega_2 t - \sin \omega_1 t \sin \omega_2 t \qquad Eq.\ (6)$$

and

$$\cos(\omega_1 t + \omega_2 t) = \cos \omega_1 t \cos \omega_2 t + \sin \omega_1 t \sin \omega_2 t \qquad Eq.\ (7)$$

Adding *Eq.* (6) and (7), results in

$$\cos(\omega_1 + \omega_2)t + \cos(\omega_1 - \omega_2)t = 2 \cos \omega_1 t \cos \omega_2 t \qquad Eq.\ (8)$$

Now, substitute *Eq.* (5) and (8) into (4).

$$i = a_1(E_1 \cos \omega_1 t + E_2 \cos \omega_2 t) + a_2[E_1^2(\tfrac{1}{2} + \tfrac{1}{2} \cos 2\omega_1 t) + E_2^2(\tfrac{1}{2} + \tfrac{1}{2} \cos 2\omega_2 t) + E_1E_2(\cos(\omega_1 + \omega_2)t + \cos(\omega_1 - \omega_2)t)] \qquad Eq.\ (9)$$

From *Eq.* (9), it is possible to find some of the frequencies present when there is square law non-linearity. ω_1 and ω_2 are the fundamental frequencies which appear at the output as well as the input, $2\omega_1$ and $2\omega_2$ are harmonics of these frequencies. $(\omega_1 + \omega_2)$ and $(\omega_1 - \omega_2)$ are the sum and difference components of these frequencies. If the higher order terms had been considered in *Eq.* (1), more combinations of sum and difference frequencies would be present in the final equation.

This might give us a clue as to why IM tests correlate better with listening tests than do harmonic distortion measurements.

Harmonics are present in music fed to an amplifier. The added harmonics produced by an amplifier will therefore be masked somewhat by the music. They may not be noticeable to the listener and hence will not be considered too objectionable.

But if IM distortion is significant, sum $(\omega_1 + \omega_2)$ and difference $(\omega_1 - \omega_2)$ frequencies of two musical notes will be created in the amplifier. These frequencies will tend to be more noticeable, even at low levels of distortion.

Whatever the true explanation for the correlation may be, one thing is certain: The correlation is there.

Types of Tests

A large variety of tests are possible to measure IM. Two are used in various phases of the audio industry. One of these has been adopted by most hi-fi manufacturers.

The first, recommended by the Society of Motion Picture and Television Engineers (known as the SMPTE method) is used as a standard by much of the hi-fi industry. This method specifies that

*EICO Electronic Instr. Co., Inc., 131-01 39th Ave., Flushing, N. Y.

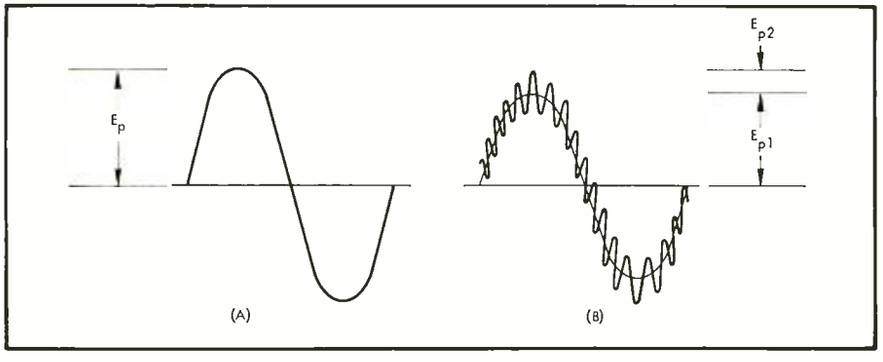


Fig. 1. Sinusoidal signal, (A), and sinsoidal signals mixed at a ratio of 4:1, (B).

NEW ALL-TRANSISTOR FOR PLAYBACK® PERFECTION

Transistors have changed the idea that old-fashioned vacuum-tube amplifiers could not be appreciably improved. First proof of what transistors could really do came to us five years ago when we applied solid state circuitry to specialized amplifiers for the telephone industry, the military, and other commercial and professional users. This early experience taught us that transistors had a revolution in store for future amplifier development; it was only a matter of time and a great deal of experimentation before we could make a more truly perfect amplifier available for studio PLAYBACK and serious home use.

Three years ago, at a time when most amplifiers were of the vacuum-tube type, we marketed our first all-transistor power amplifier for PLAYBACK applications. Today, the 351B model is credited as the most advanced single-channel amplifier of its type in the professional field. Shortly after the 351, we introduced the now famous 708A "Astro"—the only all-in-one stereo center with all-transistor power output stages. Now, after five years of actual production experience with solid state circuitry, we take pride in introducing the 360A all-transistor stereo pre/power amplifier . . . for PLAYBACK perfection.

WANT TO HEAR THE SOUND OF PLAYBACK PERFECTION?

That question contains a strong claim, but one that we have seen substantiated time and again during the many listening tests performed on the new solid-state Altec 360A Royale II stereo amplifier/preamplifier. In fact, the difference in perfection between this unit and even the finest vacuum tube amplifier is amazingly apparent. The lowest frequencies are unbelievably solid and life-like; snare drums sound like snare drums, an organ is an organ (you almost look for the pipes). Transient distortion, background hiss, and microphonics are conspicuous by their absence. Hum is so completely inaudible, even at loudest volumes, that we conclude there just isn't any. The highs are crisp, clean, transparent; for the first time, you hear a piccolo in complete purity because the amplifier does not contain, and does not need, a built-in bass boost for the lower end.

In short, the 360A is so far more perfect than the finest tube amplifier, we predict that others will hastily experiment and a rash of transistorized amplifiers will follow. But at Altec, experimentation is over! Five years of transistor amplifier production have literally put the 360A five years ahead of the home music field.

But no amount of words on paper can relate the somewhat startling audio revelation we had when we first listened to the 360A. The sound of perfection is not easy to describe. May we suggest a trip to your nearest Altec Distributor for a personal evaluation of this thing we call "transistor sound" (or perfection if you will).

NEW IN APPEARANCE, TOO!

The 360A is the first "keyboard" amplifier. Named for its unique musical-instrument type front panel keyboard control arrangement, the 360A offers operating convenience at one central front panel location, eliminating the universal objection to a miscellany of switches.

POWER • 70 watts (IHFM); 35 watts per channel.

INPUTS • 12, stereo or mono: magnetic or ceramic phono, tape head, stereo microphones, tape, radio, auxiliary.

OUTPUTS • 7, stereo or mono: left, right and center speaker outputs, left and right channel recorder outputs, center channel voltage output for auxiliary amplifier, headphone output jack.

KEYBOARD CONTROLS • Rumble filter, stereo-mono switch, tape monitor, channel reverse, hi-low gain, volume contour, scratch filter, phase reverse, headphone-speaker output switch.

OTHER FRONT PANEL CONTROLS • Input selector, channel reverse, independent bass and treble controls (friction coupled), blend control, balance control, volume control.

REAR PANEL CONTROLS • Magnetic-ceramic phono input selector, speaker impedence selector.

PRICE • $366.00 including cabinet. Only 5½" H, 15" W, 11¼" D.

SPECIAL FEATURES • Automatic reset circuit breakers for over-current protection of each channel and AC line. Diffused keyboard illumination plus daylight power indicator. Both headset and speaker monitoring for tape recording on front panel. Variable crossover type bass tone control for bass boost independent of mid-range.

PERFECT PARTNERS

FAVORITE OF BROADCASTERS
The 314A Emperor Royale FM Multiplex Tuner.

For FM stereo that will do justice to the Royale II, the 314A Emperor Royale FM Multiplex tuner is the answer. The 314A is a fully professional component which is offered in the Altec PLAYBACK catalog for network relay and rebroadcast applications. Among its distinctive features is a monophonic output for feeding a 351B all-transistor power amplifier for single-channel music distribution througout the home. Price: $359.00, including cabinet.

Hear Altec's complete line of genuine studio PLAYBACK components soon at your nearest Altec Distributor (see your Yellow Pages).

Also, be sure to ask for your courtesy copy of the Altec Catalog," PLAYBACK and Speech Input Equipment for Recording and Broadcast Studios," which illustrates how the big name record companies and broadcast networks use Altec equipment to achieve PLAYBACK perfection. Or, write for your free copy to Dept. A-1.

ALTEC® LANSING CORPORATION

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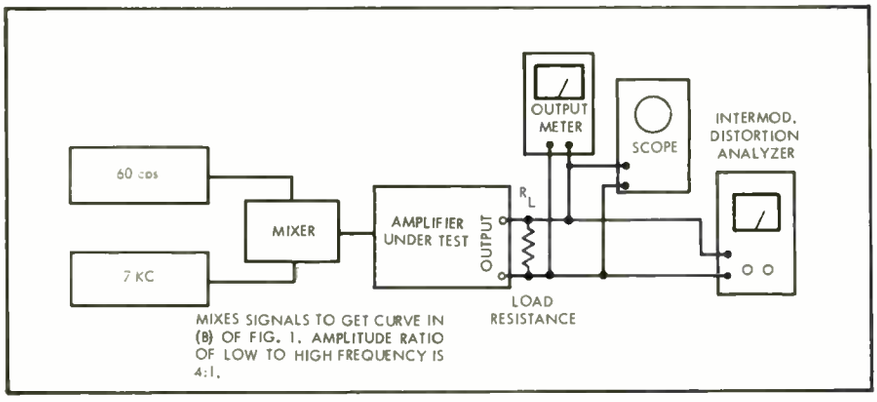


Fig. 2. Test setup for measuring IM distortion.

one low frequency (between 40 and 400 cps) and one high frequency (between 1000 and 12,000 cps) be fed simultaneously to the amplifier under test.

Stringent test methods require that the higher frequency be half the upper frequency limit of the amplifier and the lower frequency be the low-frequency limit of the amplifier. A second test would be performed using the same upper frequency with 100 cps as the lower frequency. However, the industry has more or less settled on one test only, usually using 60 and 7000 cps.

The ratio of the amplitudes of the lower to the upper frequency is 4:1, or a difference of 12 db. The output from the generator appears somewhat as shown in (B) of *Fig.* 1.

The sidebands generated using this type of test can be determined from *Eq.* (9). One pair of sidebands is at frequencies $(\omega_1+\omega_2)$ and $(\omega_1-\omega_2)$. Call the amplitudes of these sidebands A_A and A_B respectively. Another pair of possible sidebands is $(\omega_1+2\omega_2)$ and $(\omega_1-2\omega_2)$. Refer to the amplitudes of these frequencies A_C and A_D respectively. It would be possible to determine additional sidebands from *Eq.* (1), if more terms, such as a_3e^3, a_4e^4, and so on, were included in the analysis.

If the relative amplitudes of individual sidebands can be measured on an harmonic analyzer, the percentage of intermodulation distortion can be determined from *Eq.* (10). E_2 is the amplitude of the higher frequency fed to the unit under test.

$$\left(\frac{(A_A+_B)^2+(A_C+A_D)^2+\ldots}{E_2^2}\right)^{\frac{1}{2}}100\% \qquad Eq.\ (10)$$

The SMPTE method indicates what effect low-frequency non-linearity has on a high frequency. The second, or CCIF (International Telephonic Consultive Committee) method, is used to check the other end of the band.

In this latter method, two high frequencies of identical amplitude, are fed to an amplifier. If distortion is present, sum and difference frequencies are formed. The difference frequency is considered most indicative of distasteful distortion, so that the percentage distortion using this method, can be determined from:

$$\frac{Amplitude\ of\ difference\ frequency}{sum\ of\ amplitudes\ of\ two\ test\ signals}\times 100\% \qquad Eq.\ (11)$$

Once again, an harmonic analyzer can be used to determine the relative amplitudes of the various components.

If the two high frequencies are distorted, the generated low frequency will indicate the amount of distortion present. All portions of the high frequency end of the spectrum can be checked simply by shifting (in frequency, not amplitude) the two test frequencies while maintaining a constant difference frequency. An increase in amplitude of this difference frequency indicates just where the amplifier under test fails.

Each method provides significant results. It is impossible to pinpoint one method as more indicative of quality than the other. The SMPTE method will be discussed in detail only because it has become more widely used and not because of any apparent superiority.

SMPTE

A test setup used to measure IM distortion is shown in *Fig.* 2. The output from the amplifier is connected across an *accurate* load resistor, R_L. If the output is sinusoidal, the power, W, delivered by the amplifier is determined by measuring the rms voltage, E, with the output meter. The power may then be calculated from

$$W=E^2/R_L \qquad Eq.\ (12)$$

The peak voltage is E_p. The rms value of this, E, is $E_p/\sqrt{2}$. The rms voltage across the resistive load, R_L, is used to determine the amount of power dissipated in the load. Making use of *Eq.* (12), and letting $E=E_p/\sqrt{2}$ and $E^2=E_p^2/2$, the power due to the sine wave in (A) of *Fig.* 1 is

$$W=(E_p^2/2)(1/R_L) \qquad Eq.\ (13)$$

In order to measure IM distortion, a signal similar in form to that of (B) in *Fig.* 1 must be fed to the amplifier. The peak voltage at the output of the amplifier must be identical to that of E_p in (A), if the IM test is to be made at the equivalent level as was the harmonic distortion test described in a previous article. This is necessary to maintain identical voltage swing in the amplifier in both cases.

To produce this condition, from *Fig.* 1,

$$E_p=E_{p1}+E_{p2} \qquad Eq.\ (14)$$

where E_p is the peak amplitude of the sine wave signal in (A) of *Fig.* 1; E_{p1} is the peak amplitude of the low-frequency signal and E_{p2} is the peak amplitude of the high-frequency signal. E_{p1} and E_{p2} are both used in the IM tests.

When a peak-to-peak type of output meter is used, the required output level can be found quite easily. The peak-to-peak levels are identical in both the sinusoidal and modulated cases.

For example, assume you wish to measure the IM distortion at an output level of 25 watts, and the load resistor, R_L, is 16 ohms. If a pure sine wave were fed to the amplifier, the rms voltage across the 16-ohm load resistor must be, from *Eq.* (12):

$$E_{rms}^2=R_LW=16(25)=400 \text{ volts}$$

and

$$E_{rms}=20 \text{ volts.}$$

The peak voltage is $E_p=\sqrt{2}E_{rms}=\sqrt{2}(20)=28.2$. A peak-to-peak reading meter will read double this or 56.4 volts.

To measure IM at this level, the peak-to-peak signal must also be 56.4 volts, and can be read directly on the peak-to-peak scale of the output meter.

Although the peak-to-peak output voltages in the sinusoidal and modulated signal cases are identical, the power delivered to the load is different in both instances. This is shown in the following analysis.

The voltages in the modulated cases are related by the ratio of 4:1. If E_{p1} is the peak voltage of the low-frequency signal and E_{p2} is the peak voltage of the high-frequency signal.

$$E_{p1}=4E_{p2} \qquad Eq.\ (15)$$

Substituting this into *Eq.* (14) yields

$$E_p=4E_{p2}+E_{p2}=5E_{p2}$$

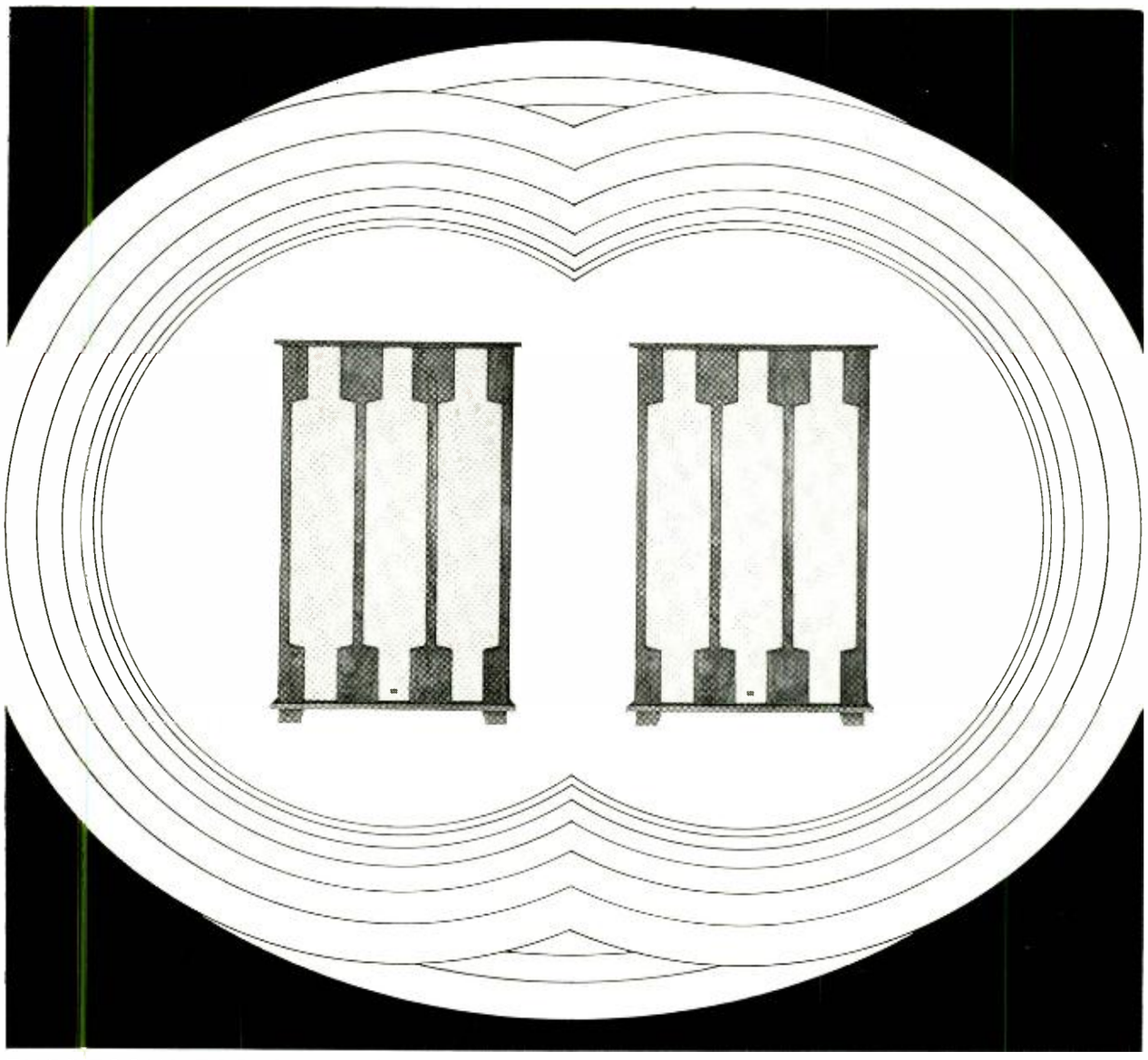
or $$E_{p2}=E_p/5 \qquad Eq.\ (16)$$

but $$E_{p1}=4E_{p2}$$

therefore $$E_{p1}=4E_p/5 \qquad Eq.\ (17)$$

To find the power contributed by each of these voltages, E_{p1} and E_{p2}, across the load resistor, R_L, the peak voltages must be converted to rms values. This is easily accomplished by dividing each of these by $\sqrt{2}$, or, from *Eq.* (17),

$$E_{rms1}=\frac{E_{p1}}{\sqrt{2}}=\left(\frac{4}{5}\right)\frac{E_p}{\sqrt{2}} \qquad Eq.\ (18)$$



EXPRESSLY FOR STEREO

Symphony No. 1

The music is spacious, transparent, alive with detail in proper perspective — utterly faithful to the texture and dynamics of the original, as you expect from Bozak speakers. The B-4000, distinctively styled in mahogany or walnut, is surprisingly small for such big music. A pair are unobtrusive in even a modest living room. They are also available in kit form. Ask your Franchised Bozak Dealer, or write for catalog.

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and from *Eq.* (16),

$$E_{rms2} = \frac{E_{p2}}{\sqrt{2}} = \left(\frac{1}{5}\right)\frac{E_p}{\sqrt{2}} \quad Eq. \ (19)$$

The power delivered by E_{rms1} is, from *Eq.* (12) and (18)

$$W_1 = \frac{E^2_{rms1}}{R_L} = \left(\frac{16}{25}\right)\frac{E_p^2}{2}\left(\frac{1}{R_L}\right) \quad Eq. \ (20)$$

and the power delivered by E_{rms2} is, from *Eq.* (12) and (19)

$$W_2 = \frac{E^2_{rms2}}{R_L} = \left(\frac{1}{25}\right)\frac{E_p^2}{2}\left(\frac{1}{R_L}\right) \quad Eq. \ (21)$$

The total power delivered to the load, R_L, is the sum of these two individual values, or

$$W_1 + W_2 = \left(\frac{17}{25}\right)\frac{E_p^2}{2}\left(\frac{1}{R_L}\right) \quad Eq. \ (22)$$

Substituting *Eq.* (13) into (22) we get

$$W_1 + W_2 = (17/25)\,W_p \quad Eq. \ (23)$$

Thus the power delivered to the load during an IM test is 17/25 the power delivered during the sinusoidal harmonic distortion test, if both tests are to be conducted under identical voltage swing conditions. This is known as the equivalent sine wave power. 17/25 is an important number to remember.

If the output meter responds to rms values of the waveshapes rather than peaks, the power at the output can be calculated using *Eq.* 23. Power is a function of the rms voltage developed across the load resistor. An rms measuring voltmeter indicates (by calculation) the power that is across the load. If the meter reads the signal drawn in (B) of *Fig.* 1, the equivalent sine wave power is 25/17 the power calculated from the meter reading.

The procedure for setting the output level can now be accomplished as follows. The previous numbers will be used in this example.

1. Assume you wish to measure the distortion at the equivalent of 25 watts sinusoidal output. The equivalent sine wave power of the IM signal is 17/25 of 25 watts, or 17 watts. This is determined from *Eq.* (23).

2. If the load resistor, R_L, is 16 ohms, the voltage across it for 17 watts output is $V_{rms} = \sqrt{WR} = \sqrt{(17)(16)} = 16.45$ volts.

3. Adjust the input so that the rms-measuring output meter will show 16.45 volts. This is 25 watts of equivalent sine wave power. Measure the IM distortion at this level.

Little error would be introduced if an average measuring meter were to replace the rms measuring meter. In either case, the rms scale should be used for the reading.

Use the IM analyzer in accordance with the instructions supplied by the manufacturer of your particular instrument. On most instruments, the INPUT signal to the amplifier under test and the analyzer are mounted on one common chassis. There is a common ground between the input and output. This can lead to complications.

On some stereo amplifiers, the 4-ohm tap on the output transformer is connected to ground. The ground at the input and the common ground at the output of these amplifiers, must be isolated from each other to permit the IM test. An isolation transformer must be used at the output of the amplifier, as shown in *Fig.* 3. The transformer should have at least double the power capabilities of the amplifier under test and should have a 1:1 turns ratio.

Preamplifiers

The circuit shown in *Fig.* 2 can be used to measure distortion in preamplifiers as well as power amplifiers, although, when testing preamplifiers, the load resistor, R_L, must be omitted from the setup.

The 17/25 fraction is no longer valid, for it is not power that is of prime concern here but solely voltage. The usual convention is to rate the IM of a preamplifier at levels determined by an output reading on an average or rms measuring instrument.

The 4:1 ratio of signal amplitudes fed to the power amplifier can also be applied to the low gain section of the preamplifier, for the gain is relatively uniform over the entire audio spectrum. The percentage distortion can be read as in the power amplifier case.

But how should equalized stages be measured?

No convention has been established to measure distortion originating in this section. I will thus suggest a method which seems the most logical to me. The following considerations must be noted.

If the ordinary 4:1 mixed signals were fed to an equalized preamplifier, the high-frequency sideband components would usually be attenuated and the low frequencies emphasized. Besides, this type of signal mixture at the input to an equalized playback stage is not usual.

Assume a complete recording system were under test. Two signals at a 4:1 ratio would have been fed to the recording preamplifier and recorded on a disc or tape. When played back, the ratio of these two signals at the output of a properly equalized preamplifier, would still be 4:1; but there would also be the additional components produced due to IM distortion. The measured IM would be the total distortion from all factors—the record preamplifier, the recording medium (disc or tape), and the playback preamplifier.

We are interested only in the distortion due to the playback preamplifier itself. To be representative, the output from the preamplifier should consist primarily of the signals at the 4:1 ratio. The signals from the distortion analyzer should be mixed in the proper proportion and fed to the preamplifier so that this ratio will be maintained at the *output*. IM components due to the nonlinearity of the preamplifier can then be measured in the conventional manner.

The following procedure may be used to perform this test.

1. Feed the lower of the two frequencies into the preamplifier. Adjust the level control on the generator to read 1 volt on the output meter.

2. Remove the lower frequency and feed the upper frequency to the preamplifier. This time, adjust the level control on the second generator for an output reading of 0.25 volts.

3. Now, mix the two signals and feed them together to the preamplifier. Adjust the combined signal level controls so that the meter at the output indicates the voltage at which the distortion measurement is required.

4. Read the percentage distortion as usual.

Although many people measure distortion by simply feeding two signals with a 4:1 ratio to the input of the preamplifier, the above procedure will probably provide a more valid reading. Æ

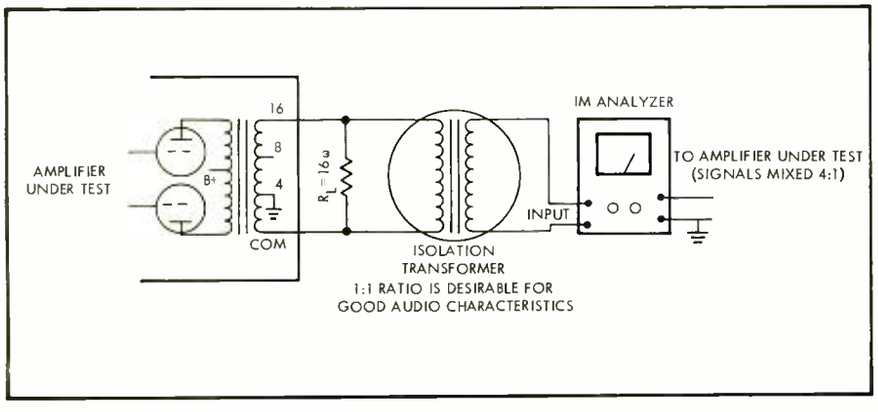
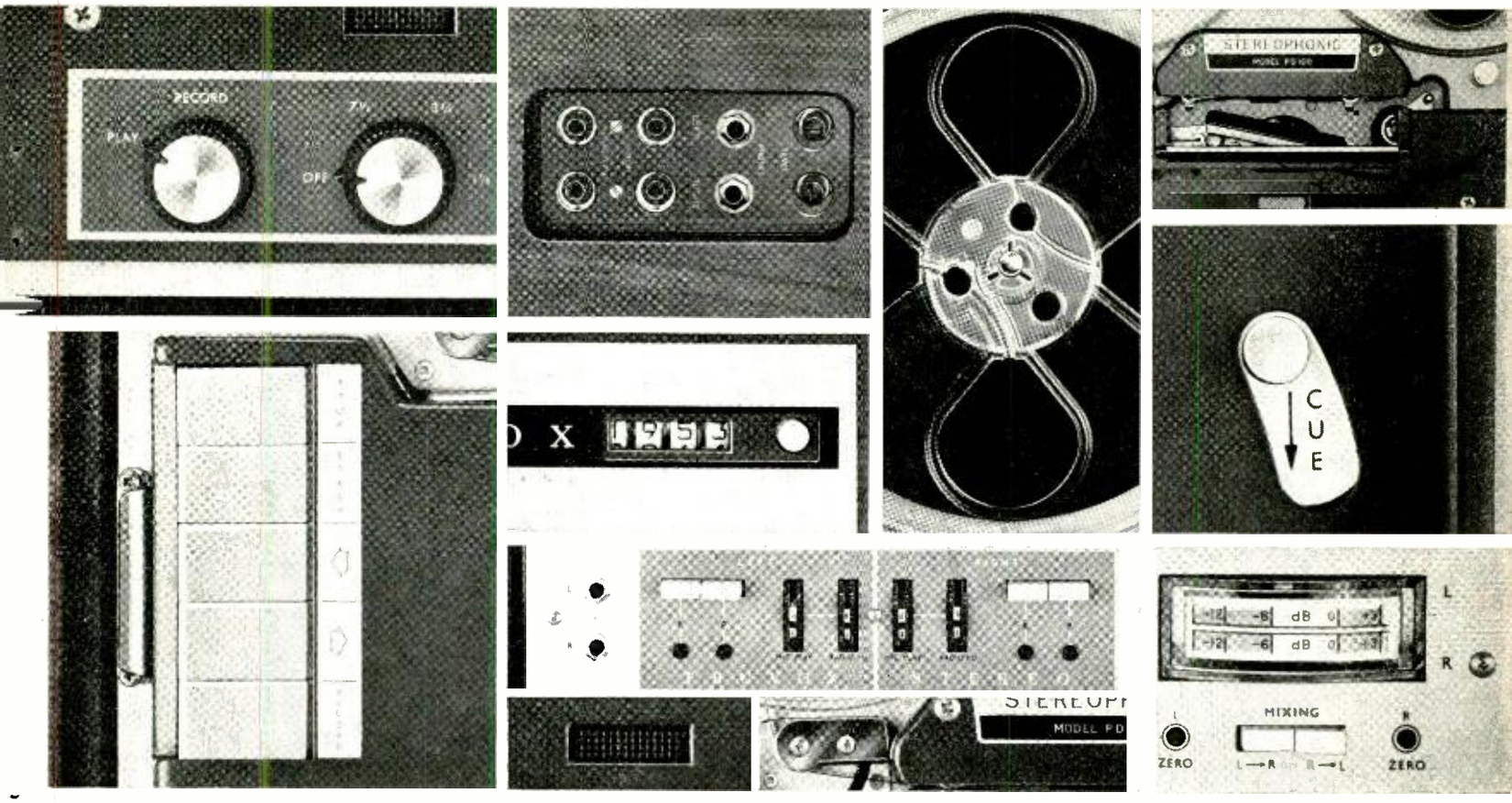
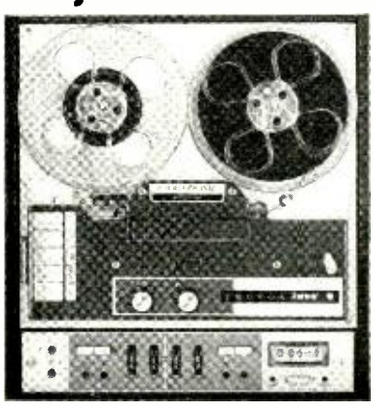


Fig. 3. Isolation transformer used when common tap of output transformer is not grounded.

the one outstanding feature is that it has them all



New Benjamin-Truvox PD-100



The Truvox PD-100 is a new 4-track, stereo tape deck with built-in 'record', 'playback' and 'monitor' preamplifiers. It is so complete in every detail, no one feature or facility can be said to dominate. It has them *all*. A remarkable example of British thoroughness in audio equipment design!

Whether you judge this unit by these features or by the quality of its performance, there is only one conclusion you will reach: *the PD-100 stands squarely with the finest professional tape units available today.*

features: □ operates vertically or horizontally □ 3 speeds: 7½, 3¾ and 1⅞ ips □ 3 heads: 'erase', 'record', and 'playback' □ 3 motors: including Papst 'squirrel-cage' motor for capstan drive □ 6½-inch capstan flywheel □ 'record-playback' preamps with cathode-follower outputs □ transistor preamps for monitoring 'record' quality with low-impedance headphones directly from tape. □ 2 VU db-calibrated meters □ 4-digit counter with automatic zero-reset button □ stop-start' cueing button □ self-adjusting instantaneous 'stop' brakes □ hinged-cover giving access to tape heads with convenient splicing guide-plate built in □ automatic end-of-play and tape-break 'shut-off' □ patented 'hubloc' spindles hold reels securely when operated vertically □ function signal lights.

recording versatility: □ off-the-air tapes of FM-multiplex, mono radio or TV programs □ stereo and mono tapes from your favorite records for unlimited playback without wear to your records and stylus □ sound-on-sound □ echo, fade and mixed input effects.

and here are some hints of the quality you can expect: □ frequency response: 30 to 20,000 cycles at 7½ ips; 30 to 12,000 at 3¾; and 50 to 8,000 at 1⅞; ±3 db □ wow and flutter: less than 0.1% at 7½ ips; 0.15% at 3¾; and 0.25% at 1⅞. □ signal/noise ratio: better than 50 db □ channel separation: better than 55 db

Dimensions of the PD-100: 14¼" wide x 15⅞" deep x 7" high. Price is $399.50 (less base). At your high fidelity dealer, or write:

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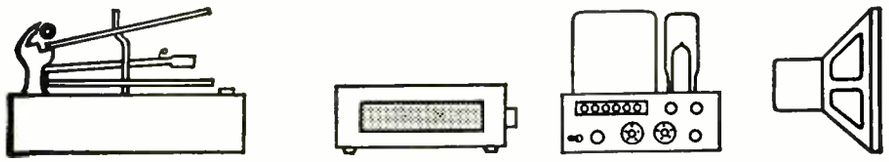


STANTON STEREOTABLE SYSTEM, MODEL 800B

The Stanton Model 800B is a single-speed turntable combined with the Model 200 stereo tone arm, an arm which will accommodate all modern cartridges.

Simple statements, but they cover a number of fresh solutions to old problems.

At first glance (see *Fig.* 1.), it would seem that we are examining a fairly conventional turntable and a highly un-conventional tone arm. Don't let appearances deceive you—you are looking at one of the most extraordinary turntable suspensions we have ever seen. Rather you would be looking at it if you lifted the platter.

You see, the turntable platter is literally riding on air, or, more precisely, on a magnetic field. We'll go into the benefits of this suspension later but it certainly lifts the Stanton 800B out of the ordinary category.

And don't forget that unconventional appearing arm; it is as unusual as it appears.

Let's look at the arm and turntable more closely:

The Model 800B Turntable

Looking at *Fig.* 2 we see that the platter and arm are part of the same structure so that they are held in firm and fixed relation to each other, an obviously desirable condition. We can also see that the platter-arm structure rests on the motor-mounting board by means of rubber balls (those thick-walled circles on the diagram). Thus the arm-platter structure is acoustically isolated from the motor and the base so that all unwanted vibrations (including rumble) are prevented from reaching these two critical areas. The platter is isolated even further because of the magnetic suspension.

The magnetic suspension essentially consists of two flat circular magnets which are magnetized in such a way so that their force fields are vertical. One of the magnets surrounds the bearing well and the other is on the underside of the platter surrounding the shaft. The magnets are polarized so that they repel each other, and their force field is sufficiently strong to keep the platter "riding on air."

Thus the platter makes no mechanical contact with the rest of the structure; the shaft is used only to guide rotational motion. One advantage is obvious: no contact, no wear. A less obvious advantage is the additional damping-out of unwanted vibrations which have succeeded in getting by the rubber ball; certainly this type of suspension will not pass vertical vibrations as easily as a solid bearing. Frankly we were quite intrigued with the whole concept.

Are there any disadvantages to this suspension system? The only possible one we could think of was the introduction of a magnetic field near the record-playing surface, and the potential hum pickup by the cartridge. In fact we found no hum-induction whatsoever, which is what one may expect considering the central location of the magnet.

The platter is driven by a soft idler wheel which engages the motor capstan and the platter when the rectangular metal knob at the left-front of the turntable is pushed towards the right. Pushing the knob also turns on the power to the motor. By the way, the idler is also mounted on a flexible suspension so that it minimizes transmission of unwanted vibrations to the platter. The motor is a four-pole synchronous unit with enough power to get the platter to speed quite fast.

One detail which we just love is the removable arm-mounting board. The *instantly* removable arm-mounting board. Of course, not everybody needs to interchange tone arms as frequently as we do, but many people do have occasional need. Anyhow, that arm board is held in place by another one of those flat circular magnets, only in this case there is attraction rather than repulsion. So, all you have to do is pull up hard enough to overcome the attraction (not *too* hard), unplug the connectors, and put a new arm board and arm in position (two guide pins locate the board accurately each time).

Oh yes, the entire turntable, base, and arm measure 15⅞-in. wide, 12⅞-in. deep, and only 6½-in. high. A compact and handsome package.

Fig. 1. The Stanton Stereotable System, Model 800B.

The Model 200 Tone Arm

Previously we noted the unconventional appearance of the tone arm. We were not referring to styling, although it is quite different from the usual arm in appearance. We were referring to the obvious lack of base structure. The usual arm sports a fairly hefty base to contain the vertical and horizontal pivot bearings, the exact size and layout varying with the type of pivots and/or bearings used.

But the Stanton 200 stands on a shaft which is about ⅛-in. in diameter, hardly enough to conceal bearings of almost any persuasion. Of course the secret is revealed in the name assigned to it by Stanton: "Unipoise."

The arm is supported by a *single* pivot for both lateral and vertical motion. That pivot is not sharp, but rather seems to be perfectly spherical, sort of like the tip of a ball-point pen. This ball point mates with a similarly spherical, but larger radius, surface inside that white plastic shape towards the rear of the arm. In a way, it appears similar to a giant stylus in a giant record groove, except that the groove is upside down. Doesn't act the same way, but it does help visualize what it looks like.

That single pivot naturally is the *pièce de resistance* of the Stanton 200, but there are other interesting ideas. For instance, consider that piece of white plastic that rises from the rear of the cartridge shell. Obviously a finger lift. Yes, but you get the idea fast as soon as you put your finger to it to place the arm. Its shape and location make it natural to apply pressure against it, and somehow this makes it very easy to place the cartridge on the record gently and exactly where you want it. Obviously somebody gave a lot of creative thought to that simple device. In fact, the entire arm and turntable are examples of the highest level of creative engineering: The designer did not merely take a standard design and refine it, he actually found new solutions to many of the problems.

The arm is balanced both laterally and vertically: vertically by the large weight at the rear of the arm and laterally by a small adjustable weight visible on the side of the vertical counterweight. Stylus force is set by means of a sliding weight on the forward part of the arm, calibrated up to 3 grams.

Performance

It seems almost anticlimactic to say that the performance of the Stanton 800B turntable is excellent; one would hardly expect less as a result of the fine engineering it embodies.

Excellent in this case means rumble down 43 db, total wow and flutter less than 0.15 per cent, speed accurate and stable

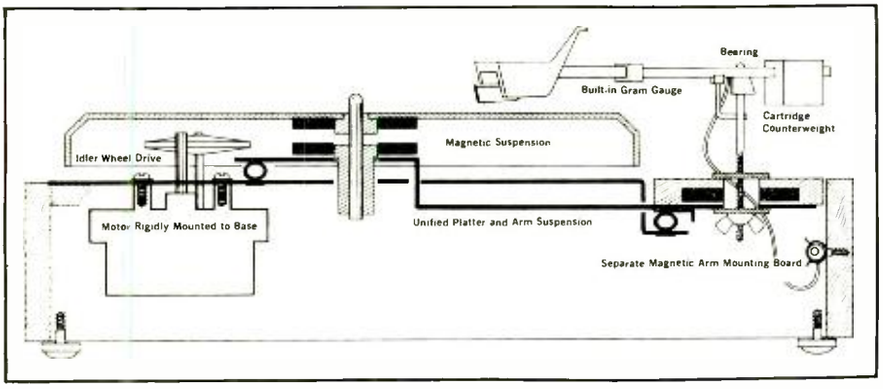


Fig. 2. Drawing showing the details of the 800B.

with a line-voltage variation of 10 per cent.

The tone arm exhibited no serious resonances down to 10 cps, the limit of our test record, and could track well with a stylus force of 1 gram, although we used a force of 1.5 grams for the complete series of tests. (We should mention that the cartridge we used, and found to be quite excellent in this system, was the Stanton 481AA. We'll report more specifically on this cartridge in the near future.)

For those interested in an unusually fine turntable system designed to perform at top level for a long, long time, we recommend investigating the Stanton 800B system. A-15

H. H. SCOTT FM-STEREO TUNER-AMPLIFIER, MODEL 340-B

Without question, the 340-B is a radically new styling concept for H. H. Scott. Gone is the familiar circular tuning dial which was truly a trademark for so many years. In a way we hate to see any change that reminds of the passing years. On the other hand, we must admit that we like the new styling much better than the old; it looks as if it would go well in that expensive and elegant cabinet in the living room. In any case its a daring thing for a manufacturer to radically change a characteristic which has won recognition in the past. We think they deserve credit both for doing it and for succeeding.

Now let us look at the instrument as a tuner-amplifier. The 340-B contains on one chassis an FM-stereo tuner, a 70-watt (IHF) stereo amplifier, and a complete audio control center. From a circuitry standpoint, it would seem to be a Scott 350C tuner and 299D amplifier on one chassis.

Sounds simple enough. Just have to get a big enough chassis, and there we are. But wait a minute, why use two power supplies? Certainly would be more efficient to use one supply for both. Hold on again, if we used a chassis that big would it fit into most modern furniture? Probably not so it would be better to lay out the circuit more compactly. And what about heat? If the amplifier and tuner are brought into intimate contact aren't we going to have heat from the amplifier affecting the tuner? Possibly, so it would be better . . .

The point is quite obvious; a tuner-amplifier is a new design problem, even if the circuitry is exactly the same as the separate tuner and amplifier.

Does that mean that a tuner-amplifier cannot perform as well as its equivalent individual components? Absolutely not! It merely means that one has to engineer them to work together. In fact the proof of the pudding is the performance specifications. Not only does the 340-B measure as well as the 350-C, for instance, but it also includes automatic stereo switching with an indicator light. And, wonder of wonders, the 340-B costs slightly less than equivalent separate components. Probably the result of savings in production, packaging, and shipping.

A delightful feature of the 340-B is its built-in thinking circuit: in the Automatic Stereo position, the 340-B detects the presence of an FM-stereo broadcast and automatically does all the internal switching necessary to process a stereo signal; if the FM signal is mono, it sets itself to deliver a mono signal to the speakers. When it sets itself to stereo, the 340-B graciously lights an indicator lamp to inform us mere mortals what it has done. Now if they would only include a circuit to start the coffee pot . . .

Another unique feature is the special balancing circuitry which permits balancing the speaker systems with any kind of program material, mono or stereo. One need only switch between the Bal-R and Bal-L positions on the Selector switch, and listen for equal loudness from both speakers. If they are not equal one rotates the balance control until they are. Simple and effective.

Now let's look at the individual sections of the 340-B:

The Tuner

The r.f., i.f., and detector sections are well-known Scott circuits, clearly related to the long line of Scott tuners. The r.f. section uses two triodes (6BS8/6BQ7A twin triode) in a cascode configuration, followed by a 6U8 oscillator-mixer. The entire front end assembly, including the first i.f. transformer, is a sub-assembly familiar to those who have seen Scott tuners in the past; it has achieved recognition as the "silver-plated" front end. Following this are two i.f. amplifier stages employing 6AU6A tubes. The signal-strength meter is located at this juncture, before the signal proceeds to the limiter stage (a 6HS6). From the limiter the signal goes to the wideband ratio detector. As we said before, this part is really quite similar, if not identical, to the Scott 350C. Indeed, the multiplex circuitry is also identical. The major area of difference is the automatic switching with the indicator light. The automatic switching is completely electronic so that it is quiet as can be. It's not fooled by random noise either as some of the early stereo indicator circuits were. Except for the set warmup time, we found that the indicator very rarely would be triggered by anything but a stereo broadcast.

The final processes in the tuner section are to amplify and de-emphasize the audio signal. Now, on to the amplifier section:

The Amplifier

As we indicated previously, the amplifier is rated at 35-watts per channel music power, and 30-watts per channel steady state. The output stage used to achieve this is a pair of 7591 pentodes in push-pull with 450 volts on the plates, and 430 volts on the screens. Well-filtered d.c. is provided for biasing.

The triode section of a 6U8 is used as a phase splitter, the pentode section operating as a voltage amplifier. Feedback from the 16-ohm tap of the output transformer goes to the cathode of the pentode section.

The preamp section utilizes four triodes (two 12AX7 twin triodes), two in the front end to amplify low-level signals and provide appropriate equalization. The remaining two triodes provide sufficient gain to make up for the losses of the tone and filter networks. Well-filtered d.c. is also provided for the filaments of all the preamp tubes.

The power supply utilizes eight 1N560 diodes in two bridge configurations, one bridge for B-plus and the other for the d.c. filament and bias supply. Additional separate transformer windings are used to provide a.c. filament voltage for the amplifier tubes which do not require d.c., and for all the tuner tubes.

Performance

Before detailing the vital statistics we have arrived at on the 340-B, we must point out that tuner statistics are not yet completely revealing, at least as far as the average consumer is concerned. In other words, most consumers, when confronted with an array of technical measurements, is not usually qualified to make valid deductions from these numbers. For instance, the fact that some numbers are higher, or lower, than equivalent ones for a different tuner does not necessarily mean that one is better than the other. That is the reason we always provide value judgments on this type of product.

Thus we say that the Scott 340-B is a top-notch tuner-amplifier; in fact a top-notch tuner *and* a top-notch amplifier if you wish to use those individual functions (as in tape recording FM broadcasts, or

Fig. 3. H. H. Scott FM-Stereo Tuner-Amplifier, Model 340-B.

playing records).

Now for some statistics: *Tuner*—the usable sensitivity, by IHF standards, was 1.9 μv; harmonic distortion, 0.7 per cent; signal-to-noise ratio, 62 db (for 100 per cent modulation); selectivity, 34 db; capture ratio, 5.5 db; AM suppression, 55 db; and separation, 33 db. (We should mention that we now use a Scott 830 multiplex generator for measurements—unquestionably one of the finest measuring tools available for multiplex testing.)

Amplifier-power output, 35-watts rms per channel; harmonic distortion for 30-watts output, 0.6 per cent; intermodulation distortion, 0.25 per cent; frequency response, within 1 db, 20–20,000 cps; hum and noise 84-db below 30-watts output; input for 30-watt output, 2.7 mv at Mag. Low input, 0.38 volts at Extra input. Listening tests revealed excellent transient response and over-all tone quality, the latter being quite noticeable when listening to FM. Altogether, we think the 340-B is quite worthy of the Scott name. **A-16**

THE CIPHER DENON 800 TAPE RECORDER

Many discerning audiofans first became acquainted with the Cipher line of tape recorders at the 1963 New York High Fidelity Show. This line consists of a number of more or less "garden variety" recorders of fairly conventional appearance and characteristics, topped off by Model 800, which encompasses many operational features that make it especially suitable for the serious recordist who enjoys conveniences usually found only in professional-type machines. Made in Japan by Denon Corporation, a subsidiary of Nippon Columbia, the Cipher is distributed in the U.S. by Inter-Mark Corporation. Denon also makes a console professional machine, and readers may remember seeing one of these units pictured in the "Hi-Fi and Electronics in Japan" section in the March, 1963, issue.

The Cipher 800 is comparatively large, measuring 19-in. high, 16¼-in. wide, and 8¾-in. deep, and weighing 55 lbs.

The 800 is a 3-motor, 3-head machine, with pushbutton operating controls. Five buttons are provided—RECORD, interlocking with the PLAY button, STOP, REWIND, and FAST FORWARD. In addition, there are two rotary switches—one to control a.c. power and select tape speeds of 7½ and 3¾ ips, and the other to select right or left channels for mono recording, or stereo. A slide switch connects the monitor jacks and the VU meters to either the record circuitry or to the playback amplifiers. In addition, there are dual-concentric record level and playback controls. Line-level input and output phono jacks are located in a compartment on the right side of the case, accessible by a hinged door, which also provides access to an octal socket for the remote control switch box, and also accommodates the power cord. Microphone jacks are located on the front panel, as are two headphone monitor jacks, one for each channel.

Fig. 4. The Cipher Denon Model 800 recorder.

Inasmuch as we received the machine without either operating instruction book, service manual, or schematic, we were in about the same position as the average purchaser of a recorder before he reads the instruction book, and consequently we are unable to give a circuit description as we usually do. However, certain information can readily be gleaned from a general inspection of the recorder, and from conventional performance measurements. Bias frequency is approximately 71 kc, permitting recording to at least 14 kc on the basis of having a bias frequency at least five times the highest signal frequency. Separate right and left bias controls are provided under a protection cover on the rear of the case, along with a bias-balance control to adjust the bias current to optimum waveform. The following shows playback performance from Ampex Standard Frequency Tape No. 31321-01, 7½ ips:

TABLE I

Frequency—cps	Relative Output—db
700	0.0
15000	+0.2
12000	+2.0
10000	+1.3
7500	+1.4
5000	+1.7
2500	+0.1
1000	0.0
500	+0.9
250	+1.5
100	+2.0
50	+2.3

At standard operating level (3 per cent harmonic distortion), the maximum playback level measured 2.6 volts. At 3¾ ips, playback response, measured with Ampex Standard Tape No. 31331-01 is shown in Table II.

TABLE II

Frequency—cps	Relative Output—db
500	−1.6
7500	−1.6
5000	−2.0
2500	−2.6
1000	−1.8
500	−1.0
250	−0.5
100	−0.0
50	0.0

Maximum playback output at standard operating level measured 2.05 v.

Frequency response in the record-playback mode at 7½ ips is shown in Table III. Feeding in a constant signal of 1.0 v., and with the recording volume control set for a "0" indication on the VU meter at 100 cps, it was noted that this indication varied slightly with frequency, as noted in the second column of figures in the table. The third column indicates playback level.

TABLE III

Frequency—cps	VU ind.	Relative Output—db
1000	0.0	0.0
15000	+0.5	−1.4
12000	+4.0	+2.0
10000	+3.2	+2.0
7000	+1.5	+1.6
5000	+1.0	+1.0
3000	+1.2	+1.0
1000	0.0	0.0
500	0.0	−0.1
250	0.0	0.0
100	−1.0	−1.0
50	−3.5	−3.0

Thus it is seen that the playback output relates quite closely to the VU meter indication, even though there is a small variation, with frequency, of the VU indication when a constant-voltage signal is fed in. In-out harmonic distortion, measured with a record VU indication of "0" level measured 2.5 per cent at 1000 cps, 2.0 per cent at 10,000 cps, and 2.0 per cent at 100 cps. Wow and flutter measured 0.17 per cent at 7½ ips, 0.2 per cent at 3¾ ips.

Record-play response at 3¾ ips measured within ±2 db from 50 to 7000 cps.

Mechanical

For its mechanical features, the Denon-Cipher 800 rates high honors. Since all tape handling is done by relay-actuated solenoids, the pushbuttons, required only to make electrical contacts, are smooth and without any mechanical resistance. A tensioning lever at the right side of the capstan actuates the stop relay, so that the transport stops when the tape runs out, regardless of direction of motion. A tensioning arm is provided at the left side to smooth out tape movement off the feed reel. In the play and record modes, the idler roller is held against the capstan by a solenoid, and a shielding cover is closed to mate with the playback head shield. While it is possible to operate the pushbuttons in an incorrect sequence and break the tape, we must admit that we have never yet seen a pushbutton-controlled machine which would not break tape with incorrect operation. That is, you *can* break tape if you *try*, but you are not likely to with reasonably intelligent operation.

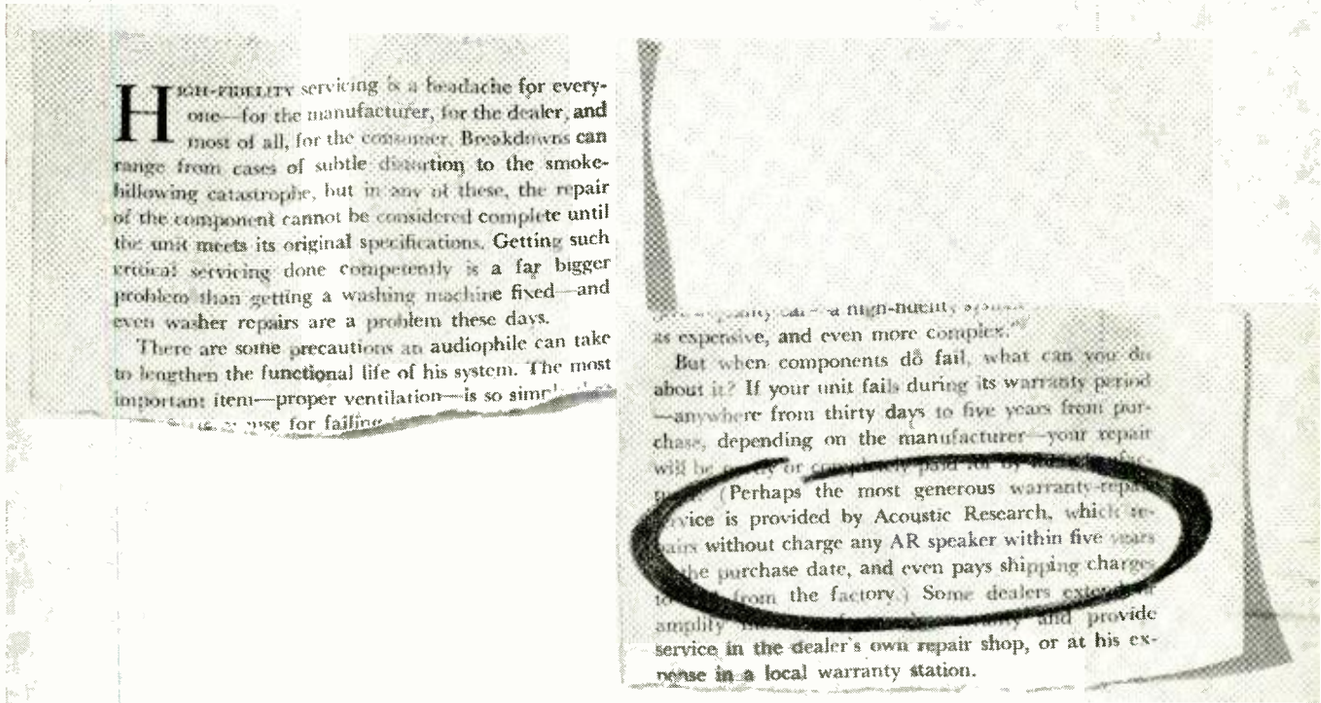
In short, we found this machine a delight to use in every respect. We would like to see this recorder incorporate a remote digital counter into the remote switch panel, and we feel that provision should have been made for a stereo headphone jack, rather than for two mono jacks. This latter is a very minor criticism, however, and it is likely that any recordist would replace one of the jacks within the first week that he had the machine in his possession, assuming he was interested in any amount of stereo recording. **A-17**

from

SERVICE...WITH A SMILE?

by IVAN BERGER

in the May, 1963 **HiFi/Stereo review**



HIGH-FIDELITY servicing is a headache for everyone—for the manufacturer, for the dealer, and most of all, for the consumer. Breakdowns can range from cases of subtle distortion to the smoke-billowing catastrophe, but in any of these, the repair of the component cannot be considered complete until the unit meets its original specifications. Getting such critical servicing done competently is a far bigger problem than getting a washing machine fixed—and even washer repairs are a problem these days.

There are some precautions an audiophile can take to lengthen the functional life of his system. The most important item—proper ventilation—is so simple

...use for failing

...as expensive, and even more complex.

But when components do fail, what can you do about it? If your unit fails during its warranty period —anywhere from thirty days to five years from purchase, depending on the manufacturer—your repair will be ... (Perhaps the most generous warranty-repair service is provided by Acoustic Research, which repairs without charge any AR speaker within five years of the purchase date, and even pays shipping charges from the factory.) Some dealers ... provide service in the dealer's own repair shop, or at his expense in a local warranty station.

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We would differ with Mr. Berger on one minor point. We don't consider our guarantee conditions "generous," but fair to all concerned. And care in manufacture keeps our repair rate very low—for some models less than one per cent.

AR speakers are $89 to $225; AR turntables are $66 and $68 (5% higher in the West and Deep South). Literature is available on request.

*If a speaker is returned and found to have no defect the owner pays freight both ways, but no other charge is made. If a returned speaker is found to be defective because of gross abuse (such as plugging into the 110V outlet), the owner is charged for both repair and freight. Of speakers returned about 4% are without defect, and 7% are judged to have been subjected to abuse.

ACOUSTIC RESEARCH, INC., 24 Thorndike St., Cambridge, Mass. 02141

HERMAN BURSTEIN*

(Note: To facilitate a prompt reply, please enclose a stamped, self-addressed envelope with your question.)

Microphones

Q. I have several questions concerning microphones. The manufacturer of my tape recorder recommends a medium impedance microphone: 10,000 to 20,000 ohms. Does this mean the "hi-Z" dynamic type? I find no microphones in any catalogs with numerical values in this range; they jump from around 250 ohms to "hi-Z." My recording subjects will be small instrumental groups including piano or harpsichord in small rooms plus organs in large auditoriums. Am I right in thinking I need a directional mike to eliminate undesirable reflections in the small room? Will the large directional mikes serve as well for organ recording in a large room where some reverberation pickup is desirable?

I have done some recording on a portable home recorder with an inexpensive crystal mike, and the results were very disappointing. Will a dynamic type mike give me a better sound, or is it necessary to have a recording studio to obtain good sound? Can you give me any ideas or references on microphone techniques, especially placement of mikes in small rooms for recording piano, and so on?

Since the condenser microphones I have priced are out of my reach, I assume I will purchase mikes of the dynamic type. What qualities should I look for in the specifications of mikes, aside from frequency response? To ease the financial load, I had planned to buy one mike now and content myself with mono recording till I could afford a second identical mike; however, I have seen listings for factory matched mikes for stereo. Is there enough variation in the production of mikes that you feel it is important to buy a matched pair?

A. A microphone in the range of 10,000 to 20,000 ohms would be classed as high impedance or medium high impedance. A high-impedance microphone is not necessarily a dynamic type.

In choosing a microphone, much depends on the nature of the music, on the kind of sound you wish to capture, and on the contours and furnishings of the room. If you are recording with an audience present and wish to minimize audience noise, a directional mike might be preferable; or this kind of mike might be best if there is too much room reverberation. On the other hand, in some locations an omnidirectional mike might result in greater naturalness and sonority of the recorded material.

Crystal mikes are generally inadequate for high quality recording. A few such mikes are suitable for this purpose, but these are mostly made abroad and are quite expensive. For the utmost in results, condenser mikes are often used (although not exclusively so) but run into several hundred dollars. The home recordist can often obtain very good results with one of the better dynamic mikes costing under $100, possibly under $50, at consumer net price.

In examining microphone specifications, consider sensitivity. This should be rated no worse (no lower) than −55 db/ microbar; worse, for example, would be −60 db/microbar. Otherwise you may find that noise produced in recording is too high compared with the audio signal. Possibly, you might not get enough signal to drive the tape recorder to full level. Specifications generally have nothing to say about the dynamic range and distortion characteristics of the microphone. Sometimes you can find out about these by writing to the manufacturer.

There is always some variation between two units of the same model of any product. Microphones conform to the rule. However, the more expensive the microphone, the smaller will the inter-unit variation probably be, because of greater care in manufacturing and quality control. Nevertheless, because it is highly desirable that stereo microphones be virtually identical in their characteristics, I think it is a good idea to make the effort to buy a matched pair.

Recording with Two Tape Machines Simultaneously

Q. I have two Concertone 505 tape recorders that I am using in conjunction with a Fisher X-202-B amplifier. My problem is to connect the tape machines correctly to the X-202-B so that I can copy a tape from one machine to the other or record on both machines at the same time. Therefore I have connected the two tape machines as follows. I have inserted a Y-connector in each "recorder output" jack of the X-202-B and connected both outputs to Channel A to the Channel 1 inputs of the Concertones; and both outputs of Channel B to the Channel 2 inputs of the Concertones. Outputs from one Concertone are connected to the "monitor inputs" of the X-202-B. Outputs from the other Concertone are connected to the "Aux. 1" inputs of the X-202-B. Theoetically, three manipulations of the Mode Selector on the front panel of the X-202-B should be able to record on both machines at the same time. In actual practice this does not work. When I attempt to record on both decks at the same time, using my tuner as a program source, the following happens. The Concertone whose outputs are connected to the monitor jacks of the X-202-B operates perfectly, but the Concertone whose outputs are connected to the Aux. 1 jacks of the X-202-B gives a record deflection only on the Channel 2 VU meter; Channel 1 remains dormant until I unplug the Channel A, Aux. 1 input, and then the machine immediately starts recording on both channels. There should be no interaction between the Tuner and Aux. 1 positions of the Mode Selector switch, and I cannot understand why the Concertone won't operate properly unless I unplug the Channel A, Aux. 1 input of the X-202-B.

A. First let's summarize your requirements and problem. You want:

1. To be able to record on both machines at once.
2. To be able to play Machine I (connected to Aux. input) while recording (copying) on Machine II (connected to Monitor input).
3. To be able to play either Machine I or Machine II.

Your problem concerns the first requirement. Machine I will not record on Channel 1 unless the cable from this machine's output to the X-202-B's Aux. input is disconnected.

The X-202-B, in common with most such units, shorts all unused inputs to ground in order to minimize crosstalk. Therefore when the selector switch is turned to the tuner input, all other inputs, including Aux. 1, are grounded.

The Concertone has individual A-B controls for Channels 1 and 2, permitting you to compare the tape playback signal with the incoming signal. In the A ("Source") position, the incoming signal, taken after one stage of amplification, is connected to the output jack. If this output in turn is connected to the Aux. 1 input of the X-202-B, it gets grounded. Therefore I believe your trouble is due to one of the following:

1. You inadvertently have Channel 1's A-B control in the A ("Source") position instead of the B ("Tape") position.
2. Channel 1's A-B control is defective, allowing an appreciable amount of the source signal to reach the output jack and become grounded.

See what happens who you exchange the roles of Machines I and II.

Tape Machine Playback Preamps

Q. Would playing a tape through the tape head of my preamp offer improved reproduction over that obtained by playing back through the preamp of a tape machine in the $400 to $500 bracket?

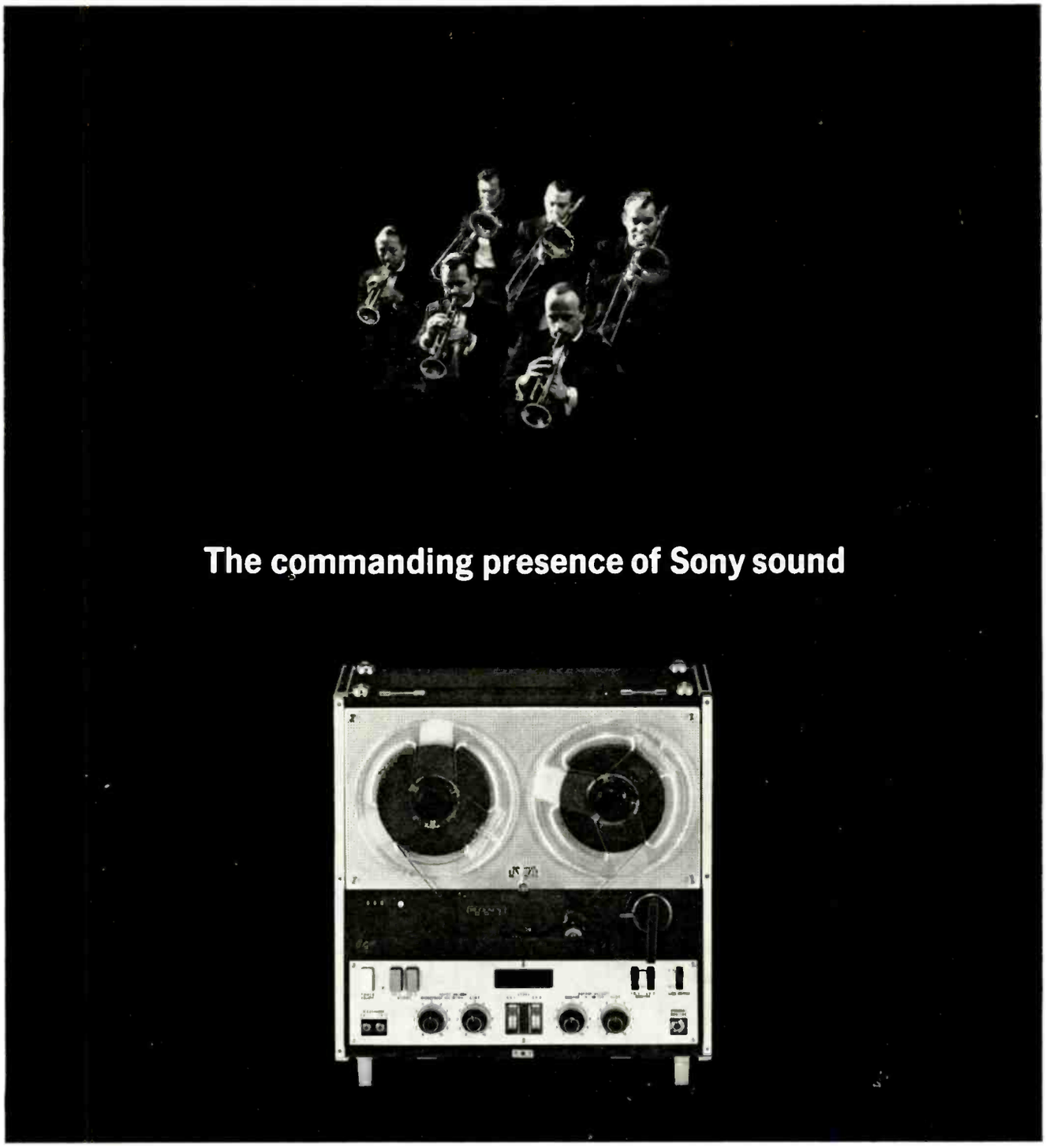
A. One of the big problems in tape playback is keeping noise (including hum) at a very low level in the playback preamp. Based on a 400-cps signal recorded at 7.5 ips at a level resulting in 3 per cent harmonic distortion on the tape, preamp noise should be at least 55-db down. Very few tape machine preamps and still fewer audio preamps are this good. I am not sure that your particular audio preamp keeps noise as low as do the very best tape machine preamps, but it is certainly better than the average tape machine preamp. However, tape machines in the $400 or $500 category tend to have excellent preamps.

Peak Recording Level

Q. The specification sheet of my tape recorder states that the signal-to-noise ratio is "55 db peak recording level." What is meant by peak recording level?

A. This denotes the level which results in 3 per cent harmonic distortion at 400 cps (or sometimes 250 cps) on the tape.

* *280 Twin Lane, E. Wantagh, N. Y.*



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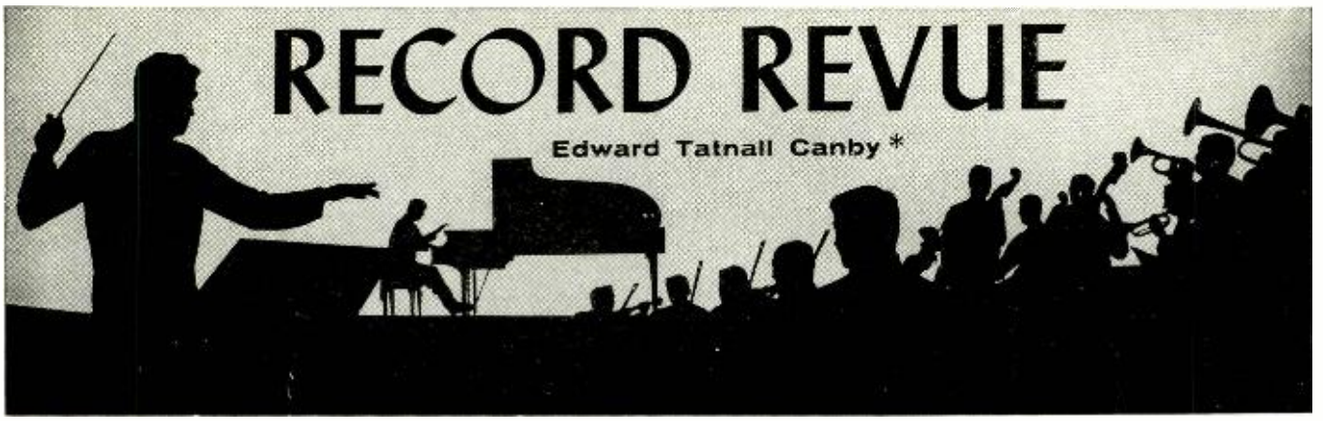

Lovely "Memories"

Musical Memories of Scandinavia. Gunnar Hahns Folk Orch.
London Int. TW 91300 mono

It looks just like any one of hundreds of mood-music-style inspirational recordings issued these days—but this one turns out to be one of the loveliest, most musical discs of light fare I can remember. Superb, in a simple and unpretentious way.

Just fifteen-odd short dance tunes, played by one of those local-country folk orchestras (not very folkish and thoroughly professional) that abound in European lands, part of a whole series under the same "Memories" title, from hither and yon. You'd never know from the cover how nice it is. Justifies my occasionally grab-bag trials of any old record that's sitting around looking at me—just in case!

Instead of the expected watered-down salon music of most such releases, this is forthright, vigorous playing of excellent arrangements, using occasional folk instruments gracefully and with taste. But what appealing melodies! What sparkling rhythms! You'll be enchanted unless your musical ear is cast concrete.

Lively History

The Civil War, Its Music and Its Sounds Vol. 2. Frederick Fennell, Eastman Wind Ensemble, Reactivated Battery B, 2nd N.J. Light Artillery, male chorus; Martin Gabel, narr. Booklet.
Mercury LPS2-902 (2) stereo

In spite of a bit too much gun fire, this is by far the best Civil War album I've yet heard and seen. For one thing, it is adult, earnest, unsensational (and thereby the more impressive), not forgetting to mention the terrible aspects of the war along with the inspiring. Its research and information is unusually well presented, in the nature of a musical and weapons-significance background to the course of the war—a most interesting discussion of both aspects.

To me, the most important is the music, which is not only painstakingly authentic to the period, note for note, but is equally faithful in the actual instrumentation, duplicating with near exactitude a brass band of the time via instruments now largely out of use. The resulting sounds are presented imaginatively and with fine musical spirit. Even the soldier songs are an unexpected pleasure—for instead of the usual Hollywoodish arrangements sung by singing-commercial-ensembles or large trained choirs, these are given out by young male voices of a soldier-like sort, and no fancy operatics at all. Just rousing song. Maybe the Civil War soldiers weren't as good, but for once, at least, we have no prancing studio tenors, no bellowing bassos. Not on *this* musical battlefield!

There isn't a false musical note anywhere—the harmonies, for instance, are strictly of the time, including the harmonizations of the songs. Both familiar and unfamiliar, the music thus vividly portrays a bygone era in strictly musical terms of authenticity—even to an astonishing version of the "Star Spangled Banner," full of naive leftover Eighteenth century ornamentation! The still-strong feeling in America for modal music is unexpectedly clear, too (as in "Johnnie Comes Marching Home"), a sort of atavistic throwback to an earlier musical language at a time when the European "classical' idiom was barely known to the mass of Americans as a whole.

The reconstituted band of wind instruments of the Civil War period assembled and recorded by Mr. Fenneli is impressive. The bulk of it is made up of a strange family of reversed brasses that play rearwards over the shoulder, into the faces of the following ranks of soldiers. These instruments make a lovely mellow sound, noticeably unlike band music sounds of today. And the mild difficulties encountered in hitting the proper pitch makes for an unexpected added realism in the playing—the battlefield bands must have sounded exactly like this, in the field!

Bugle calls, drum rolls, fife tunes, add musical perspective and a typically Mercury-Records battery of muskets, repeaters, Parrots and Napoleons hurl realistic stereo fusillades and bombardments around the modern living room. Some astonishing ricochets! The whole package show is written up in an excellent accompanying booklet.

The Badmen. Songs, Stories and Pictures of the Western Outlaws, 1865–1900.
Columbia L2S 1012 (2) stereo
(Legacy Collection)

These big documentaries are really getting to be something. The danger, of course, is too much sound and fury signifying not enough, and a good many of these are blown up beyond their real interest, in the text and pictures and/or in the sound. Not so here.

The album, to be sure, is enormous and flamboyant, to outdo anything of the sort including most of the fancy Civil War albums. But the material in both sections (separately housed within the box) is top-notch, flamboyant or no. Acres of pictures, startling photographs and sensational engravings of the period. Excellent and readable texts, with long and exciting accounts of the various desperados and desperadesses involved. And in the sound, a series of recorded interviews with some surprisingly lively survivors, first-hand witnesses. One old lady, here, wasn't far removed from Jesse James' killing. A superb old storyteller weaves his own Mark Twain-like tale of innocent boyhood on the frontier—he "went West" to seek adventure, complete with city clothes and not a gun to his name, and he found it all right. The strong, middle-aged voice that tells this story was actually 90 years old at the time—right now, he would be 100. Astonishing. Long account by the wife of a U.S. Marshall, Bill Tilghman, of her husband's activities bringing in the badmen. (He was killed much later, anticlimactically, by a mixed-up Prohibition officer.) These are generally fascinating excerpts, distilled from much larger hunks of recorded source material.

On the rest of the four record sides you will find musical re-creations of some of the old songs, the ballads about the badmen (a few of them well represented in the text stories) and about the life and times. Musical quality is good, thanks to Pete Seeger, Ed McCurdy, Jack Elliott, Harry Jackson, Carolyn Hester, Jaques Manahem, and the songs include "language" material, reflecting the Spanish influence in the old West. I wouldn't call these recreations 100 per cent tops, though. The atmosphere is often forced and self-conscious, notably an unfortunate faked-up episode in a bar room. Right out of Madison Avenue, that.

Mustn't let a touch of gray-suited pomposity, more or less inevitable from Columbia, spoil a really splendid assembling-together of real Badman material. I can't imagine a more interesting way to introduce kids to the West itself in the bad old days, as distinguished from the TV Western, its gun-popping pseudo-image.

Ranging Among the Classics

Hindemith: Violin Concerto (1939); Viola Concerto ("Der Schwanendreher") (1935). Ivry Gitlis, vl, Westphalian Symph., Reichert; Gunther Breitenbach, vla., Vienna Symph., Haefner.
Vox PL 11980 stereo

A fine pairing of works in the best Vox manner, a different set of performers for each side but a unified theme, a similarity in the music, that makes a whole of the disc. Similar recording in both: a rather prominent and close-up solo instrument, a broad orchestral sound, somewhat in the background but fully realized.

The Hindemith, Prokofieff and Stravinsky concerti for various instruments share an odd similiarity—the extreme "busy" quality of their soloists, who tend to play on without a break for many minutes at a time. This somewhat professional approach isn't easy for the first-time listener, who finds it all too typical of most high-level 20th century concerti. The classicists, such as Mozart, Haydn and Beethoven, and the big Romantic composers, made a point of careful balance, allowing rest for both soloist and audience. Hindemith's violin concerto will strike you on first playing in just this fashion: the violin plays an awful lot of notes with very few pauses for breath en route. So will the viola concerto, though not as much; for it is a folk-tune concerto on a more relaxed level (related to the Brahms "Academic Festival" Overture).

Don't let this hold you back. Hindemith (like Beethoven and Mozart and Haydn) may seem to write the same style over and over again—all the familiar Hindemith sounds are here in force. But both of these works, taken on their own, make skillfull use of musical expression, both are full of quickly memorable tunes and ideas and both display the complex but highly sensible Hindemith harmonies, always leading towards solid, fat, old-fashioned chords, fit for any ear.

The two performers are excellent. Gitlis has an impeccable ear for pitch, a splendid ability to blend into the harmony when the

(*Continued on page 58*)

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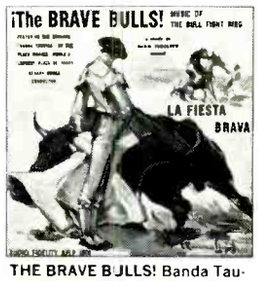
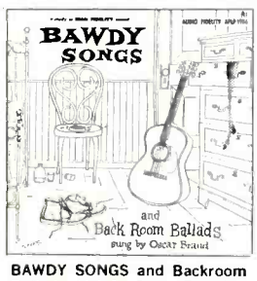


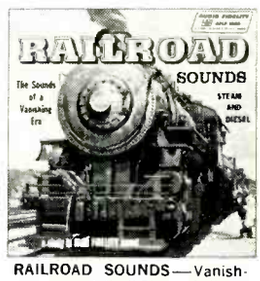
THE BRAVE BULLS! Banda Taurina Music of the Bullfight Ring! El Relicario, Cielo Andaluz, La Virgen de la Macarena, etc. **AFLP1801/AFSD5801**



BAWDY SONGS and Backroom Ballads, Vol. 1, Oscar Brand—Lusty, spicy musical folklore. —Roll Your Leg Over, No Hips At All, Sam Hall, etc. **AFLP1906**

PORT SAID, Mohammed El-Bakkar—Tantalizing love songs, exotic dances. Haun Meelee, Bint Il Geran, Al Jazayair, etc. **AFLP1833/AFSD5833**

SOUND EFFECTS, Vol. 1—Perfect auditory images! Jets, Racing Cars, Crowds, Thunder, Heartbeats, Surf, Birds, Lions, etc. **DFM3006/DFS7006**



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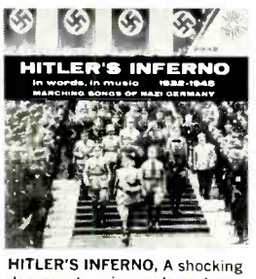

HITLER'S INFERNO, A shocking documentary in words and music. Hitler speaks, Nazi Storm Troopers sing. Nazi German marches. **AR2445** (mono)

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ABOUT MUSIC

Harold Lawrence

Bring On The Animals!—Opera's Zoo Story

Address rehearsal of *Aïda* was in full swing. On the stage, a small army of soloists, choral singers, trumpeters, horses and soldiers faced their commander-in-chief in the pit, Sir Thomas Beecham. Amneris had just placed the Pharoah's standard in the hands of the young Egyptian officer, Radames, to the words "Ritorna vincitor" (Return conqueror), when she faltered on the attack of a high note. Suddenly a horse responded to the call of nature, a prolonged call. As singers and supers quickly stepped out of range, Sir Thomas rapped his baton on the podium railing, shook his head sadly, and, clucking his tongue, said, "Very bad stage manners—but what a critic!"

The horse to which the late English conductor attributed such keen musical perception belongs to a vanishing race of operatic performers. While animals still tread the opera boards, they are usually assigned bit parts. In recent years we have seen borzois in *Simon Boccanegra*, stallions in *Die Walküre*, a donkey in *La Périchole*, a pig in *Gypsy Baron*, and, of course the neigh plus ultras of *Aïda*. In view of the dwindling zoological presence in opera, members of Animal Equity naturally resent the use of the phony dragon in *Siegfried* and the stuffed swan in *Lohengrin*. Wagner, they will point out, approved the use of rams to draw Fricka's chariot in *Die Walküre*, called for ravens to wing across the stage in *Die Götterdämmerung*, and even introduced a bear in *Siegfried*. And, as late as 1938, Valkyrie maidens galloped across the stage dressed as mounted carabinieri in an updated performance of *Die Walküre* at the May Festival in Florence.

Olé!

The operatic menagerie was heartened a couple of years ago by the news that an enterprising impresario had staged *Carmen* in an open air arena in southern France using a live bull. But the more realistic animals recognize the fact that, apart from special performances, their operatic heyday is past.

There was a time when jungle beasts, exotic birds, insects and reptiles swarmed across the boards of European theatres in great profusion, and the stage director was a sort of latter-day Circensian animal trainer whose productions contained the seeds of the modern circus and the Hollywood wide-screen Epic.

17th Century "Spectaculars"

Animals in fact, played an important role in the birth of the lyric theatre. The early operas of seventeenth-century Italy emerged out of the masques and other courtly entertainments which featured lavish spectacle. Dr. Charles Burney, the celebrated English musical historian, chronicled the staggering proportions of a Padua performance of Freschi's *Berenice* in 1680 in which there were "choruses of one hundred virgins, one hundred soldiers, one hundred horsemen in iron armor, forty cornets of horses, six ensigns, six sacbuts, six great flutes, six minstrels playing on Turkish instruments, six others on octave flutes, six pages, six sergeants, six cymbalists, twelve huntsmen, twelve grooms, six coachmen for the triumph, six others for the procession, two lions led by two Turks, two elephants by two others, Berenice's triumphal car drawn by four horses, six other cars with prisoners and spoils drawn by twelve horses, six coaches for the procession."

The animals in *Berenice* were both decorative and useful. In those days elephants were powerful box office attractions because of their spectacular dimensions and their ability to carry out tasks calmly and efficiently.

Some less formidable beasts of burden included a reindeer team in *Servio Tullio* (1685), peacocks drawing a little chariot in *Venere Gelosia* (1643), and the more prosaic camels and horses who labored in operas too numerous to mention.

Animal Acts

As dramatis personae, however, animals were often replaced by humans. In 1710 Londoners flocked to the Haymarket to see the great Italian singer Nicolini battle nightly with the "king of beasts" in an opera by Mancini. It was rumored that a tame lion had been dispatched from the Tower every opera night to be slain by the singer. But Joseph Addison, who paid regular visits backstage during the 1710–11 season, learned otherwise. The first lion, he wrote in *The Spectator*, "was a candle-snuffer, who being a fellow of a testy, choleric temper, overdid his part, and would not suffer himself to be killed so easily as he ought to have done . . . Besides, it was objected . . . that he reared himself so high upon his hinder paws, and walked in so erect a posture, that he looked more like an old man than a lion." He was dismissed after a few performances.

The second was a tailor with a "mild and peaceable" disposition. He, too, was unsatisfactory: "If the former lion was too furious, this was too sheepish for his part; insomuch that after a short, modest walk upon the stage, he would fall at the first touch of Hydaspes (Nicolini), without grappling with him."

The third lion was a country gentleman who had taken the part for the sheer enjoyment of it. His temper was "made out of such a happy mixture of the mild and choleric, that he outdoes both his predecessors, and has drawn together greater audiences than have been known in the memory of man."

Handelian Warblers

The sparrows utilized in Handel's *Rinaldo* during the same operatic season were more authentic than Addison's Bert Lahrs, but they proved less reliable. Flocks of them were released in a grove toward the conclusion of Act One, intended to flutter in the branches while behind-the-scene piccolo, flute and strings imitated bird calls. But the sparrows ignored the grove and invaded the hall instead. "So many flights of them had been let loose in this opera," wrote Addison, "that it is feared the house will never get rid of them; and that in other plays they make their entrance in very wrong and improper scenes, so as to be seen flying in a lady's bed-chamber, or perching upon a king's throne; besides the inconvenience which the heads of the audience may sometimes suffer from them."

While the choice of sparrows was regrettable (trained pigeons or doves certainly would have been preferable), one could not say that the use of birds was dramatically inappropriate. But what of the apes in *The Cruelty of the Spaniards in Peru* (1658)? In this gory opera, the Conquistadors kill, torture and eat their victims; e.g., in Scene 5 a Spaniard turns the spit while another bastes an Indian prince. Monkeys, parrots and apes appear in the opening scene, which features a complicated rope dance performed by two apes.

For the sportsmen in 17th-century opera audiences, directors sometimes staged hunt scenes involving stag, deer, bears and wild boar. Bear-baiting by dogs, a favorite divertissement of the aristocracy, was also included in the more elaborate productions.

"Bring on the animals!" was the cry often heard backstage in vaudeville days when the show was faced with an unresponsive audience. Think of what a well-stocked menagerie might do for operas in like distress. Æ

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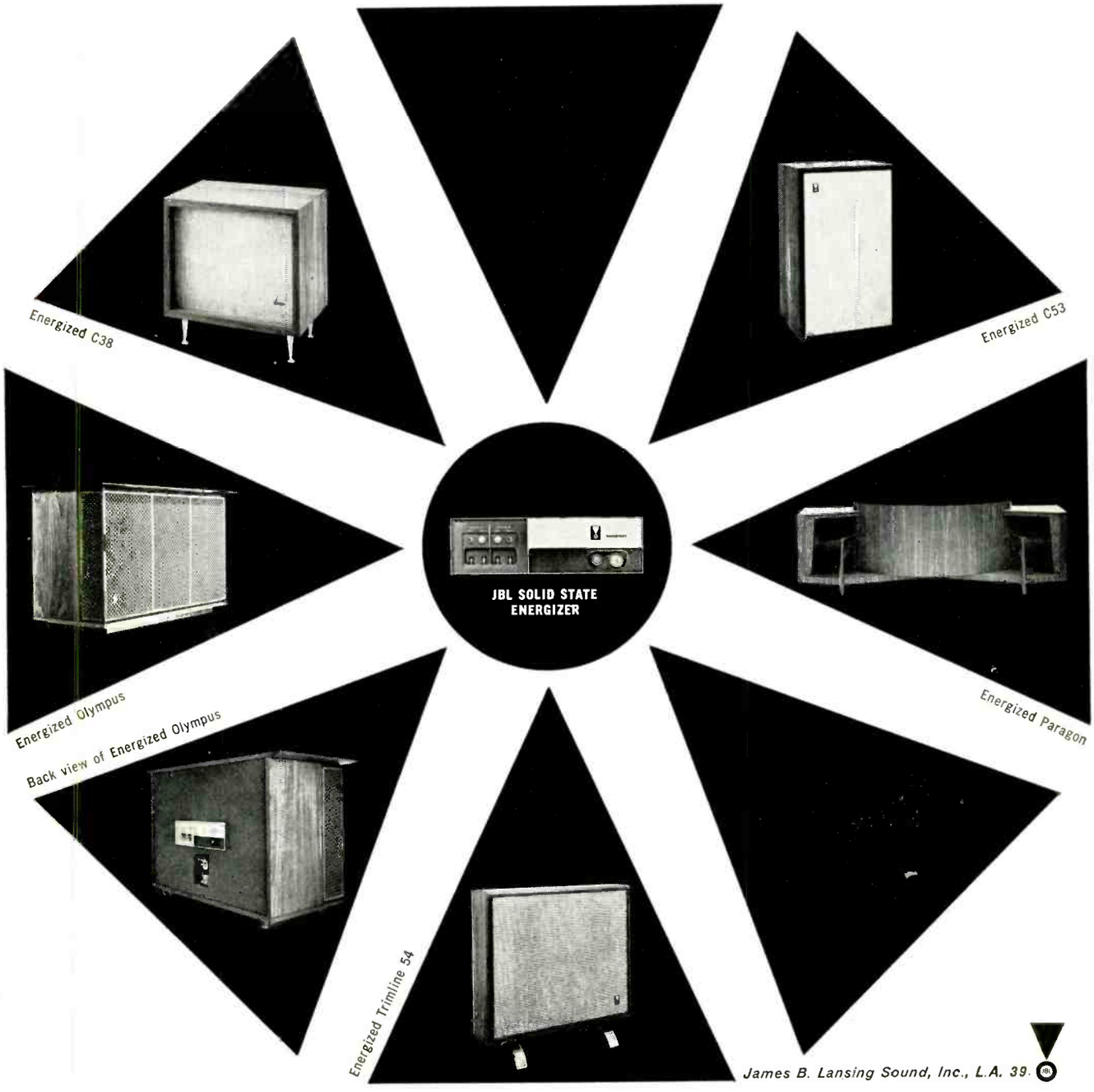

JAZZ AND ALL THAT

BERTRAM STANLEIGH

Recording Electric Guitar and Organ

As nearly everyone knows who has used a tape recorder to record from a radio or phonograph, substantially better results can be obtained by feeding an electrical signal directly into the recorder instead of placing a microphone in front of the loudspeaker and recording its acoustical output. There are a number of reasons for this; chief among them is the fact that microphones and loudspeakers, because of the complicated task they must perform in converting mechanical energy to electrical energy, and back again, impart a coloration of their own that alters the original sound.

In the case of jazz and popular music, there are two instruments whose sound is produced through loudspeakers and whose quality suffers in recording when microphones are used instead of feeding the electrical signal directly into the recording console. They are the electric guitar and the electronic organ, and it is sad to observe that the quality of recent recordings on these two instruments appears to be deteriorating at a time when, in all other respects, recordings of music are getting better than ever. Probably stereo is to blame. By employing microphones to pick up the sounds coming from guitar and organ speakers, it is possible to record directional perspective as well as musical sound. But the loss of depth, clarity, and detail is disturbing. I have been comparing several recent LP's of electronic organ music with 78's of 1947–48 vintage, and the comparison is hardly flattering to the recent products. Certainly it is possible for engineers to combine direct and acoustical pickup in a manner that will preserve the best aspects of each. Let us hope that they start to apply themselves to the problem instead of leaving it to the liner note writers whose solution is simply to assure us that each new disc is the absolute ultimate in high fidelity.

Clancy Hayes: Swingin' Minstrel
Good Time Jazz Stereo S 10050

A West Coast banjo player and vocalist, Clancy Hayes has a reputation as a twenties song stylist. With the help of some of the best dixieland sidemen on the coast, he is heard in a mellow collection of traditional favorites. Clancy's direct approach to his material makes for agreeable listening, but the music he has chosen includes some of the most distinguished tunes in jazz history, and it is difficult to hear such songs as *Willie the Weeper, Ain't She Sweet, Wolverine Blues, Honeysuckle Rose,* and *After You've Gone* without recalling how much more effectively they have been handled by others. Particularly sad, is the weak recreation of Fats Waller's great *Honeysuckle Rose;* Ralph Sutton plays piano for this number and the four other tunes on side A, and although he turns in consistently high calibre performances the ghosts of New Orleans' and Chicago's greats somehow manage to make their presence felt and to stimulate nostalgia for earlier versions. From the audio standpoint, any comparisons with older discs must all favor the present contender. In spite of a tendency for most of the sound to emanate from either the left or right speakers, this is delightful stereo, particularly in such passages as the interchange between Bob Short on the tuba and Clancy on guitar in *Willie the Weeper,* and the duet by Clancy on banjo and Pud Brown on clarinet in *Dancing Fool.*

Jimmy Witherspoon: Baby, Baby, Baby
Prestige PR 7290

With his poignant, ringing tones and strong driving rhythm, Jimmy Witherspoon delivers a number with the kind of deep felt conviction that transcends his material and speaks in terms of basic human anguish. This is classic blues singing of a kind associated with all-time greats like Ma Rainey, Bessie Smith, and Leadbelly. For his new album "Spoon" has the kind of small group backing that the blues require. Two groups of sidemen are used: eight of the discs twelve tunes have the support of Kenny Burrell, guitar, Leo Wright, alto sax and tambourine, Gildo Mahones, piano, George Tucker, bass, and Jimmie Smith, drums. The remaining four numbers, backed by a group of West Coast musicians, also include bits of trumpet, flugelhorn, and harmonica. With support of this kind, and Witherspoon's strong, rich voice, it seems a pity he should have been miked so closely and that the instrumental contribution has been held down so severely.

Georgie Auld Quintet: Plays the Winners
Philips Mono PHM 200-096

After a dozen years, Georgie Auld gets together with Frank Rosolino on trombone and Lou Levy on piano in an effort to recreate Auld's quintet of the early fifties. With Leroy Vinnegar on bass, in place of Max Bennett, and Mel Lewis replacing the late Tiny Kahn on drums, the new group swings together in an easy, light-hearted manner. Auld, himself, is more relaxed than he has often been in the past, and his tone comes across better on this platter than on any other I can recall. According to the liner notes, the entire album was recorded in just over four hours—a remarkable achievement, for this is music making of a consistently high order. Perhaps the single session gives this set its cohesive atmosphere; perhaps it's just the pleasure this group derives from getting together again. Whatever the reason, the results are extraordinary. The sound of the mono version has excellent presence, and each of the voices comes through with such good balance and clarity that I don't miss the directional quality of stereo.

The Jimmy Woods Sextet: Conflict
Contemporary Stereo S 7612

Six compositions by Jimmy Woods, demonstrate his talent and the variety of his inventiveness and provide an effective showcase for an excellent group of modern musicians: Jimmy Woods, alto, Carmell Jones, trumpet, Harold Land, tenor, Andrew Hille, piano, George Tucker, bass, and Elvin Jones, drums. The title of the set derives from one of the pieces, but it is also indicative of the feeling of contention between varying ideas that pervades each of the numbers. Their creator contributes a set of serious liner notes in which he describes some of the emotional conflicts that stem from his desire to make music and to pursue his studies in Sociology at Los Angeles State College. Each of the works is tightly scored, making maximum technical demands on the players and affording no opportunity for extended solos. In spots, the complicated juxtaposition of voices is downright ugly. Woods has attempted to say considerably more than actually emerges, but the very real conviction in these works is stamped in each measure. The present album may not represent total fulfillment for this young man, and it is likely that we will have to wait several more years before he acquires the simplicity and economy of expression that he needs if he is to become more articulate, but he is saying more and has more promise than any of the other young men who have emerged in the last dozen years.

Les McCann Ltd.: The Gospel Truth
Pacific Jazz Mono PJ—69

Pianist Lee McCann, backed by bass and drums, plus organ on three of his ten solos, swings through a group of traditional spirituals and religious tunes of his own creation. The close relationship between jazz and the church music of the Negro has been emphasized by a number of jazz historians. For many jazz musicians, the earliest contact with music was in church, and the renewed interest in church music by modern musicians is both natural and richly rewarding. McCann's approach to this material is a meaningful mixture of deeply felt religion and modern jazz invention. While his own compositions are not as profoundly moving as such traditional numbers as *Let Us Break Bread Together, Didn't it Rain,* and *Bye and Bye,* they are nonetheless fine enough to appear in the same collection. Throughout the playing is a model of fine piano style. Technique is employed solely for purposes of expression and no idea fails to come across for want of technical ability. A credit line on the liner indicates that the instrument played by McCann is a Yamaha piano, an instrument of which I have no knowledge. I had assumed that the softer, more diffused sound on this recording was the result of distant miking. In any event, the sound is less brilliant and resonant than that of the usual concert instrument.

The Oscar Peterson Trio: Bursting Out with the All Star Big Band
Verve Stereo V—8476

Oscar Peterson has contributed several dozen albums to the jazz archives. His bright, flashy technique has always been more than adequate for stirring up excitement, but too often his improvisation is long on technique and short on invention. Sad to relate, the addition of five trumpets, four trombones, six saxes, four French horns, and a tuba do nothing to improve the situation on his latest release. Far from adding to the excitement, they merely serve to inject an element of distraction. For the most part the big band is utilized in loud chordal bursts which serve to interrupt, without punctuating, the flow of the musical line. Although not marked stereo, the recording has excellent directional characteristics when played in the stereo position, and the bright, brassy sound of the band comes through with an open, agreeable quality. Played in mono, full band passages sound choked-up in the middle register, while the tuba, curiously, becomes more prominent.

Freddie Hubbard: Hub-Tones
Blue Note Mono 4115

This set affords an opportunity to hear Hubbard, known to most of us for his trumpet with Art Blakey's Jazz Messengers, in five very extended solos. The four other participants on this worthwhile disc are James Spauling, alto sax and flute, Herbie Hancock, piano, Reginald Workman, bass, and Clifford Jarvis, drums; they supply excellent rhythmic support, and occasional flaccid solos, but the foreground is reserved for Hubbard who uses the opportunity to maximum advantage, covering a wide variety of moods and displaying a formidable technique.

Sonny Stitt: My Mother's Eyes
Pacific Jazz Mono PJ—71

With Charles Kynard prominently featured on organ and discrete backing from Ray Crawford, guitar, and Doug Sides, drums, Sonny Stitt contributes another album to his long list of solo recitals. The present disc is notable in that Sonny limits himself to tenor sax, whereas he generally alternates between tenor and alto, and for the stylish organ playing of Kynard. In all other respects this set is just one more example of the consistent quality of Sonny's playing. He just blows away from start to finish, making glorious sounds never at a loss for fresh ideas. Æ

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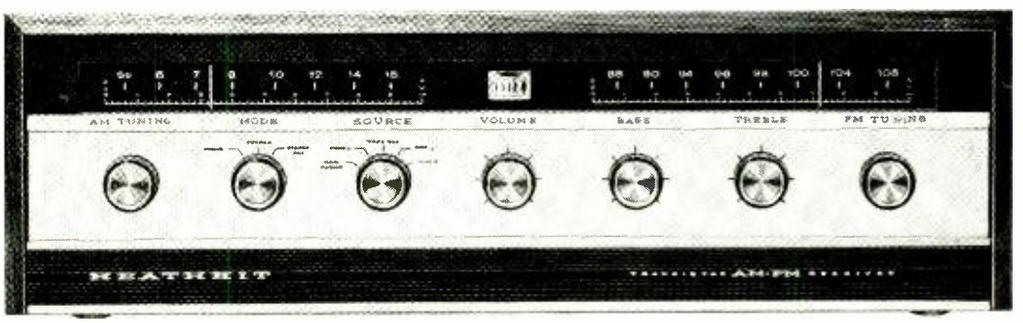

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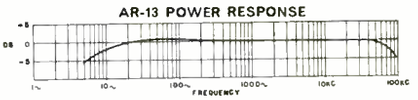

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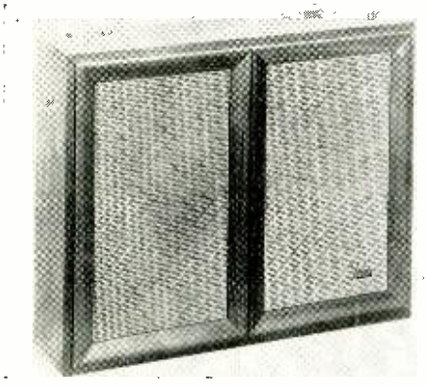
NEW PRODUCTS

● **New Tape Recorder.** New this year from Superscope Inc., U. S. distributor of Sony tape recorders, is the Model 600 Sterecorder, 4-track stereo and monophonic recorder featuring vertical or horizontal operation, microphone and line mixing, and "source" and "tape" monitoring. Other professional features of the Sony 600 Sterecorder include: two V.U. meters (switchable for reading input or recorded signal), sound-with-sound (mike and line mixing), sound-on-sound, separate monitor level

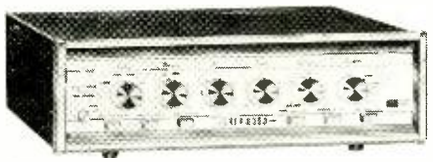
controls, hysteresis-synchronous drive motor and belt-free drive mechanism. Other features are: automatic shut-off, automatic tape lifters, cathode follower line outputs, and special equalized magnetic phono input for stereo connection from a magnetic cartridge for copying stereo discs. Sony Model 600 Sterecorder is complete with carrying case and two Sony Model F-87 dynamic cardioid pattern microphones. Price is less than $450.00. Superscope, Inc., 8150 Vineland Avenue, Sun Valley, California. **A-6**

● **Hanging Speaker System.** Frazier, Inc., Dallas, Texas, announces availability of the "Bel Aire" speaker. The Bel Aire is designed for wall mounting for people who have a space problem. It is equipped with hanger brackets mounted on 16-in. centers. If desired, solid walnut legs are available for floor mounting. Its Danish modern



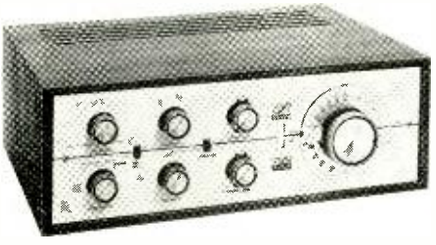
styling will fit almost any decor. It has a useable frequency range from 50 to 12,000 cps with an impedance of 16 ohms and a power handling capacity of 20 watts on speech and music. Its dimensions are 23⅞-in. wide; 19-in. high; and 5½-in. deep. The Bel Aire is available in an oil walnut finish. Fraziers, Inc., 2649 Brenner Dr., Dallas, Texas. **A-7**

● **80-Watt Stereo Amplifier.** As a stereo preamp, stereo control center, and stereo power amplifier, the Sherwood S-5500III is said to offer a number of professional-quality features which make it ideally suited for use in home music systems



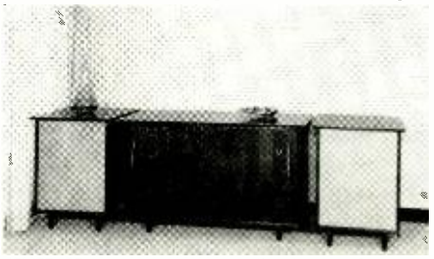
with tape decks, phonographs, and tuners. The phono channel features well-filtered d.c. filaments for extremely low noise and hum, measuring 72-db below rated output. Phono input sensitivity is 1.2 μv. Tape head input sensitivity is 1.6 μv and tuner input sensitivity is 0.25v. The frequency response of the S-5500III is 20 to 20,000 cps ± 0.5 db. The power amplifier provides 40-watts per channel of music power (36-watts continuous) at 1.5 per cent IM distortion. The S-5500III is priced at $174.50. Sherwood Electronic Laboratories, Chicago, Illinois 60618. **A-8**

● **FM-Stereo Receiver Kit.** The EICO Model 2536 incorporates an FM-Stereo tuner and an integrated 36-watt stereo amplifier on one compact chassis. The kit features preassembled front-end and i.f. strip (consisting of 4 i.f. stages and the ratio detector). Both are entirely prewired and prealigned for best performance on weak signals. A circuit board is provided for the stereo demodulator circuit, and the coils supplied are pre-aligned. It is claimed that the completed kit does **not** require alignment or adjustments. The



model 2536 features a precise rotary tuning dial with illuminated readout, a bar-type electron-ray tuning indicator, and a stereo defeat switch. The power amplifier provides 36-watts IHFM music power and 28-watts continuous power, total of both channels. Harmonic distortion at 10-watts per channel at 40 cps is 0.5 per cent. IM distortion at 1-watt per channel is 0.25 per cent. A full complement of controls is provided. Price $154.95 for the kit, $229.95 wired. EICO Electronic Instrument Co., Inc., 131-01 39 Ave., Flushing 54, N. Y. **A-9**

● **Stereo Furniture.** The new Prelude line of stereo furniture features 1-in.-thick solid American Walnut at prices below walnut veneer cabinets. The new line includes contemporary designs in cabinets and enclosures. Six cabinets are available in a variety of leg and door designs

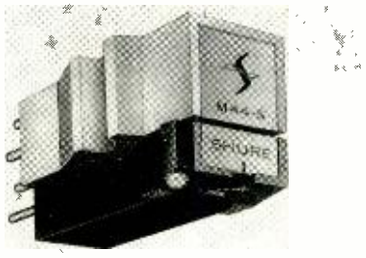


(WH45L cabinet with WH21L enclosures shown) . . . all in matched American Black Walnut. Finishes offered include Watco oil finish, high or satin-gloss lacquer finishes, and custom finishes including antique. All Prelude Stereo Furniture is designed to take component and speaker systems of any manufacturer. Cabinetry may also be adapted for special interior installations such as television and tape recorders. Prelude Stereo Furniture, Gardena, California. **A-10**

● **Thinnest Speaker System.** University Loudspeakers, a division of Ling-Temco-Vought, Inc., has introduced the ultra-thin "Tri-Planar." The "Tri-Planar," measuring only 1¾-in., is claimed to be the world's thinnest speaker system. The concept, sound radiating from both sides of the system, surrounds the "Tri-Planar" and the listener. This is a complete three-way system with one of the largest woofer

areas found in any system, 264 square inches. Finely crafted in oiled walnut with modern cane grille, the "Tri-Planar" will enhance any room. So compact, it may be used any way desired—on wall, floor, table, or the smallest conceivable shelf. The frequency range is from 45 to 18,000 cps. Power rating is 20 watts of integrated program material. The size of this system is 23-in. wide by 15-in. high by 1¾-in. deep. Only $79.95. University Loudspeakers, 9500 West Reno, Oklahoma City, Okla. **A-11**

● **New Cartridge.** Shure Brothers has announced a radically new Stereo Dynetic cartridge with a no-scratch, retractile stylus that tracks at an effective vertical angle of 15 deg. Called the M44, the new cartridge is especially set to track records at the same effective vertical stylus angle major recording companies are now using when they cut records. In other areas of performance, the M44 delivers the same quality as other Stereo Dynetic models. Frequency response is a virtually flat 20–20,000 cps. Channel separation is greater than 25 db at 1000 cps and compliance is 25×10^{-6} cm/dyne for the M44-5 with a 0.5-mil diamond stylus, and 20×10^{-6} cm/-dyne for the M44-7 with a 0.7-mil dia-



mond stylus. In designing the M44 to play all records better, not only those cut at an effective angle of 15 deg., Shure has incorporated a scratch-proof, retractile stylus that momentarily retracts whenever excessive forces are applied to the tone arm. The M44-5 is priced at $49.50 net and the M44-7 is priced at $44.50 net. Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, Illinois. **A-12**

● **New Changer "Dust Bug."** The new changer "Dust Bug," made with Cecil E. Watts parts adjustable to **any** changer arm, cleans without interfering with changer or tone arm operation. Removes static and dust while it protects the rec-

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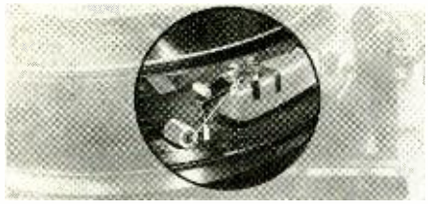
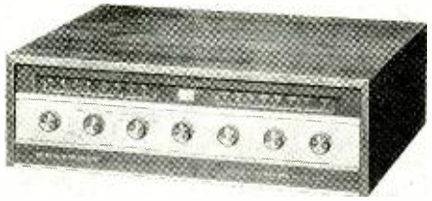


ord surface. The changer "Dust Bug" is carefully pre-balanced for minimal additional tracking force. Plush pile cleaning head with added antistatic agent as developed by Cecil E. Watts, world's most renowned authority on record care, eliminates dust and microscopic dirt ahead of stylus. Retail price is $5.00. Elpa Marketing Industries, Inc., New Hyde Park, N. Y. **A-13**

● **All-Transistor Stereo Receiver Kit.** The new Heathkit all-transistor AR-13 receiver is the first of its kind in kit form. Featuring the latest in solid-state circuitry, this compact unit houses two 20-watt power amplifiers, two separate preamplifiers, plus a wideband AM, FM and FM-stereo tuner. Features include **automatic** switching to stereo plus a stereo broadcast indicator light; two filtered tape



recorder outputs; concealed secondary controls. The unit is styled in Heathkit's new low-silhouette design with a beautiful walnut cabinet and extruded gold-anodized aluminum front panel. The price is $195.00. Heath Company, Benton Harbor, Mich. **A-14**

RECORDS

(*from page 50*)

sense demands it, thus making the musical whole quickly intelligible. Breitenbach's viola has a fine, singing tone with that plaintive, slightly hoarse, edgy quality that is the viola's special solo feature. Nice, folksy old German tunes built into a complex concerto structure.

Debut of Leonard Pennario on RCA Victor Records with Boston Pops/Arthur Fiedler

RCA Victor LSC 2678 stereo

Leonard Pennario, RCA Victor not so candidly tells us has, since he played with the N.Y. Philharmonic while still in the Air Force at 19, "grown steadily in artistic stature, eliciting flowing praise from conductors and critics alike both here and abroad." Not even a mention of his long career as a Capitol Records performer, well known to almost anyone who buys RCA Victor records! But, then, one does not mention the competition. Fact is, Pennario has moved over to RCA and this is his debut.

Not bad at all, even Dynagrooved. It isn't a subtle performance in any of its three items, nor is Dynagroove very subtle either in capturing the nuances of the Boston Symphony in its Pops guise. But Arthur Fiedler is an accomplished pepper-upper who likes to nibble into the bigger classics for kicks and effect. Pennario, a hard man at the keys when something best-sellish is wanted, can also turn his superb technique into sudden idealism. Maybe he's awed here by the surroundings—after so much of Hollywood; in any case, he plays with both brilliance and real sincerity, though his poetics are a bit mannered here and there. Without a doubt it is Pennario who makes this recording, not the Boston Symphony and Fiedler. A better-than-Pops debut from start to finish.

The music? RCA almost forgets it in small type on the cover. A really lively version of Franck's one folksy piece, the *Symphonic Variations*, a rather casual, if noisy, rendition of Rachaminoff's *"Paganini" Variations* and a fabulously light-fingered whirl-through of a pleasing little war horse, the Litolff *Scherzo*.

Haydn: Symphonies Nos. 89, 90. Vienna Symphony, Somogyi.

Westminster WST 17043 stereo

Haydn: Symphonies No. 44 ("Trauer"), 49 ("La Passione"). Orch. San Pietro, Ruotolo.

Decca DL 710069 stereo

Supplementing the fabulous "Library of Recorded Music" series of Haydn Symphonies, these continue one of the most welcome trends in LP classics—more Haydn. At last, we have begun to understand how superbly *recordable* this genial composer's music is, and our tastes continue, too, to veer more and more in the direction of a liking for his kind of music, as perhaps opposed to the "1812" Overture! The "1812" has its place in hi fi, as who doesn't know; but in all truth it is not made for recording, any more than Pike's Peak is made for Mercury stock sedans to climb in so many minutes to set an all-time record, as one did not so far back.

Some roads, then, are made not to stretch an auto's powers but simply to bring out the best in a good car. So with Haydn's music! And some composers, notably Haydn, are equipped also to bring out the very top best in the simple orchestral forces they employ. Economy of means: splendidly craftsman-like music, first-rate sound for recording.

Westminster's pair of middle-late symphonies, heretofore among the many dozens virtually unknown to us, are earlyish examples of the familiar late-Haydn style, as in the "Surprise," "London," "Military," "Oxford." But some aspects of these two immedi-

ate predecessors reflect interesting earlier facets of style, such as, for instance, the busy and Mozart-like (more precisely, J. C. Bach-like) first movement of No. 89. A fine team plays these two—put together an Austrian orchestra and a Hungarian conductor and you can usually count on good Haydn. Home territory.

Decca's Italian performers are of a different sort, one of those new, intensely virtuoso small Italian groups the first of which to hit the market was, I think, "I Musici." Very ardent, very earnest, playing in semi-chamber music style with a lean, spare sound and recorded close-up in somewhat dead acoustics, the players turn out very beautiful slow movements but in their fast movements tend towards a dry, didactic, choppy sound, disciplined but lacking in shape. Too bad, for the carefully phrased and shaped line is the essence of Austrian music—and nowhere more so than in fast music.

Odd—like the French, the Italians have always been blind to certain expressive aspects of German music, however much they play it. The current has gone much better the other way: German composers have absorbed immensely from both the French and the Italians.

Telemann: 3 Concerti—Suite Concertante. Pro Arte Orch. of Munich, soloists, Kurt Redel.

Westminster WST 17042 stereo

'Sfunny—in my day as a music student in college, old Georg Philipp Telemann was still the Man tLat Didn't Make It, the composer who was Better Known than Bach in the Baroque period (and how stupid people were not to see how foolish they were). Telemann, we understood, wrote enormous amounts of music and nobody cared a fig, whereas Bach. . . .

Well, Telemann, in our decidedly more advanced age, is more and more appreciated while Bach is just as good as ever. Telemann was extraordinarily versatile as well as unbelievably prolific, even for his time. Forty operas, for instance, and forty-four Passions (it says on the record), where we have just two of Bach's three or four. Like Hindemith today, he wrote something for everything, colorfully and in a more playable, more modern style than Bach, at that. Always superbly suited to the instruments, as well as full of virtuosity for their benefit.

There could be hundreds of Telemann LP's like this—but here is an excellent one to try. The South German group plays musically and in fine German style, if a bit dogmatically on occasion.

These are typical Telemann color-combos—concerti for 2 violins, for flute, oboe d'amore and viola d'amore, for single flute, and a monumental "concertante" suite for three oboes and bassoon—all these with string orchestra.

Judith & Doris Lang—Concert for Two Pianos.

Golden Crest CR 4070 mono

I must say, I was so bedazzled by these two young sisters' pianistic sounds that I didn't even notice the disc was mono. Dunno whether it comes in stereo too.

The girls made their whirlwind debut with old Mitch Miller, the bearded Satan, on big-time TV. That's just how they sound here, but nicely so, I'll admit. High powered, incredibly skillful, tuned to each other like one mechanism, full of bounce and enthusiasm, these sisters project on two pianos the American Ideal, just like the ads—let's HAVE FUN! Let's run hand in hand down the beach, straight into the surf; let's idle under a green waterfall (smoking Pool or something), or lean rakishly into a red sunset out of a red super-convertible. That's it! These girls have it!

Nevertheless, they are pianists to contend with in any league. They've long since solved all the technical problems they'll ever run into, their coordination is the best I've ever heard; their *forte* chords sound like dual trip hammers and their *piano* sounds are nicely soft—and they know all about bringing out planes of melody and accompaniment in the often-complex 20-fingered music they play. Their feeling for the snazzy recent French music of Milhaud and Poulenc is wonderfully spontaneous—it's their stuff, all right. Fine rhythmic verve, too, throughout.

As youthful performers, zestful, peppy, full of bounce, the sisters can't now be beat. But, Golden Crest airily announces, "the future looks bright for Judith and Doris Lang." Future with Mitch? Maybe.

P.S. and by the way: the Lang girls, it says, practice two pianos by remote control, one piano in the living room and the other downstairs in the play room. Papa Lang, an engineer, rigged a sound system so that "at a flick of a switch" each girl can hear the other. Feedback, anyone? (Or maybe they play with earphones.)

French Horn Masterpieces. James Stagliano; Paul Ulanowksy, piano.

Boston BST 1009 stereo

I question the word "masterpiece" in connection with many of the juicily Romantic items on Mr. Stagliano's program, but otherwise I find this as pleasantly horny a record as you'll find, showing off the professional sound of the instrument most admirably. Almost all of the pieces are slow and dreamy (a few fast, blatty items, for contrast) and the horn—particularly in stereo—comes from far, far away in that peculiarly spaceless manner that is its greatest asset. Nice recording. The piano is good too—it ought to be, with the accomplished Paul Ulanowsky at the keyboard.

Unusualities

The Glory of Cremona. (15 famous violins played by Ruggiero Ricci.) R. Ricci, vl., Leon Pommers, pf.

Decca DXE 179 mono
(Bonus 7-inch LP included)

There's more than mere wads of cash involved here—though plenty of that was symbolically on hand when these fifteen priceless fiddles were brought together in one place, complete with high-level protection that must have been of impressive proportions. There is, for once, the actual comparative sound of an outstanding cross-section of really great violins, played by a first-rate musician who surely can bring forth their tonal qualities as well as anyone ever could.

The big question: *can you tell the difference?* It's one thing to talk big about Stradivarii (six of them here) and another to spot the Strad tone in the middle of fiddles by Amati, Guarneri, Bergonzi and so on, not to mention Sears Roebuck—not here represented.

Well, I assure you that the differences are gratifyingly clear, as between one of these instruments and the next and as between whole groups, the Strads vs. the Guarneri instruments, for instance. Aided by Mr. Ricci's own interesting account of the performer's feelings about them and by a good historical survey of violin-making and of the individual makers, you can go ahead with confidence to use your own good ears—and marvel at the non-engineering subtlety of this great field of craftsmanship. For here, as if in defiance of modern technology, are fifteen wood-built masterpieces not a one of which can be equalled today, though the earliest dates from around 1560 and the most modern from 1744!

When we get around to inventing the perfect Super-Strad Mark XXXVI, made out of plastics and glued with epoxy by automation, we can maybe boast about modern acoustical engineering.

The main record presents each of the fifteen violins in a different short work—some of them modern and most dating from well after the creation of the instruments themselves. (Funny, to hear an instrument constructed in 1677 playing a piece by Kabalevsky from a few years ago.) Presumably Mr. Ricci has more or less matched the music to the instruments, though there is none that can't be played on any of the fifteen.

(*Continued on page 65*)

DIVIDING NETWORK

(from page 28)

The extreme simplicity of the mathematical condition for perfect transient response makes us wonder if there may not be an equally simple physical configuration. Let's reflect on the basic operation we are performing. We are passing an electrical current through a network and taking off a voltage produced by the current through one element of the network. We are also passing a current through an identical network (remember neither the network nor the current knows that one network is "upside down" compared to the other), and taking a voltage off the *remaining* elements of the network. One voltage taken across Z_a and the other across $1 - Z_a$.

Why do we need two networks then? Why not use just one and take one voltage across the Z_a branch and the other across the $1 - Z_a$ branch? The answer is both simple and encouraging—no reason at all! We can just take one network and by taking the voltages from the proper places obtain both perfect transient and steady-state response. Of course we are helped considerably in our ability to do this since we are working within the amplifier, and need not be concerned about loading down our reactances. The essential tool here is the differential amplifier, which amplifies only the difference in voltage between the two grids. By using such an amplifier as shown in *Fig.* 12 we can utilize only one "half" of a dividing network, and achieve a division capable of being linearly combined to produce both transient response and perfect frequency response.

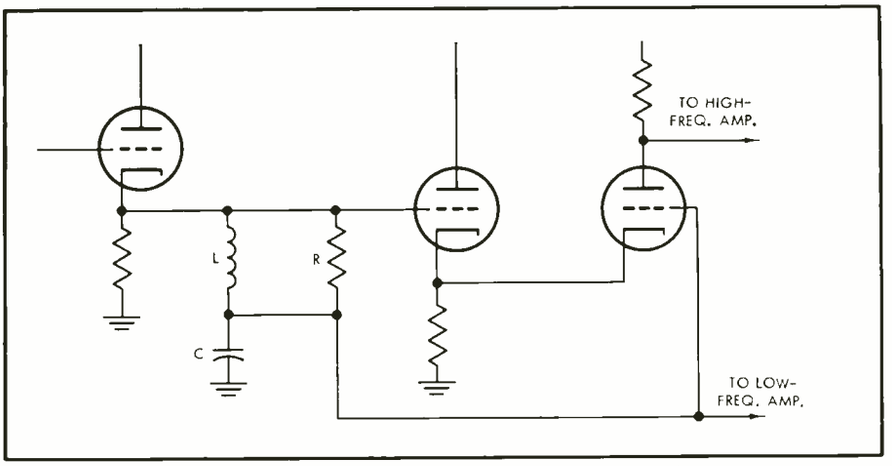


Fig. 12. By using a differential amplifier we need use only one section.

In closing, let's keep in mind that our analysis has been based on theoretical considerations, assuming both a linear dividing scheme and a linear mixing (adding) scheme. In actual practice, the linear division, taking place in electronic components where lumped constant theory applies, will be quite easy to achieve. The linear addition, however, takes place under quite different conditions—in an acoustical medium where distributed constant theory prevails and nonlinearities are all too prevalent. Therefore, although we could check the accuracy of our results quite readily in an electronic system, using a linear mixing network to recombine the outputs of the two channels, we would have no easy time at all to verify this acoustically. As a matter of fact, because of the finite wave velocities and the dimensions relative to the wave lengths involved, it could be verified only to a limited extent and only at certain points. Æ

STEREO DISC

(*from page 34*)

as being an inordinately large tip mass. Again, the term pre-distortion, though technically correct, offers calumnious implications to many minds. A more balanced view regards the compensation as correctly shaping the groove modulations to bring, in effect, the recording stylus shape into agreement with that of a standard reproducing stylus, thus banishing tracing distortion.

The use of the compensation does not free the recording engineers of all need for restraint in choosing the levels of the modulation. All the old limits, including the curvature-overload limit, are still to be respected. From the point of view of the recording engineers, compensation means that these limits may be approached more closely. As with any new technique, it would take some time for the proper use of compensation to be fully mastered, so that one should not be surprised if early efforts were only partially successful.

Tracking Distortion

The distortion arising from a disparity between cutting and tracking angles—tracking distortion—is well understood by now and need offer no great difficulties in the future. It may be largely removed by merely using a cutter of the proper inclination and standardizing the tracking angle of the cartridge. These tracking errors have mostly to do with the vertical, and it is this angle which should be standardized. The proposed standard is 15 deg. The lateral angle should also, of course, be maintained within a degree or two of the perpendicular to the nominal groove axis, as always.

There remain some minor problems associated with an interaction between the use of a non-vertical cutting inclination and the use of tracing compensation. The interaction leaves a residual distortion comparable to that which a 0.05-mil mis-match in tip radius would leave. Even that interaction may be undone, if a vertical cutter is used, and electronic compensation, similar to that for tracing error, is used to adjust the effective cutting angle.

There is also a mechanical analog computer for the simultaneous correction of cutting angle and compensation for tracing. The name "mechanical analog computer" is a little pretentious, since the procedure merely involves playback of a first cutting and re-recording with reverse polarity.[4] The process adjusts the effective cutting angle to that of the playback cartridge and provides an effective cutting-stylus shape matching that of the playback cartridge. While the effective cutting angle is independent of the actual angle characteristic of the cutter, the residual distortion is least if the cutter angle is the reverse of the tracking angle. Then, the residual distortion is due only to the effective tip mass of the playback cartridge used in the re-recording. Since the playback and recording can proceed simultaneously with the making of the first cutting, some of the objections to a two-step process may be overcome.

Conclusions

The era of distortionless stereo disc recording and reproduction is almost at hand. Tracking distortion may be fully relieved, along with tracing distortion. Relieving the latter leaves tip-mass distortion to be reduced by means independent of tracing error problems, means which need not be used up by diminishing the stylus radius. Continuing advances in reducing effective stylus-tip mass, in the reproducing cartridge, would reduce the last major source of distortion in stereo phonograph reproduction. **AE**

[4] The technique was first proposed by MacNair for correcting tracing error in the discussion following the paper by Pierce and Hunt, "Distortion in Sound Reproduction from Phonograph Records," in the *Journal of the Society for Motion Picture Engineers* for August, 1938.

A TON-AND-A-QUARTER OF SOUND

(*from page 23*)

a common vertical axis for the two cylindrical section horns.

A sufficient number of parameters had now been fixed so that the cut-off frequency and mouth area could be selected. Several mouth areas were selected and the corresponding cutoff frequencies calculated for a 40-in. horn length. Next graphs were studied showing the variation in specific acoustical impedance at the throats of exponential horns as a function of frequency for various mouth areas. The best combination for this particular design was thought to be a 1350 square-inch mouth with a 45 cps flare cutoff frequency. For this situation the graphs predict some horn resonances near cutoff. These graphs are for free-space conditions. With the horn set on the floor and close to room walls, the horn behavior should be considerably better than predicted by the graphs. Another mitigating factor is that the beneficial damping effects of the driver and its generator are also neglected in such graphs. The absence of any serious resonance conditions in this horn driver system was confirmed outdoors without any nearby aiding surfaces except for the ground.

Since the bass horn is relatively short, excellent control over its polar characteristic is not very feasible. Good control is possible only when the horn length is large compared to the radiated wavelength. The pattern is narrowest when the horn mouth dimensions are about one wavelength. For longer wavelengths, control is lost as the pattern begins to become very broad. With this in mind, instead of using the same 100 deg. angle as in the high-frequency horn, the bass horn angle was made narrower in order to try to compensate a little for the excess broadening at the lower frequencies. This angle is about 64 deg. Actually, other factors also were involved in this angle determination, such as mouth area. But, the objective was to try to match as well as possible the polar patterns of these two horns.

With the drivers selected, and the bass horn parameters fixed, the design could now be completed. The volume of the back cavity was calculated to be 3.7 cubic feet per driver. A test showed no detectable difference whether a partition was used or not between the back cavities of the two drivers. Weight and design complexity were lessened by the omission of such a partition. In the final design a small partition divides the speakers on the front side. This was done mainly for structural rigidity in that high pressure region.

Horn section models and a mold were constructed, and bass horn sections cast with concrete according to the design shown in *Fig.* 5.

The low- and high-frequency channels are each directly connected to individual power amplifiers. The crossovers are high-impedance electronic type ahead of the power amplifiers. Originally, all the electronics were vacuum tube type with four 50-watt power amplifiers for a two speaker stereo system. The tube electronics have now been replaced with transistorized units.

The room where this system is located has a volume of about 3000 cubic feet. All the walls are concrete. The floor is concrete over earth and is covered with a wall-to-wall rug. The roof is an open beam type using heavy timbers and it is in turn covered by a 3-in. thick layer of concrete. The entire environment is therefore quite solid. But the environment was not built for this speaker system. It was in existence long before this system was conceived or built.

This completed system was originally used outdoors with very thrilling results. It is planned someday to build a larger system for permanent use in this garden area. Here the two speakers were about 25-feet apart, while the listening area was about 60-feet away. The fidelity of reproduction at even the loudest levels was phenomenonally good. The instantaneous peak power inputs to the individual drivers for the loudest levels tolerable were about 40 watts. Indoors, for the same tolerance, the input peaks measured about 1 watt. Calculation showed that in the room the sound level is about 110 db for one acoustic watt into the room.

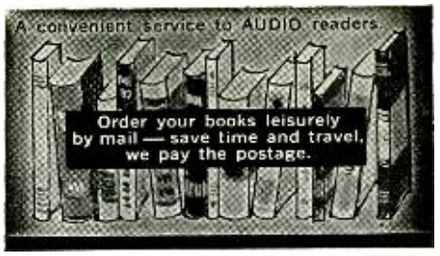
The high-frequency channel has an electrical-to-acoustical conversion efficiency of about 45 per cent, while the low channel is about 25 per cent. For indoor use four one-watt amplifiers would suffice for the loudest listening levels. However the transistor amplifiers used are capable of much more: about 35 volts peak into each of the 8-ohm bass channels, and similar peak voltages into each of the 24-ohm treble channels.

Any possible deleterious effects due to grill cloths were avoided by not using any such obstructions in the sound path. In fact, when the first high frequency sectoral horns were completed it was remarked by some that the curved surfaces of the horns are quite pleasing and that they could be left in direct view. Thus the horn system has no enclosures. With the application of several layers of linen-white latex wall paint to all the concrete surfaces the decoration of this system was easily and very satisfactorily accomplished. It fits very well with the decor of its present environment.

It must be emphasized that these two horns are intended for use only with the Altec Lansing 288C (or older 288B) drivers and the Jensen P15-LF units. To attempt to directly mount other types of drivers to these two horns with no design modifications will most certainly result in poorer performance. For top performance attention must be paid to details.

With this system any distortions or flaws in the source material is readily apparent. The biggest problem now is finding the rare extremely high quality source material which will permit the full realization of the system's capabilities. The best recorded source material used is in the form of 15 ips and 7.5 ips two-track stereo tapes recorded with two condenser microphones.

Several individuals contributed heavily to the successful accomplishment of this project. Primarily, gratitude is expressed to Mr. William Kloepfer for his considerable help and encouragement. Also, Mr. David Richardson and Mr. and Mrs. Ralph Cappelli are thanked for their efforts. AE



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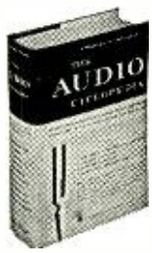

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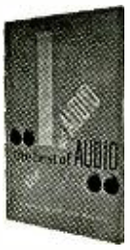

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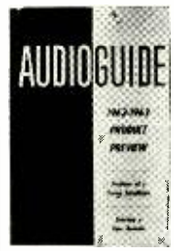

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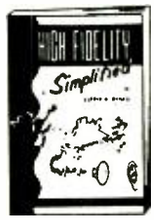

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Getting The Most Out Of Your Tape Recorder
Herman Burstein

Written in "plain talk" for the man who has, or wishes to buy, a tape recorder. It answers the myriad questions raised by tape recording enthusiasts. Its chapters cover every phase of operation and maintenance—from adding a tape recorder to the hi-fi system, to a thorough dissertation on microphones. Lots of practical information on how to buy. 176 pages.
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RECORDS

(*from page 59*)

A supplementary bonus 7-inch LP presents all fifteen in sequence playing an identical short passage, the opening of the Bruch G minor Concerto, a passage without accompaniment which moves from low pitch to high and from faint to loud. Good idea. (Check on yours—the little disc tends to fly out of its folder and may have been quietly and/or larcenously removed by previous fingers.)

Christmas in the Congo. Les Troubadours du Roi Baudoin.

Philips PCC 607 stereo
(electronically re-channeled)

Don't worry—aside from a superbly African "Silent Night," this disc doesn't include much that will sound outdated in January. Not unless you are a local resident in the Congo.

The boy singers are presented in their second recording and are perhaps even more impressive here than in the strangely mixed Catholic mass they sang on the first. On both, they show an incredibly disciplined excitement, shaped and released into music by the Father who originated this singing group, presumably before the Troubles that followed the removal of King Baudoin and his subjects from the scene.

There is much talk here of the African influence; but what is interesting in these kids' singing is the astonishing mixture of purely local African music with clear Western influences.

"Silent Night" goes the furthest; aside from the strange words and a certain wild, primitive purity, the carol is more or less as usually harmonized—the children have no trouble at all in "hearing" Western-type harmony. Far from it! Such exquisitely accurate intonation I have seldom heard. Other numbers on the program range all the way over to what must be pure-bred Congolese music, chants, exclamations, repeated again and again, often with leader and chorus, plus vigorous drums, the rhythms astonishingly complex and performed with utter ease and familiarity. This could only be the "real stuff" of native music. The more remarkable, then, that these kids can sing "Western" with so little trouble. Kids are kids the world over. No problems in *learning;* that's what kids are made for. Given the chance.

The gaudy and rather beautiful record album provides about as little useful information as any I've seen. I can't find even a suggestion as to what the various items are all about. Just the titles in "Congolese," like for instance, *Tambwe Dishinda* or *O Siekeni Wee Mama.* Maybe *Wee Mama* is the Virgin Mary in Congolese guise.

Heroic Music for Organ, Brass and Percussion. E. Power Biggs and Ensemble. (Orchestrations by Biggs, percussion by Daniel Pinkham).

Columbia MS 6354 stereo

The sure-fire "trumpet voluntary" formula, trumpets (preferably British) with orchestra and/or organ was made popular by Mr. Biggs in his long-time Sunday morning CBS broadcasts. It goes on and on, and this is the latest entry in the field, with a bit more variety than usual (and more arranging-from-the-original), but still basically the familiar and inspiring sound, with extra trumpets and added trombones. We have Jeremiah Clarke himself and the famous "Voluntary," supposedly by Purcell, that here takes on its rightful name, "The Prince of Denmark's March," but remains the prototype of trumpet tunes for modern ears. We have Handel, Croft, Purcell, plus a brace of Telemann to fill up the second side.

Good of its type, spacious in sound, played with a bit of hardness here and there and a bit too much show—for my chaste taste, anyhow. It'll sell. AE

NEW LITERATURE

● **Hi-Fi Primer Now Available.** A 64-page booklet which takes the mystery out of high fidelity equipment and simplifies the selection of component units has been prepared by the Institute of High Fidelity, Inc. It explains the function of all the components used in a high fidelity system, how to shop for them, and how to buy them. In addition, the booklet points out that high fidelity can add to the decor of almost any room and it also includes a glossary of high fidelity terms. It is available from the Institute of High Fidelity, 516 Fifth Avenue, New York 36, New York for a 25¢ handling charge. **A-1**

● **TV-FM Aids for Home Reception.** "TV-FM Reception Aids for the Home," an 8-page 2-color booklet, describes and illustrates Jerrold's family of reception aids for improved home televiewing and listening. Photos and descriptions cover: Super-Powermate, twin-transistor, mast-mounted TV preamplifier; Powermate; "De-Snower" type VHF preamps; new "Silver-Circuit UHF preamplifiers; top-of-the-set "Ultra-Vista," "Super-Vista," and "Vista" UHF converters; 2-transistor indoor Super-Powermate, amplified TV Coupler; plus splitters, extenders, multi-set couplers, mixing networks, filters, traps, matching transformers, isolation networks, a TV/FM broad-band amplifier the "Challenger"; and the TV-FM Magic Carpet Antenna. Distributor Sales Division, Jerrold Electronics Corporation, 15th & Lehigh Ave., Philadelphia 32, Pa. **A-2**

● **M-S Stereo Paper.** Gotham Audio Corp. has available reprints of an article titled "M-S Stereophony and Compatibility." This paper describes the "mid-side" or intensity method of stereo microphone pickup which gives full stereo separation while always assuring complete compatibility so that mono listeners hear the full sound picture. Limited quantities of this article are available; therefore requests should be made on company letterhead or identify affiliation. Gotham Audio Corp., 2 West 46th St., New York 36, N. Y. **A-3**

● **Tape Recording Booklet.** A newly-released booklet from Sarkes Tarzian, Inc. entitled "Lower the Cost of Fun with Tape Recording," contains 32 pages if information for the beginning tape enthusiast. Included are sections on how to have fun with your tape recorder, how to record from various sources, splicing and editing, the care of your tape recorder, and tests for tape quality. Sarkes Tarzian, Inc. Magnetic Tape Division, Bloomington, Ind. **A-4**

● **Cartridge Cross-Reference Manual.** The Electronic Applications Division of Sonotone Corporation has just released its well-known cartridge cross-reference replacement manual in a revised, up-to-date edition. The cartridge cross-reference data is divided into two sections: cartridge to cartridge and phonograph to cartridge. The manual is also indexed by models for fast and easy reference. Over 4000 cartridges and phonograph models are listed. The 24-page manual is printed in two colors. The last page shows all current Sonotone replacement needles (including the new resilient Sono-Flex needle), as well as cartridges. The Sonotone Warranty Policy is reproduced and other audio products made by Sonotone are pictured, including ceramic microphones, headsets, tubes, tape heads and speakers. In addition to regular punching, the manual features a hole punched in the top lefthand corner for hanging from the service bench or sales counter. For a free copy of Sonotone's new cartridge cross-reference replacement manual (SAC-25), write Electronic Applications Division, Sonotone Corporation, Elmsford, New York. **A-5**

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NEW IN SOUND FOR "64": Full fidelity loudspeaker systems. Brochure. Island Associated Industries, 1261 Staley Rd., Grand Island, N. Y.

DUST MARRING RECORD ENJOYMENT? Write for brochure describing Mercury Dis Charger. Keeps records dust free, extends record life. An ideal gift. Mercury Scientific Products Corp., P. O. Box 275, Solana Beach, California.

CUSTOM RECORDS FROM YOUR TAPE. 25 minutes. $6. p.p. We use hot stylus. Write for quantity prices. Sound Specialties, 7846 Palm St., Lemon Grove, Calif.

HIGH FIDELITY MAGAZINE: Complete set May, 1953 through January, 1959 (missing August, 1958). Excellent condition. Best offer takes. MacDonald, 6415 Meadow Road, Dallas 30, Texas.

WANTED: Marantz Model 3 electronic crossover. H. P. Haley, P. O. Box 47, Albany, Ga.

FOR SALE: Bozak B-200X and B-200Y, $20 each; B-290A, $30; all four for $60. Also Jensen P-15LL, $20. Hopkins, 1916 Valley High, Cedar Falls, Iowa.

● **Test Instruments Catalog.** A new 26-page Short Form Catalog is now available from Hewlett-Packard Company. Designed to provide a complete and ready reference to the many types of electronic test instruments now available, the catalog indexes products of Boonton Radio Company, Dymec Division of HP, Harrison Laboratories, Hewlett-Packard Company, F. L. Mosely Co., and Sanborn Company (Industrial Division). Typical instruments listed include: oscilloscopes, voltmeters, oscillators, signal generators, power supplies, electronic counters, pulse generators, microwave equipment, event recorders, strip-chart recorders, X-Y recorders, impedance measuring instruments, and equipment for digital data acquisition and r.f. measurement/control. Copies of this catalog are available without charge from Hewlett-Packard Field Offices or directly from the factory. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. **A-18**

Industry Notes . . .

● **More Moves at University. Stan Neufeld,** National Sales Manager for University Loudspeakers, recently announced the appointment of **John Pacconi, Jr.,** as Special Products Manager. The Special Products division of University covers a complete line of microphones, electronic sirens and other solid-state electronic equipment. Mr. Pacconi will be responsible for the sales of these products to distributors, dealers and O.E.M. accounts throughout the United States.

Mr. Neufeld also announced the appointment of **Charles Overstreet** as Advertising Manager. Mr. Overstreet will be responsible for all advertising and public relations requirements for University's line of high-fidelity and public address speakers, microphones and related electronic equipment.

More recently, **Haskel A. Blair,** President of LTV University announced the appointment of **W. Fred Steers** as Manager of Engineering. Mr. Steers will be responsible for all phases of engineering covering the many products in University's line of high-fidelity systems and components, public address speakers, microphones, and related electronic equipment. Mr. Steers is probably best known for his most recent service as Executive Vice President in charge of Manufacturing and Engineering of the Glaser-Steers Corporation.

Last, but not least, University announces the 1964 holiday promotion—Fiesta Mexicana. One day next April, fifty "Very Special Men" and their wives will board a "Very Special Airplane." The "Very Special Men" will be the highest-over quota distributors of University's complete line of commercial and industrial public address speakers, high-fidelity component speakers and speaker systems, microphones, and related electronic equipment. The "Very Special Airplane" will be a Univerity chartered 707 Jet. Its takeoff will signal the beginning of University's 1964 Sales Promotion Holiday, Fiesta Mexicana. The Holiday, now an annual event with University Loudspeakers, will be an eight-day all expense paid vacation in Acapulco and Mexico City.

● **Electro-Voice Adds Tennessee Plant.** The addition of a new Electro-Voice plant, to be erected in Newport, Tennessee, was announced today by **Albert Kahn,** president of the Michigan-based electro-acoustic manufacturer. The structure, which will add 30,000 square feet of production space to the firm's facilities, will consolidate phonograph cartridge production, now housed in three separate plants, Kahn explained. Construction work, it is expected, will begin soon. To be erected by the community of Newport and leased to Electro-Voice, the addition has been under study by E-V management for some time, according to the announcement. Although a consolidation economy in phonograph cartridge production is the prime objective, Kahn pointed out, there are others which, he explained, are regarded as being of almost equal importance. Among those cited were the expansion and improvement of the firm's manufacturing capabilities for its rapidly-expanded cartridge division and for military and original equipment microphones.

● **Concord Introduces Merchandising Manual.** A completely new type of tape recorder Merchandising Manual for representatives and distributors has been introduced by Concord Electronics Corporation. **Don Hassler,** Marketing Manager for the West Coast concern, said that the Merchandising Manual includes sections on success-proven dealer sales promotions, merchandising techniques, service programs and complete details on the Concord tape recorder line, in both technical and easy-to-understand lay language. In addition, the new manual also offers various merchandising ideas and materials as publicity releases, direct-mailers, advertising mats, p.o.p. displays, glossy photos, point-of-sales literature, informative product fact books, streamers and banners, plus other selling aids. Concord Electronics Corporation, 809 North Cahuenga Boulevard, Los Angeles 38, California.

ADVERTISING INDEX

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Taped sound retains full fidelity even after hundreds of playbacks — yours to enjoy always — on VIKING tape components, naturally.

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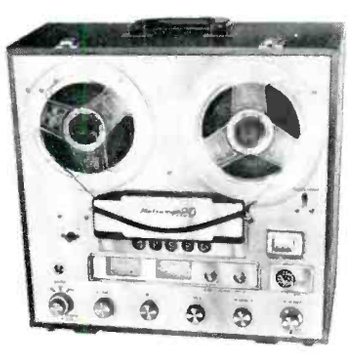

88 Stereo Compact — for connoisseurs of the fine things in high fidelity stereo sound.

Two speed tape recorder with choice of half or quarter track stereo. Three new type hyperbolic heads—no more old fashioned pressure pads. New design amplifier with excellent 30-18,000 cps frequency response, lets you monitor off the tape with "A-B" comparison switch. Independent channel controls and VU meters, two motors, record indicator light, counter, automatic tape shut-off. With its attractive, brushed aluminum face panel, the 88 Compact fits any installation for vertical or horizontal operation.

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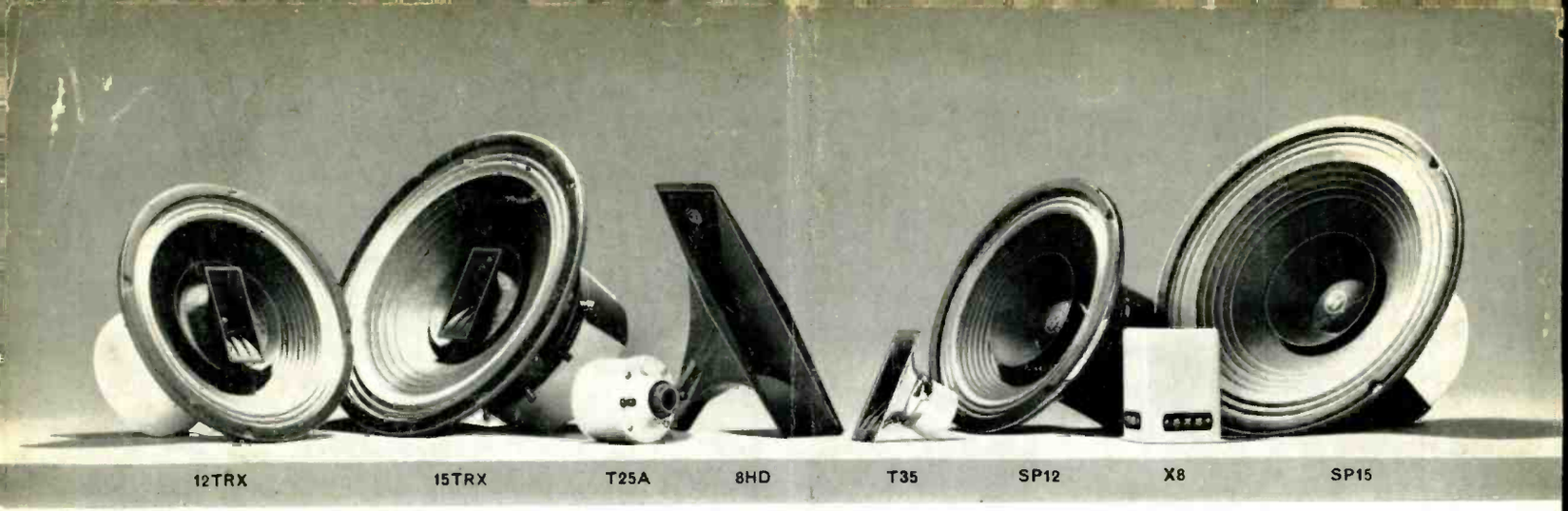


A Return to the Fundamental Concept of High Fidelity: SOUND OF UNCOMPROMISING QUALITY!

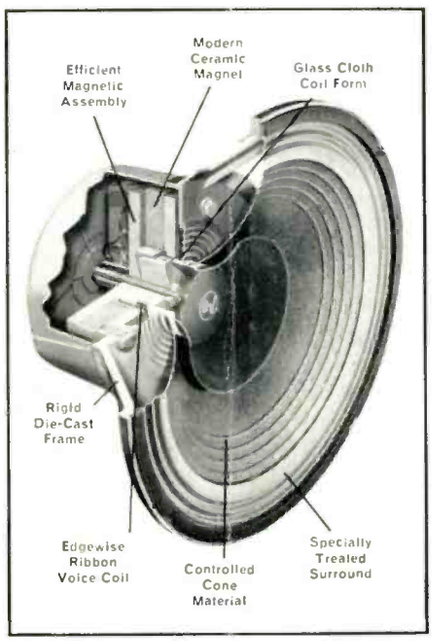
Before you make the final choice of speakers for your high fidelity system, take a moment to review your goals. What comes first—size, cost, or performance? If performance is of prime importance, then you owe it to yourself to look at—and listen to—Electro-Voice Deluxe component speakers. Granted, they are not the smallest or the least expensive speakers you can buy, but their design is predicated on the need for quality reproduction above all other considerations.

Your ear is the final arbiter of speaker system quality, but it may help you to know what's behind the unequalled popularity of E-V in the component speaker field. It begins with the finest engineering laboratory in the industry, finest not only in equipment, but also in the size of its staff and in its creative approach to electro-acoustics.

The basic design for E-V Deluxe components was laid down over a decade ago, and, despite numerous detail improvements, this approach is just as valid today. It begins on a firm foundation: the rigid die-cast frame that provides a stable basis on which this precision instrument can be assembled. It is this frame that assures that each E-V Deluxe speaker will forever maintain its high standard of performance by maintaining perfect alignment of all moving parts.

Added to this is a magnetic assembly of generous proportions that provides the "muscle" needed for effortless reproduction of every range at every sound level. In the case of the SP15, for example, four pounds, ten ounces of modern ceramic magnet (mounted in an efficient magnetic assembly weighing even more) provides the force needed for perfect damping of the 15-inch cone.

Within the gap of this magnetic system rides the unique E-V machine-wound



edgewise-ribbon voice coil. This unusual structure adds up to 18% more sensitivity than conventional designs. Production tolerances on this coil and gap are held to ±.001 inch! The voice coil is wound on a form of polyester-impregnated glass cloth, chosen because it will not fatigue like aluminum and will not dry out (or pick up excess moisture) like paper. In addition, the entire voice coil assembly can be made unusually light and rigid for extended high frequency response.

In like manner, the cone material for E-V Deluxe components is chosen carefully, and every specification rigidly maintained with a battery of quality control tests from raw material to finished speaker. A specially-treated "surround" supports the moving system accurately for predictably low resonance, year after year, without danger of eventual fatigue. There's no breaking-in or breaking down!

Now listen—not to the speaker, but to the music—as you put an E-V Deluxe component speaker through its paces. Note that bass notes are neither mushy nor missing. They are heard full strength, yet in proper perspective, because of the optimum damping inherent in the E-V heavy-magnet design.

And whether listening to 12-inch or 15-inch, full-range or three-way models, you'll hear mid-range and high frequency response exactly matched to outstanding bass characteristics. In short, the sound of every E-V Deluxe component speaker is uniquely musical in character.

The full potential of E-V Deluxe component speakers can be realized within remarkably small enclosure dimensions due to their low-resonance design. With ingenuity almost any wall or closet can become a likely spot to mount an E-V Deluxe speaker. Unused space such as a stairwell can be converted to an ideal enclosure. Or you may create custom cabinetry that makes a unique contribution to your decor while housing these remarkable instruments. The point is, the choice is up to you.

With E-V Deluxe component speakers you can fit superlative sound to available space, while still observing reasonable budget limits. For example, a full-range speaker such as the 12-inch SP12 can be the initial investment in a system that eventually includes a T25A/8HD mid-range assembly, and a T35 very-high-frequency driver. Thus the cost can range from $70.00 up to $220.00, as you prefer—and every cent goes for pure performance!

Write today for your free Electro-Voice high fidelity catalog and list of the E-V audio specialists nearest you. They will be happy to show you how E-V Deluxe component speakers fulfill the fundamental concept of high fidelity with sound of uncompromising quality!

ELECTRO-VOICE, INC.
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