A Ton-and-a-Quarter of Sound ............ page 19
ON A DESERTED MOUNTAINTOP
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SCOTT MONOPHONIC 310 IS
ABOUT TO BE REPLACED...
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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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Number 5 in a series of discussions by Electro-Voice engineers

The ultimate goal of most sound reinforcement systems is to improve distribution of the desired original sound without changing its essential character—except, of course, in measure-ment its volume. This would imply the use of "flat" response in all elements of the system. While this may prove useful in some instances, it is least likely to be successful where acoustics are poor. The microphone will (typically) pick up the original sound plus a proportion of both reflected and reproduced sound, thus "coloring" the reproduction and often increasing the apparent severity of the acoustic problems.

Often unidirectional microphones are used to reduce pickup of anything but the original signal, but these too can add to the problem. Typically, most unidirectional microphones use single front and rear openings to achieve their cardioid polar pattern. It seems a simple and direct method to obtain satisfactory cancellation of sound from the rear. Unfortunately, with a single rear opening, a small acoustic phase shift remains at low frequencies, requiring the use of an undamped mechanical system to retain flat on-axis response.

This undamped condition gives rise to high shock sensitivity and a sharp increase in "proximity effect" (bass response rises as the microphone distance is decreased). At close distances the system has no fixed response and uniform results are impossible. To eliminate these problems, a new type of unidirectional microphone has been designed. Based on the Continuously Variable-D* principle (currently available in the E-V Model 676) it allows exact adjustment, during manufacture, of phase shift at all frequencies to minimize both proximity effect and shock sensitivity. Proper damping of the mechanical system is also provided while flat on-axis response and uniform cardioid directivity is retained.

Another problem is strong low frequency resonances in the room. These tend to overemphasize and blur low bass sounds and to trigger feedback. The Model 676, in addition to flat response, is provided with a variable tilt-off circuit in the microphone to reduce its sensitivity to low frequencies. The tilt-off starts at 750 cps and is down 5 or 10 db at 100 cps depending on the setting of the external switch ring at the rear of the unit. No reduction of front-to-rear cancellation occurs in any tilt-off position.

The reduction of proximity effect, plus the control of bass response at the microphone, when carefully used with the proper speaker and amplifier characteristics, provides a new measure of clarity and naturalness of sound, even under adverse acoustic conditions.

* Patent No. 3,095,484

For technical data on any E-V product, write:
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Number 5 in a series of discussions by Electro-Voice engineers

STOP RUNAWAY P. A. BASS

E. J. Schober
Senior Microphone Engineer

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For technical data on any E-V product, write:
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General . . .

  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 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. H. 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 attendant 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 lower 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 overloaded 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 high-pass to ground in a crossover which is providing 50 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 pre-amplifier provides 220 volts. This is connected to one of the arms of one potentialmeter, the other end being grounded. The arm of the pot is adjusted so that the smaller resistance, or some 5k of the 250k 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-
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tensionometer 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.
A Troubadour is a Troubadour is a Troubadour

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**TROUBADOR**

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*Patent Pending.
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 audiophiles who have become disenchanted with the present sound available on some of the major labels. To the credit of Warner's engineering staff, there is no hopping off of top or bottom segments of the frequency spectrum in order to accommodate the deficiencies of cheap playback equipment. Dynamics are left relatively unhampered 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 cheaper playback systems 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 true attraction by winning the coveted列车ive Association of America's prestigious Musical Foundation for the Preservation of Barbershop Quartet Singing. Following the New York performances of "Music Man" and the film version of the show, the group is in Cincinnati playing concerts atupper club such as the one that provided the live acoustics for this recording. Anyone who enjoys the good stereo sound 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 barbershop quartet would tackle. The orchestra of Bill Cross is housed 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 of this male trio that has enjoyed in show biz, but no one at the club would deny that the music on this disc is new and fresh. All three members of this group are graduates of the famous Harry Belafonte Singers, belonging to 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 home theater will decide it has the quality necessary to make the 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 caliper of its songs to keep the customers from flocking in their seats. In terms of wholenessomeness, the story surpasses even the "Sound of Music," the previous contender for top honors in this picture-like-family category. In "Sound of Music," Rodgers and Hammerstein have finally 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 probably guessed by now, is based on the old movie "Miracle on 54th 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 Scrooges and Gimbels department stores while preserving as much as possible of the charm that made the film "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 may well manage to surprise.

The leading man making his Broadway debut is Craig Stevens who projected Peter Gunn into the role with spectacular effect last year in television listings as long ago as 1958. Jane 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, her voice is the strongest and most forceful 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 wrote for "The Music Man" and "The Unsinkable Molly Brown." The closest link to earlier Broadway successes is the bouncy music for the marchers in the Thanksgiving Day Parade. The single exotic touch in the score is a short number 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 not an ordinary Goulet recording. For one thing, we are quite aware of the fact that the average recording artist's voice does not have the same accent as that given to his work by his label. Since recording sessions will sometimes be over before the vocalist has even had a chance to study the sheet music, these releases are a就能 u话s are a direct result of the session engineer's skill. For another thing, the real sound of a recording is the result of a collaboration between the recording artist and the label. Since the label has the financial resources to put the composer, the arranger, the conductor, the engineer, and the session player in the recording studio, it is only to be expected that the label's imprint will be evident on the disc.

Robert Goulet 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, Goulet has stepped out splendidly at the concert Columbia taped for this recording. So many studio recordings these days are turned out haphazardly with the singer running through a bunch of songs with one eye on the music stand before him and the other on the fellow next to him telling him he's already late for his next appointment. This Goulet recording, on the other hand, puts the listener in a position that spent its good money to attend his gala concert at the Chicago Opera House. What attending is a performance enriched to jewel-like precision by weeks of rehearsal and, more importantly, by exposure to a series of audiences. Lyn Duddy and Jerry Brailer created the special material Goulet uses in the concert, a set of up-tempo Wake Up that opens the show as well as the ballad Melinda, the breezy Concentrate on One Thing at a Time, the Fades Are Marching In. Jerry Brailer 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 "Camelot." Unfortunately, the 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 seize. France is far too poor in personality singers even with the great Piaf gone. It is hard to believe that a decade ago Patachou made her first real mark in this country with a smash fourteen-week engagement at the Empire Theater at the Astoria Hotel. A typical collection of Patachou favorites has been miked at close range, consequently it will be a shock to forget that the singer and the small acoustic room are really working in a large hall. The only reminder of the locale is to be found in the reaction of the audience heard around the footlights as Patachou explains, in her unique way, the meaning, latent and significance of the songs she is about to sing.

Gordon Jenkins: In a Tender Mood
Columbia CS 8889

The recordings of Gordon Jenkins demonstrate the changes that have gone down the way of conductors who choose not to stay put on one label. While many band leaders may lose some of their best players to the 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 with other signs are the far cry from the basic principles of Columbia's low-distortion process and the solid musicianship of a conductor-arranger who has conducted and arranged for the trappings of fads in sound or the vagaries of the musical marketplace. In the case of this stereo recording you never lose the melody in such an arrangement as Begin the Beguine, Patachou at the Wind. The freshness of the album lies in the way Jenkins introduces his idea, perhaps in a way that you over theheader 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 time happens to be a Jenkins composition, as in the case of Breezy, the task is easier but the important point is that he handles most tunes as though he had collaborated on their composition.

www.americanradiohistory.com
When a component-oriented audio engineering journal comes out in favor of an integrated, all-in-one stereo receiver, it has to be a remarkable piece of equipment. Here is what the "Equipment Profile" column of the December, 1963 issue of Audio has to say about the new Fisher 500-C:

"The 500-C incorporates a 75-watt (IHF) stereo amplifier, an FM-stereo tuner and an audio control center, all on one 36.5-lb. chassis...

"...We found that the tuner drifted less than 0.01 per cent.

"The output transformers are quite husky (we have a strained back to document that)...

"By implication, and sometimes overtly, we have been led to believe that separate components are inherently better than integrated components. Well, 'taint necessarily so. In fact, it is our opinion that one would have to pay considerably more to get performance equal to the 500-C in separate components.

"...The FM section pulled in 36 stations, loud and clear...

"Considering the performance, and the many features, and the quality of the parts, we doubt that you could do better in separate components at anywhere near the price of the 500-C. Don't misunderstand us now, we firmly believe that it is the component design approach that makes such an excellent value possible. On the other hand it should be clear from the performance statistics that the Fisher 500-C is an excellent instrument by any standards.

"One thing more: the Fisher 500-C is an unusually fine sounding unit, a fact not necessarily revealed by statistics...We took an instant liking to it."

The price of the Fisher 500-C is $389.50. The Fisher 800-C, with both AM and FM-Stereo but otherwise identical, costs $449.50. Also available is the Fisher 400, an only slightly more modest receiver with FM-Stereo only, at $329.50. Walnut or mahogany cabinets for all models, $24.95. All prices are slightly higher in the Far West.

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AUDIO • JANUARY, 1964

7
LETTERS

Is Stereo Necessary?

Sir: I agree with Mr. Honey (“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 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. GILLING 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, have only 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 “...sim-plified” arrangements of timeworn old chasubals, 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. IRVAN 9175 San Juan Place La Mesa, Calif.

“Fluid” vs. “Solid-State”

Sir: Edward T. Cunly brought out an interesting point in his comment on “Fluid” vs. “solid-state” (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 with that of its electrical counterpart.

An analogy might be drawn to the characteristic sound of a pipe organ with regard to that of its electrical 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 electric and electronic organs, however, have “instant” touch and, in general, are completely void of extraneous noise. Mr. Biggs suggests 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. Cunly’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 problem with wireless microphones which definitely fill a need in 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 overcrowded service—technically and ethically, Ed.)

Yes, the FM band has been degraded. However, the contribution of 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 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. You individually are what makes 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

Wont to Visit?

Sir: I have been actively interested in “Hi Fi” for at least 30 years and have by now accumulated a large collection of all types of records (non-classical) and some tapes. I wish 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.

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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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THIRD CHOICE IN TABLES

This is a time of rapid change, they say. Even phono tables are changing. That is—almost any phone 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, light-weight 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 listeners.

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 anyway; 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 lower would seem to be the quality—high performance at a modest price via design and manufacturing ingenuity. Very possible 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-choice way 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 not less than the entire larger structure of the new home equipment market. Moreover, it involved price considerations that to this time continue to bewild er 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 varietics of changers in the price field, but they all seem to vary widely enough. Yet no matter how seldom they change, 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. 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 hi-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 purist (in the days before worldwide competition had set) and it could be had with the fabulous GE variable reluctance magnetic cartridge, and usually was so had. Now, it's back again. 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 adddlet. He told you, innocently, that the only right thing to do was to buy 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 muffin. And it cost a lot more than the changer. Plus nuttin'.

But whether you slice it, 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 the above-manuals mainly because they sold the other way. One each seems somehow to have ended up as a sort of undesirable “junior” edition of a more respectable—maybe components line. Again in the component field that is a kiss of death, and of NO SALE on the cash registers. Always, it hasn't helped, moreover, that 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, explain ing lots. Get rid of bulk mass; substitute, in new, lighter, cheaper formats, mechanical ingenuity. Not only in careful mass-machining to higher, but more expensive, standards; but also in newly ingenious dynamic balance, 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 one Shenton made famous for the 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 been only inch ed upwards in price. All that remained was to sell the idea to the hi-fi know-nothing. Uh. 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 so many times a very interesting combination, together with a number of ideas for improvement which have, as I say, been seen before in modern forms. Perhaps now the muddle 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 bought it. This is the new Third Choice, a turntable system that really seems different, that is utterly unlike any changer at whatever cost, and not really like the accepted image of the component table, either, in price, bulk or in "feel."

We 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 circuit board and pre-aligned, and high quality circuit board and pre-aligned.

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 oil finish walnut cabinet.

EICO CLASSIC 2400 STEREO/MONO 4-TRACK TAPE RECORDER Performance on a par with recorders selling at twice the price. 4 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 slippage, provides slurf-free starts, permits easy cueing & editing
- Automatic end-of-tape switch & digital counter
- Jam-proof belt shift mechanism selects 7 1/2 or 31/2 ips speed
- Requires no head wearing pressure pads
- New combination tone and record-play

4-track stereo head
- Equalization selector provides uncompromised equalization on both speeds.
- 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 $260.95.

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
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- Tape monitor switch
- Distortion at 10-w/channel 0.5%; IHF, power bandwidth at 1% distortion, 30-20 kc.

TUNER SECTION
- Low noise, shielded & temperature compensated front-end for drift-free performance
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- Velvet-smooth rotary tuning
- IHF usable sensitivity 3 db (30db quieting); 1.5 av (20db quieting)
- IHF distortion 0.6%; IHF capture ratio 30db.
- Kit 5154.95; 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 muddles and highs. Two speakers: 8" high-gain energy woofer-midrange transducer, and matched 2" tweeter. Wired only, $44.95.
Choose Mylar or Acetate

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ENGINEERED for highest fidelity

High Output—can accept signals with dynamic range to realize the full potential of even the finest professional equipment.

Wide-Range Response—virtually flat response for all recording frequencies.

Low Distortion—distortion is less than 0.002% at maximum record level as measured by Navy Specification N-T-0061.

High Uniformity—uniformity within in a 1200-foot reel is within plus or minus 1/2%. A new oxide formula and special selectivity of oxides protect recording heads from wear and prevent abrasion.

Humidity and Temperature Protection—special coating, priming, and binding techniques help keep Tarzian tape in new condition longer in ordinary good tape storage conditions.

Complete Line—choose from 1/2 and 1-mil acetate, or 1-mil and 1/2-mil tinsulfil Mylar tape on 3, 3 1/2, 5, and 7-inch reels; lengths from 150 feet to 2400 feet for every recording application.

Tarzian Tape won't turn up its nose at any recording job you care to give it. Some manufacturers claim that their "premium" tapes are so good that you shouldn't use them for your fun activities, but only for the greatest music.

Why should you pay premium prices to have someone tell you what you should record? Tarzian Tape gives you unsurpassed quality at a price that makes it excellent for any recording session—from children's birthday parties to the latest version of Beethoven's Ninth.

As long as you have the practical good sense to avoid damaging your recorder with cheap "white box" and "special" tape, but you don't want to pay premium prices for a fancy box, come along with Tarzian. In case your local hi-fi or photographic equipment dealer cannot supply you, send us his name and we'll see that your requirements are supplied promptly.

Meanwhile, send for a free copy of Tarzian's illustrated 32-page booklet, "The Low Cost of Fun With Tape Recording." It's full of tips to make your tapes more enjoyable and more valuable.

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* *I*

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 one time as something really different, novel enough in the show 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 "fool" for those who may wonder why it has had such an impact on people in general. The "fool" is by no means all pleasurable, and thus its significance is the greater—for these are sacrificers of 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 slow, 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, (if may the table is light enough), or even a silver dollar. It starts up with deliberation, like a Pullman moving out of the terminal, not exactly like a 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 euing-in of milkband grooves. Just try that and see what happens—the most distantly prolonged wow you've ever heard. Rrrr0000000W, like the old wind-up phonograph when you crashed it while the record was playing.

Few people object. Just give the little motor a few seconds to get its breath and your minimum-powered table is running true and exactly at speed. It will 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 systems is half of the battle won towards high performance.

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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 servomotor 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

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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.

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For people on the go... it's the Cosmopolitan - Combination Tape Recorder with AM Radio. A versatile companion and co-worker for business or pleasure travels. 5" reel capacity. Push-button operation. Amazing fidelity, Remote mike. Foot-pedal control. This all-transistorized recorder has big recorder features in miniature form.

You don't feel it if you keep your hands where they belong. It's only when you try to rush things, try by giving the table an extra twist, that you find your stylus radely jumping the record as the table bounces from the left an inch or so, and splashes back. Quite startling the first time it happens to you. You can 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 stomp 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 jigggle 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)—10, the Floorboard was conquered. There was still 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 aol 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 goodudge. Remember, many years ago, the old newspaper-pressed 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.

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• 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.
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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.
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• Clean, full-size pictorials show every connection at a glance, for faster, surer assembly and easy checking.
• Engineered specifically for accurate reproducibility of performance from unit to unit. This makes the Dynatuner an ideal kit as well as an ideal tuner.
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AUDIO • JANUARY, 1964
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 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 toy- ing 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 faultlessly 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 innate desires seems to increase rather than diminish. We don’t mean to single out audiophiles 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 not extensively 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 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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AUDIO • JANUARY, 1964

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what makes an automatic sound like a turntable?

The U38!

expressly designed for automatic turntables

The new generation of automatic turntables tracking and tripping at lower and lower forces demands this new kind of cartridge. Demands a "floating stylus" that protects your diamond and record as it plays... demands complementary electrical characteristics which maximize the use of forward-looking circuitry whether vacuum tube or solid state. The U-38 meets these demands and makes your automatic sound like a turntable. With Pickering's famous plug-in replaceable stylus assembly you get a cartridge with a life-time of trouble free performance. Pickering and Company, Inc., Plainview, New York.

U38 cartridge with AT Stylus... 2.5 grams tracking force ATG... 1.3 grams

Plug in head assembly for Garrard Type A and Model AT6
should Sherwood increase its prices by 20%?

Years ago, Sherwood high-fidelity tuners and amplifiers were evaluated by highly-respected, totally-impartial research companies as either the finest designed or the best valued on the market. Although we were pleased by such endorsements of pure quality in design and performance, the really significant fact was that other leading components carried higher price tags. Subsequent Sherwood components have received ratings indicating features and performance equal or superior to brands carrying price tags at least 20% higher. A current example of Sherwood design superiority is our new S-8000 receiver. Sensitivity is rated at 1.8 microvolts. Capture effect is an outstanding 2.4 db. No other FM receiver can claim the 80-watt music-power rating of the S-8000, and only one other (priced $50 higher) offers the professional D’Arsonval zero-center tuning meter that’s standard with Sherwood. We still believe that our old-fashioned policy of superior engineering and realistic prices is best for both you and Sherwood.

SOME OF THE S-8000 FEATURES THAT MAKE THE DIFFERENCE

1. Zero-center tuning
2. 80-watt music power
3. Complete stereo control center
4. 1.8 µV (HIF) sensitivity
5. Wide-band 3-mc. gated beam limiter
6. 1-mc. band pass balanced ratio detector
7. 2.4 db. capture effect
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10. Long-life Novar output tubes
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STEREO RECEIVERS • TUNERS • AMPLIFIERS • STEREO INDICATOR LIGHTS • SPEAKER SYSTEMS • CONTEMPORARY CABINETRY

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Ton-and-a-Quarter of Sound

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 least-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.

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 disheartening 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
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 wavelength 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 somewhat frequency dependent than for a larger mouth. However, all is not perfect with the large mouth; it yields 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 28SB 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 eps cutoff the 26-in. length results in a mouth area of 654 square inches. The arc length at the mouth is 41.9 defence and the height is 56.6 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 mold, mold, and two horns were constructed.

Another frequency-response curve was made with the Altec 28SB 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 eps 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.

As a matter of interest, the second-harmonic distortion was calculated for 1-watt (acoustic) input at 1000 eps 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 percent 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 eps (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 390 eps. 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. 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 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
multiple drivers handling systems of course. The use of bass reflex systems can be advantageous, depending on the design and application. However, it is important to consider the sacrifice in quality at higher frequencies.

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 eps 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 excursion 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 drivers. Once the horn and driver is determined, the required compliance can be calculated. This compliance is made up of two principal parts: 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 cone. 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

Fig. 4. High frequency concrete exponential sectoral horn for Altec Lansing 288C driver. Horn consists of two identical 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, 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 eps 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 eps 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.
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 diaphragm displacement versus 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 in another make of short voice 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 cps. It is capable of peak excursions of $\pm 0.5$ in. with excellent linearity over a range of $\pm 0.20$ in. from neutral. This is more than adequate linearity for horn loading with several acoustic watts output at 50 cps. In spite of the necessary 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 35-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

(Continued on page 62)
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 ever 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.

Two element constant-resistance network.

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 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. 1. Two element constant-resistance network.

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

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 make.

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.

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<tr>
<td>Frequency Response:</td>
<td>20-20,000 cps</td>
<td>20-20,000 cps</td>
</tr>
<tr>
<td>Output Voltage at 1000 cps (Per Channel, at 5 cm/sec peak velocity):</td>
<td>6 millivolts</td>
<td>9 millivolts</td>
</tr>
<tr>
<td>Channel Separation (at 1000 cps): Greater than 25 db</td>
<td>Greater than 25 db</td>
<td></td>
</tr>
<tr>
<td>Recommended Load Impedance:</td>
<td>47,000 Ohms</td>
<td>47,000 Ohms</td>
</tr>
<tr>
<td>Compliance: 25 x 10^-4 cm/dyne</td>
<td>20 x 10^-4 cm/dyne</td>
<td></td>
</tr>
<tr>
<td>Tracking Range: 1/4 to 1/6 Grans</td>
<td>1/6 to 3 Grams</td>
<td></td>
</tr>
<tr>
<td>Inductance (Per Channel): 680 millihenries</td>
<td>680 millihenries</td>
<td></td>
</tr>
<tr>
<td>D.C. Resistance (Per Channel): 650 Ohms</td>
<td>650 Ohms</td>
<td></td>
</tr>
<tr>
<td>Stylus: .0005&quot; diamond</td>
<td>.0007&quot; diamond</td>
<td></td>
</tr>
<tr>
<td>Stylus Replacement: N44-5</td>
<td>N44-7</td>
<td></td>
</tr>
</tbody>
</table>

Monophonic Stylus 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 WITH RETRACTILE STYLUS

the new standard in distortion-free hi-fi cartridges

LITERATURE: Shure Brothers, Inc. 222 Hartrey Avenue, Evanston, Illinois

Manufactured under U.S. Patents 3,055,968; 3,077,521 and 3,077,522. Other Patents Pending

AUDIO • JANUARY, 1964
variable "s" since this provides us with a form suitable for calculating the steady state part ω0 of the complex frequency s) or the transient response (by using the real part ω of s).

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

\[
\begin{align*}
G_{hi}(s) &= \frac{1/RC}{s^2 + (1/RC)s + 1/RC} \quad \text{Eq. 1(A)} \\
G_{hi}(s) &= \frac{s^2 + (1/RC)s + 1/RC}{s^2 + (1/RC)s + 1/RC} \quad \text{Eq. 1(B)}
\end{align*}
\]

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.

If we recombine the outputs of the two channels linearly, we should have and obtain the response 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 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 \( E/s \) 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

\[
\begin{align*}
E_{in}(t) &= E\left[ i - e^{\gamma t} \left( \cos \gamma t + \sin \gamma t \right) \right] \\
E_{hi}(t) &= E\left[ e^{\gamma t} \left( \cos \gamma t - \sin \gamma t \right) \right] \\
E_{hi}(t) &= E\left[ e^{\gamma t} \left( \cos \gamma t - \sin \gamma t \right) \right] \\
E_{hi}(t) &= E\left[ e^{\gamma t} \left( \cos \gamma t + \sin \gamma t \right) \right] \\
E_{hi}(t) &= E\left[ e^{\gamma t} \left( \cos \gamma t - \sin \gamma t \right) \right] \\
E_{hi}(t) &= E\left[ e^{\gamma t} \left( \cos \gamma t + \sin \gamma t \right) \right]
\end{align*}
\]

These two voltage outputs are plotted in (A) of Fig. 4. It would seem that adding these two responses would not re-create 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

\[
\begin{align*}
g_{th}(s) &= \frac{1/RC}{s^2 + (1/RC)s + 1/RC} \quad \text{Eq. 3(A)} \\
g_{hi}(s) &= \frac{s^2 + (1/RC)s + 1/RC}{s^2 + (1/RC)s + 1/RC} \quad \text{Eq. 3(B)}
\end{align*}
\]

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

These 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.
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Mark well the coding shown here. You’ll find it on the back of all EASTMAN Sound Recording Tapes.

Look! "Lifetime Coded" for Positive Identification!

"Lifetime Coding"—your assurance of highest quality! A permanent legend continuously repeated on the back of EASTMAN Sound Recording Tapes (1) identifies Eastman Kodak Company as the manufacturer; (2) provides positive batch-coating identification, thus assures the most closely matched sound characteristics, tape after tape, in the industry. The coding also provides a convenient means of cataloging tapes.

**No stretch**—thanks to the new DUROL Base! A specially prepared form of cellulose triacetate, this support material is distinguished for its high strength, low elongation. When equipment accidents happen, the new Eastman tapes break clean with practically no stretch. As a result, splices are made quickly, easily, with minimum program loss.

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**EASTMAN KODAK COMPANY**
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AUDIO * JANUARY, 1964

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At leading electronic supply houses: Type A303, a vastly superior low-print tape with output comparable to a fine general-purpose tape... also Type A304, a high-output tape with remarkably low print-through.

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Unique ultra-handly Thread-Easy Reel with indexing scale and built-in splicing jig.
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 \( G_M \) we find it reduces to

\[
G_M(s) = \frac{s}{s + \sqrt{L/C}} \quad \text{Eq. 4(A)}
\]

and that \( G_{10} \) reduces to

\[
G_{10}(s) = \frac{1/\sqrt{L/C}}{s + 1/\sqrt{L/C}} \quad \text{Eq. 4(B)}
\]

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.

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 \( G_M \) and \( G_{10} \) 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 do 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 inverter 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—one in its normal arrangement and once inverted. (See Fig. 11.) As we anticipated, the transient response of this network is perfect.

(Continued on page 60)
*GYROPOISE® MAGNETIC SUSPENSION introduces a new perfection to the reproduction of sound. Its secret is silence! The record platen rides on a cushion of air—suspended magnetically! Mechanical silence is the result. Vertical rumble is eliminated. But there's much more that recommends this remarkable turntable. It's a matched, balanced, coordinated system, complete unto itself. The arm and platen suspension have been unified to eliminate all mechanical feedback. The Unipoise® tonearm is balanced from a single bearing point. Its cartridge—the famous Stanton Stereo Fluxvalve—rides the record with a leather touch. The motor, too, is engineered for silence, rigidly mounted to the base to dissipate all possible vibration. The 800B Stanton Stereorable® System even looks silent. The lines are slim, quiet and functional, with a base of natural walnut and fittings of gleaming brushed metal. See for yourself—and listen too—at your franchised Stanton dealer. Stanton Magnetics Incorporated, Plainview, New York.

STANTON
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 signaling 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 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.

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 stylus 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-
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DOUBLES ANY SPEAKERS' LOW FREQUENCY RANGE

Now Hi-Fi can be low-cost. Because this new stereo amp makes inexpensive, smaller speakers work just like the big, expensive ones. Here's how:

The LUX SQ63 Stereo Amp is equipped with MFB—or Motional Feedback. It's the world's first stereo amp which incorporates variable cross-over MFB. If a speaker's normal bass response is to 80 cycles per second, MFB will extend it to 40 CPS or less.

For true Hi-Fi, you need bass frequencies in the 20-30 CPS range. But such speakers are big and costly. With MFB in your amplifier, you can choose inexpensive speakers whose normal range is only to 60 CPS. MFB brings it down to the 30 CPS you want.

With the new LUX SQ63 and MFB, you'll save money and get true Hi-Fi from a far more compact system.

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38 South Dearborn St., Chicago 3, Ill. Phone: State 2-7195/6

LUX CORPORATION Osaka, Japan
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 stylus 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 ruptures, 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 indentor 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 unindentated surface.

The linear component would lead only to a high-frequency loss, but the non-linear 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. 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 "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, with a 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 curve 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 pre-stressed 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. The deformation calculated from the deviation of the dashed curve is 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

---

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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: 231/4" x 311/4" x 15½". Oiled walnut finish. $229.95 Hear it at your hi-fi dealer, or write: Desk R-1.
the dashed curves associated with A 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 visous 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 bona 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 bluntier 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 such 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 by virtue 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 to 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.

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 Dynamagrove, 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, full 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 styli
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.

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RONALD L. IVES

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 fails 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 neate new aghin, 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 5-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 capacitor, effectively absorbs the flybacks occurring when the circuit is broken, so that relay operation does not produce a loud “boop" in the speaker.

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 = CR) 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-Tarzian 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 11/2-in. diameter brass spacers, 1/8-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 1/4-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.
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 welding 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 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 .0014 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.

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**ADC Point 4 Specifications**

- **Type**: Induced Magnet
- **Sensitivity**: 5 mv at 0.5 cm/sec recorded velocity
- **Channel Separation**: 30 db, 75 to 8,000 cps
- **Frequency Response**: 20 to 30,000 cps ± 2 db
- **Stylus Tip Radius**: .0004 inch
- **Vertical Tracking Angle**: 15°
- **Tracking Force Range**: 5 to 15 grams
- **IM Distortion**: Less than 1%, 400 and 4,000 cps at 14.3 cm/sec velocity
- **Minimum Compliance**: 30 x 10^-6 cm/dyne
- **Vertical and Horizontal**: 30 x 10^-6 cm/dyne
- **Price**: $19.00

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

$$i = a_e e + a_i e^2$$  \hspace{1cm} (1)

where $i$ is the plate current, $e$ is the signal voltage, and $a_e$ and $a_i$ are constants. Higher order terms in Eq. (1) (such as $a_{e^3} + a_{e^2}e^2 + a_{e^3}e^2 + \ldots$ 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

$$e = E_1 \cos \omega_1 t + E_2 \cos \omega_2 t$$  \hspace{1cm} (2)

where $E_1$ and $E_2$ are the peak voltage of signal 1 and signal 2 respectively. $\omega_1$ and $\omega_2$ are the frequencies of each of these signals. Squaring Eq. (2) gives

$$e^2 = E_1^2 \cos^2 \omega_1 t + E_2^2 \cos^2 \omega_2 t + 2E_1E_2 \cos \omega_1 t \cos \omega_2 t$$  \hspace{1cm} (3)

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

$$i = a_1(E_1 \cos \omega_1 t + E_2 \cos \omega_2 t) + a_2(E_1^2 \cos^2 \omega_1 t + E_2^2 \cos^2 \omega_2 t + 2E_1E_2 \cos \omega_1 t \cos \omega_2 t)$$  \hspace{1cm} (4)

From trigonometry, it can be shown that

$$\cos \omega_1 t + \cos \omega_2 t$$  \hspace{1cm} (5)

It can also be shown that

$$\cos (\omega_1 t + \omega_2 t) = \cos \omega_1 t \cos \omega_2 t - \sin \omega_1 t \sin \omega_2 t$$  \hspace{1cm} (6)

and

$$\cos \omega_1 t + \omega_2 t) = \cos \omega_1 t \cos \omega_2 t + \sin \omega_1 t \sin \omega_2 t$$  \hspace{1cm} (7)

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

$$\cos (\omega_1 t + \omega_2 t) + \cos (\omega_1 t - \omega_2 t) = 2 \cos \omega_1 t \cos \omega_2 t$$  \hspace{1cm} (8)

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

$$i = a_1(E_1 \cos \omega_1 t + E_2 \cos \omega_2 t) + a_2(E_1^2 \cos^2 \omega_1 t + E_2^2 \cos^2 \omega_2 t + E_1E_2 \cos \omega_1 t \cos \omega_2 t)$$  \hspace{1cm} (9)

From Eq. (9), it is possible to find some of the frequencies present when there is square law non-linearity, $\omega_1$ and $\omega_2$ 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 may 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

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

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AUDIO  January, 1964
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 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 performance 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 miscellaneous of switches.

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

INPUTS • 12. stereo or mono: magnetic or ceramic phone, 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, headphones output jack.

KEYBOARD CONTROLS • Rumble filter, stereophono switch, tape monitor, channel reverse, high 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 phone input selector, speaker impedance selector.

PRICE • $366.00 including cabinet. Only 5½" H, 15" W, 11½" 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.

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 truly 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 throughout 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
ANAHEIM, CALIFORNIA

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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 \(w_1 + 2w_2\) and \(w_1 - 2w_2\). Call the amplitudes of these sidebands \(A_4\) and \(A_6\) respectively. Another pair of possible sidebands is \(w_1 + 3w_2\) and \(w_1 - 3w_2\). Refer to the amplitudes of these frequencies \(A_4\) and \(A_6\) respectively. It would be possible to determine additional sidebands from Eq. (1), if more terms, such as \(a_4 e^i\), \(a_6 e^i\), 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). \(F_e\) is the percentage of the high frequency fed to the unit under test.

\[
\left(\frac{(A_4 + B_4)^2 + (A_6 + B_6)^2 + \ldots}{F_e^2}\right) \times 100\%
\]

Eq. (10)

The SMPTE method indicates what effect low-frequency non-linearity has on a high frequency. The second, or CCIF (International Telephonic Consultant 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:

\[
\text{Amplitude of difference frequency} \times \frac{\text{sum of amplitudes of two test signals}}{100\%}
\]

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 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, \(E_r\), with the output meter. The power may then be calculated from

\[
W = \frac{E_r^2}{R_L}
\]

Eq. (12)

The peak voltage is \(E_p\). The rms value of this, \(E_p\), 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 \(E_r^2 = E_p^2/2\), the power due to the sine wave in (A) of Fig. 1 is

\[
W = (E_p^2/2)(1/R_L)
\]

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,

\[
E_p = E_{pt} + E_{ps}
\]

Eq. (14)

where \(E_p\) is the peak amplitude of the sine wave signal in (A) of Fig. 1; \(E_{pt}\) is the peak amplitude of the low-frequency signal and \(E_{ps}\) is the peak amplitude of the high-frequency signal. \(E_{pt}\) and \(E_{ps}\) 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 10 ohms. If a pure sine wave were fed to the amplifier, the rms voltage across the 10-ohm load resistor must be, from Eq. (12):

\[
E_{rms} = R_L W = 16(25) = 400 \text{ volts}
\]

and \(E_{rms} = 20 \text{ volts.}\)

The peak voltage is \(E_p = \sqrt{2} E_{rms} = \sqrt{2}(20) = 28.2 \text{ volts.}\) A peak-to-peak output 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 \(E_p\) is the peak voltage of the low-frequency signal and \(E_{ps}\) is the peak voltage of the high-frequency signal,

\[
E_{pt} = 4E_{ps}
\]

Eq. (15)

Substituting this into Eq. (14) yields

\[
E_p = 4E_{ps} + E_{pt} = 5E_{ps}
\]

or \(E_p = E_{ps}/5\)

Eq. (16)

but \(E_p = 4E_{ps}\)

therefore \(E_{pt} = 4E_{ps}/5\)

Eq. (17)

To find the power contributed by each of these voltages, \(E_{pt}\) and \(E_{ps}\), 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),

\[
E_{rms} = \frac{E_{ps}}{\sqrt{2}} = \frac{4}{5} E_p
\]

Eq. (18)
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.
and from Eq. (16),
\[ F_{rms} = \frac{F_p \sqrt{2}}{\beta} = \frac{1}{5} \frac{F_p}{\sqrt{2}} \text{ Eq. (19)} \]

The power delivered by \( F_{rms} \) is, from Eq. (12) and (18)
\[ W = \frac{F_p^2}{R_L} \text{ Eq. (20)} \]

and the power delivered by \( F_{rms} \) is, from Eq. (12) and (19)
\[ W = \frac{F_p^2}{R_L} \text{ Eq. (21)} \]

The total power delivered to the load, \( R_L \), is the sum of these two individual values, or
\[ W + W_2 = \left( \frac{17}{25} \right) \frac{F_p^2}{R_L} \text{ Eq. (22)} \]

Substituting Eq. (13) into (22) we get
\[ W + W_2 = \left( \frac{17}{25} \right) W_p \text{ Eq. (23)} \]

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 \( V_{rms} = \sqrt{WR} = \sqrt{(17)(16)} = 16.45 \text{ volts.} \)

3. Adjust the input so that the measureing 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 voltage 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 non-linearity 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.
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, 3½ and 1½ ips.
- 3 motors: including Papst 'squirrel-cage' motor for capstan drive.
- 5½-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-stair' 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 3¼; and 50 to 8,000 at 1⅞, ±3 db.
- Wow and flutter: less than 0.1% at 7½ ips; 0.15% at 3¼; and 0.25% at 1⅞.
- Signal/noise ratio: better than 50 db.
- Channel separation: better than 55 db.

Dimensions of the PD-100: 14⅞" wide x 15⅜" deep x 7" high. Price is $399.50 (less base). At your high fidelity dealer, or write: BENJAMIN ELECTRONIC SOUND CORP., 80 Swaim Street, Westbury, New York. Canada: Transwave Electronics Co., Ltd., Toronto.
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 unconventional tone arm. Let's not 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 magnets.

The platter is driven by a soft idler wheel which engages the motor capstan and the platter. A plastic-sphere metal knob at the left-front of the turntable is pushed towards the right. Pushing the knob also turns 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 change 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 connector, and put a new arm board and arm in position (two guide pins locate the board accurately each time).

Oh yea, the entire turntable, base, and arm measure 15 1/2 in. wide, 12 in. deep, and only 6 1/2 in. high. A compact and handsome package.

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 it's obvious lack of base structure. The usual arm sports a fairly hefty base to contain the vertical and horizontal pivot bearings of 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 3/4 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: "Unipose."

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 pivot 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 résistance 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 sheath. Obviously, a finger-like projection, 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 antithemctic 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.
The tone arm exhibited no serious resonance 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 481A. 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 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-B 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 (6J8/6AG7A twin triode) in a cascade configuration, followed by a 6L8 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 6AU6 A tubes. The signal-strength meter is located at this juncture, before the signal proceeds to the limiter stage (a 6H6C).

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 420 volts on the screens. Well-filtered d.c. is provided for biasing.

The triode section of a 6J8 is used as a phase splitter, the pentode section operating as a voltage amplifier. Feedback from the 18-ohm tap of the output transformer goes to the cathode of the pentode section.

The preamp section utilizes two 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 loss of this tube and filter networks. Well-filtered d.c. is also provided for the filament of all the preamp tubes.

The power supply utilizes eight IN560 diodes in two bridge configurations, one bridge for B-plus and the other for the d.c. filament and bias supply. In addition, 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...
The Cipher Denon 800 Tape Recorder

Many discerning audiophiles 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 InterMark Corporation. Denon also makes a computer professional line 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 21½-in. high, 16¼-in. wide, and 8½-in. deep, and weighing 55 lbs.

The 800 is a 3-motor, 3-head machine, with pushbutton operating controls. Five buttons are provided—Record, Rewind, Play, Stop, and Forward. In addition, there are two rotary switches—one to control the a.c. power and select tape speed of 7½ and 3½ 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 phone 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.

Thus 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. 31321-91, 7½ ips:

<table>
<thead>
<tr>
<th>Frequency (ips)</th>
<th>Relative Output (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>700</td>
<td>0.0</td>
</tr>
<tr>
<td>15000</td>
<td>+0.5</td>
</tr>
<tr>
<td>12000</td>
<td>+0.7</td>
</tr>
<tr>
<td>10000</td>
<td>+1.3</td>
</tr>
<tr>
<td>7500</td>
<td>+1.4</td>
</tr>
<tr>
<td>5000</td>
<td>+1.7</td>
</tr>
<tr>
<td>2500</td>
<td>+0.1</td>
</tr>
<tr>
<td>1000</td>
<td>0.0</td>
</tr>
<tr>
<td>500</td>
<td>+0.0</td>
</tr>
<tr>
<td>250</td>
<td>+0.5</td>
</tr>
<tr>
<td>100</td>
<td>+2.0</td>
</tr>
<tr>
<td>50</td>
<td>+2.3</td>
</tr>
</tbody>
</table>

At standard operating level (3 per cent harmonic distortion), the maximum playback level measured 2.6 volts. At 3½ ips, playback response, measured with Ampex Standard Tape No. 31331-01 is shown in Table II.

<table>
<thead>
<tr>
<th>Frequency (ips)</th>
<th>Relative Output (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>-1.6</td>
</tr>
<tr>
<td>7500</td>
<td>-1.6</td>
</tr>
<tr>
<td>5000</td>
<td>-2.0</td>
</tr>
<tr>
<td>2500</td>
<td>-2.6</td>
</tr>
<tr>
<td>1000</td>
<td>-1.8</td>
</tr>
<tr>
<td>500</td>
<td>-1.0</td>
</tr>
<tr>
<td>250</td>
<td>-0.5</td>
</tr>
<tr>
<td>100</td>
<td>0.0</td>
</tr>
<tr>
<td>50</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Maximum playback level 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>
<thead>
<tr>
<th>Frequency (cps)</th>
<th>VU Ind.</th>
<th>Relative Output (db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>15000</td>
<td>+0.5</td>
<td>-1.4</td>
</tr>
<tr>
<td>12000</td>
<td>+4.0</td>
<td>+2.0</td>
</tr>
<tr>
<td>10000</td>
<td>+3.2</td>
<td>+2.0</td>
</tr>
<tr>
<td>7000</td>
<td>+1.5</td>
<td>+1.6</td>
</tr>
<tr>
<td>5000</td>
<td>+1.0</td>
<td>+1.0</td>
</tr>
<tr>
<td>3200</td>
<td>+1.2</td>
<td>+1.0</td>
</tr>
<tr>
<td>1000</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>500</td>
<td>-0.1</td>
<td>-1.0</td>
</tr>
<tr>
<td>250</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>50</td>
<td>-3.5</td>
<td>-3.0</td>
</tr>
</tbody>
</table>

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. The VU meter on this machine indicates a zero reading when a constant-voltage signal is fed in.

In loud musicianship, 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. Now and flutter measured 0.17 per cent at 7½ ips, 0.92 per cent at 3½ ips.

Record-play response at 3½ 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 connections and adjust for sensitivity, are provided for in such a way that the pushbuttons 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 shielded cover is closed to mate with the playback head shield. While it is possible to operate the playback 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.

For Information About Profiled Products Circle Indicated Number on Reader Service Card.

Audio • January, 1964

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Fig. 4. The Cipher Denon Model 800 recorder.
from

SERVICE...WITH A SMILE?
by IVAN BERGER

in the May, 1963 HiFi/Stereo Review

HomeAUDIO servicing is a headache for everyone—for the manufacturer, for the dealer, and most of all, for the consumer. Breakdowns can range from a case of subtle distortion to the smoke-following catastrophe, but in either of these, the repair of the component cannot be considered complete until the unit meets its original specifications. Getting such critical servicing done correctly 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 and so free that it is a shame for failure.

THE ACoustics RESEARCH INC. FIVE-YEAR SPEAKER GUARANTEE

In 1961, on the basis of favorable field experience, we extended our original one-year speaker guarantee retroactively to five years. This guarantee covers parts, labor, and reimbursement of freight charges.*

The same guarantee conditions apply to the AR turntable, except that the guarantee period is one year.

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
Microphones

Q. I have several questions concerning microphone. The manufacturer of my tape recorder recommends a mid-range impedence microphone: 10,000 to 20,000 ohms. Does this mean the "hi-Z" dynamic type? I find no microphones in any catalog with numerical values in this range; they jump from around 500 ohms to "hi-Z." My recording outputs will be small instruments groups including piano or harpsichord in small rooms plus organs in large auditories. 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 purchased so far are beyond 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 at a time and match 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 better than a low-impedance one.

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 a 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 they probably cost almost and are quite expensive. For the utmost in results, condenser mikes are often used (although not that stereo microphones will be virtually identical in output. The home recordist can often obtain very good results with one of the better dynamic microphones costing under $100, possibly under $50, at consumer set price.

In examining microphone specifications, consider sensitivity. This should be rated in terms of "decibels below one milliwatt". Also, I suggest that you find that noise producing recording is too high compared with the audio signal. Possibly, you might not get enough signal to drive the recording to the 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 the inter unit variation will likely be, because of greater care in manufacturing and quality control. Nevertheless, because it is highly desirable to find a mike with characteristics, I think it is a good idea to try to find 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 Fischer 750 tape recorder. 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-jack in the "recorder output" jack of the X-202 B and connected both outputs to Channel A to the Channel 1 inputs of the Concertone; and both outputs of Channel B to the Channel 2 inputs of the Concertone. Outputs from one Concertone are connected to the "monitor output" of the tape machine, and outputs from the other Concertone are connected to the "aux. 1" inputs of the X-202 B. Theoretically, this setup should work. The Controls of the Monitor 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 connect the machine to the machine to the machine on recording on both channels. There should be no interaction between the Tuner and Aux. 1 positions of the Monitor 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 I unless the cable from this machine's output to the X-202 B's Aux. input is disconnected. That's the X-202 B, in common with most such units, shorts all unused inputs to ground to in order to minimize crosstalk. Therefore when the selector switch is in 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 when you exchange the roles of Machines I and II.

Tape Machine Playback Preamps

Q. Would you be able to make a tape through the tape head of my preamp offer improved reproduction over that obtained by using a long 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-eps 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 best tape machine preamps, but it certainly is better than the average tape machine preamp. However, tape machines in the $400 to $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 does this mean by peak recording level?

A. This denotes the level which results in the one per cent harmonic distortion at 400 eps (or sometimes 250 eps) on the tape.
The commanding presence of Sony sound

Now enter the world of the professional. With the Sony Sterecorder 600, a superbly engineered instrument with 3-head design, you are master of the most exacting stereophonic tape recording techniques.

Professional in every detail, from its modular circuitry to its 3-head design, this superb 4-track stereophonic and monophonic recording and playback unit provides such versatile features as: vertical and horizontal operating positions, sound on sound, tape and source monitor switch, full 7" reel capacity, microphone and line mixing, magnetic phono and FM stereo inputs, 2 V.U. meters, hysteresis-synchronous drive motors, dynamically balanced capstan flywheel, automatic shut off, pause control and digital tape counter—all indispensable to the discriminating recording enthusiast. Less than $450, complete with carrying case and two Sony F-87 cardioid dynamic microphones.

Sony tape recorders, the most complete line of quality recording equipment in the world, start at less than $79.50. For literature or name of nearest dealer, write Superscope, Inc., Dept. 7, Sun Valley, Calif. In New York, visit the Sony Salon, 585 Fifth Avenue.
**Lovely “Memories”**

Musical Memories of Scandinavia

Gunnar Hokmark, Folk Orchestra

London Int. TW 91300 mono

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

Just fifteen-old short dance tunes, played by one of those local-country folk orchestras (not very folkish and thoroughly professional) that abound in those pleasant bands, part of a wider issue under the same “Memories” title, from either side and you. You’d never know from the cover how nice it is. Justifies my occasionally grab-bait 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 arrangement, using occasional folk instruments gracefully and with taste. But what appalling 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


Columbia 1952-902 (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, unemotional (and thereby the more impressive), not forgetting to mention the terrible aspects of the war along with the in- spiriting. Its research and information is un- usually 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 Hollywood arrangements made up by stringing commercial ensembles or large territorial choirs, these are given out by young male voices of a soldier-like sort, and no fancy orifice at all. Just rousing song. Maybe the Civil War soldiers weren’t so good but for one, at least, we have no prancing studio tenors, no bellying 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 instrumentation. The spite- ful 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 in the home of Americans as a whole.

The reconstituted band of wind instruments of the Civil War period assembled and recorded by Mr. Fennell 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!

Bulge calls, drum rolls, fife tunes, add musical perspective and a typically Mercury—Records battery of muskets, repeaters, par- rots and Napoleon hur realistic realistic fu- tures and bombarding around the modern living room. Some astonishing ricochets! The whole package show is written up in an excel- lent accompanying booklet.

The Badmen. Songs, Stories and Pictures of the Western Outlaws, 1865—1900.

Columbia L25 1012 (2) stereo (Legacy Collection)

These big documents of the saga really getting to be something. The danger, of course, is too much sound and fury signifying nothing and a good name and these 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 flambeyant, to outdo anything of the sort in- cuding most of the fancy Civil War albums. But the material in both sections (separately housed within the box) is top-notch, flamber- vant or not. Acres of pictures, startling photographs and sensational engravings of the period. Excellent and readable texts, with full and exact description of the various des- peradoes and desperdudes involved. And in the sound, pages of recorded interviews with some surprisinglly lively survivors, first- hand witnesses. One old lady here, wasn’t far removed from John James’ Billing. A superb old storyteller weaves his own Mark Twain-like tale of innocent boyhood on the frontier —be “went West to seek adventure, complete with city clothes and not a gun to his name, and he found it all right. The spangled, middle-aged voice of this story was actually 90 years old at the time—right now, he would be 100. Astounding. Lowe account by the wife of a U.S. Marshall, Bill Tilgh- man, of her husband’s activities bringing in the bandits. (He was killed much later, anti- climactically, by a mixed-up Prohibition off- ficer.) These are generally fascinating ex- cerpts, distillated from much larger chunks of recorded sound 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 nonsense, thanks to Mr. Fennell, with a little bit of Hollywoodishness issued these days.

Ranging Among the Classics

Hindemith: Violin Concerto (1939); Viola Concerto (“Der Schwanendreher”) (1935).

Ivy Gillis, vl, Westphalian Symph., Rei- chert; 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 nice package.

Hindemith recording in both: a rather prominent and close-up solo instrument, a broad orchestral sound, with sound in the back- ground but fully realized.

The Hindemith, Prokofieff and Stravinsky concertos for various instruments and a similarity—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 concertos. The classical, such as Mozart, Haydn and Bee- thoven, and the big Romantic composers, made a point of careful balance, allowing rest for both soloist and audience. Hindemith’s quality is good, thanks to Pete Spera, Ed My- Curdy, Jack Elliott, Harry Jackson, Carolyn Dexter, Jacques Manhnen, and the songs include “language” material, reflecting the Spanish influence in the old West. I wouldn’t call it authentic—there is something, though. The atmosphere is often forced and self-conscious, not an unfortunate faked- up kind of a bar room. Right out of Madis- son Avenue, that.

Mustn’t let a touch of gray-suited pemp- rose in force. But both of these works take a really splendid assembling-together of real Bandman material. I can’t imagine an 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.

(Continued on page 58)
STEREO SPECTACULAR DEMONSTRATION & SOUND EFFECTS—Fast moving, exciting, narrated tour of dramatic situational stereo effects plus varied selections from Audio Fidelity’s vast library. Cited for engineering excellence by the National Academy of Recording Arts & Sciences. The greatest stereo demonstrator ever created! DFS 7777

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THESE ARE SOME TIME-TESTED AUDIO FIDELITY ALBUM FAVORITES!
A dress rehearsal of Aida 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 Pharaoh's standard in the hands of the young Egyptian officer, Nabû, 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 snort. As singers and supers quickly stepped out of range, Sir Thomas rapped his baton on the podium railing, shook his head sadly, and, checking 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 trend the opera boards, they are usually assigned bit parts. In recent years we have seen borzois in I Due Foscari, stallions in Don Carlo, a donkey in La Périchole, a pig in Gypsy Baron, and, of course the neigh plus ultras of Aida. In view of the dwindling zoological presence in opera, members of Animal Equity naturally resent the use of the phony dragons in Siegfried and the stuffed swans in Lohengrin. Wagner has drawn the line, but not on the use of rams to draw Fricka’s chariot in Die Walküre, called for ravens to wing across the stage in Die Götterdammerung, 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 Circean 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 spectacles. 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 horses in iron armor, forty cornets of horsemen, six scabulls, six great flutes, six minstrels playing on Turkish instruments, six others on octave flutes, six pages, six sergeants, six cymbalists, twelve huntmen, twelve grooms, six coaches 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 Teseo (1683), and the more prosaic canals and horses who hoofed in operas too numerous to mention.

Animal Acts

As dramatic personae, however, animals were often replaced by humans. In 1710 Londoners flocked to the Haymarket to see the great Domenico Nicoli battle nightly with the “king of beasts” in an opera by Manzini. It was rumored that a tame lion had been dispatched from the Tower every opera night to give the shivers to 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 follow of a petty, choleric temper, overstaid 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 Nyulaspe (Nicoli), without grapping with him.”

The third lion was a country gentleman who had taken the part of the shier enjoyment of it. His temper was “made out of such a happy mixture of the mild and choleric, that he outshone 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 artful Larks, 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 the other plays they make their entrance in very wrong and improper scenes, so as to be seen flying in a fool’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 with boiling oil. Monkeys, presumably apes appearing 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-hunting by dogs, a favorite diversion 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.

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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 acoustic output. There are a number of reasons for this; chief among these is the fact that no harmful distortion occurs in 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. This important but 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 them directly to the recording console. They are the electric guitar and the electronic organ, and it is possible to believe 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. The reason is simple. By employing microphones to pick up the sounds coming from guitar and organ speakers, it is possible to record a 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 '58s of 1947-48 vintage, and the comparison is hardly flattering to the recent products. Certainly this is due to the fact that the guitarists have been recorded in a manner that will preserve the best aspects of their talent. I hope that they will start to apply themselves to the problem instead of leaving it to the liner note writer with the promise that the recording is simply to ensure us that each new disc is the absolute ultimate in high fidelity.

Clancy Hayes: Swingin' Minstrel

Good Time Jazz Stereo $ 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 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 Misbehavin', Nobody Else But Me, Honeybucket Boss, and After You're Gone without becoming more agreeably affected if they have been handled by others. Particularly sad, in the weak recreation of Pete Walker's great Honeybucket Boss; Ralph Sutton's smiling 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 side B standpoint, my comparisons with other discs must all favor the present contender. In spite of a tendency for most of the compositions to be in a standard eight measures per chorus, the left or right speakers, this is delightful stereo, particularly in such passages as the interchange between Rob Short on the tuba and Clancy on guitar in Willie the Weeper, and the duet by Clancy on banjo and Paul Brown in clarinet in Drunken Fox.

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 feeling that transmutes his material and speaks in terms of basic human anguish. This is classic blues singing of a kind associated with all-time greats like Beale Street and L. A. Bessie Smith and Leadbelly. For his new album "Spoon" he is using a backing that the blues require. Two groups of sidemen are used: eight of the discs twelve tunes have the support of Art Farmer, guitar; Len Wright, alto sax and tambourine, Gildo Mahones, piano, George Tucker, bass, and Jannine Smith, drums. The remaining four numbers, backed by a group of West Coast musicians, also include the emotion-conflict horn, and harmonica. With support of this kind, and Witherspoon's strong, rich voice, it seems a pity he should have been so closely and that the instrumental contribution has been held down so severely.

Georgie Auld Quintet: Plays the Winners

Phillips Mono PPHM 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 Vinegar on bass, in place of Max Bennett, and Mel Lewis replacing the late Tex Kyahn 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 obvious skill is the single session gives this set its cohesive atmosphere; perhaps the quality of the pleasure this group derives from getting together again. Whatever the reason, the results are extraordinary. The Auld 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 Jimmie Woods Sextet: Conflict

Contemporary Stereo $ 7612

Six compositions by Jimmie Woods, demonstrate his talent and the variety of his invention. His most provocative showcase for an excellent group of modern musicians: Jimmie Woods, alto, Carmel Jones, trumpet, Harold Land, tenor, Andrew Hill, piano, George Tucker, bass, and Jimmy Jones, drums. The title is descriptive of one of the pieces, but it is also indicative of the feeling of opposition between differing ideas that pervades each of the numbers. Their creator contributes a set of serious liner notes in which he describes his interpretive approach to certain 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 every instrument, with no opportunity for extended solos. In spots, the compositional and instrumental technique of the group is down-right ugly. Wood's liner notes are, however, to say considerably more than actually emerges, but the very realization in this work is stamped in considerable. Each piece the 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 be considered a genuine, 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 the negro. The close relationship between jazz and the spirituals or the Negro yardhouse church is emphasized by a number of jazz historians. For many jazz musicians, the earliest contact with music was in church, and developing an 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 album there is a mixture of fine piano style. Technique is employed solely for purposes of expression and no idea fails to come across for its own musical quality. A credit line on the liner indicates that the music was recorded live, and it is the result of resultant contribution. In any event, the sound is less brilliant and thinner 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 brilliant, medium-swing technique has always been adequate for stirring up excitement, but too often it has been concentration in a single track and short on invention. Sad to relate, the addition of five trumpets, four trombones, six saxophones, and French horns, fortifying the piano trio, does 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 local choral bars which serve to interrupt, without punctuating, the flow of the composition. On the few numbers where the recording has excellent directional characteristics when played in the stereo position, and with a certain brightness sound, the reference is reserved for the performer's personal style approach through an open, agreeable quality. The thinking in mass, fall has been to leave a checkered muffled presentation. The inside track is a long story to finish, but the happy sound, curiously, becomes more prominent.

Freddie Hubbard: Hub-Tones

Blue Note Mono 4115

This set offers 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 Spaulding, alto sax and flute, Herbie Hancock, piano, Joe.support, bass, and Cliff James, drums. Here again talent, the recording has excellent directional characteristics when played in the stereo position, and with a certain brightness sound, the reference is reserved for the performer's personal style approach through an open, agreeable quality. The thinking in mass, fall has been to leave a checkered muffled presentation. The inside track is a long story to finish, but the happy sound, curiously, becomes more prominent.

Sonnny Stitt: My Mother's Eyes

Pacific Jazz Mono PJ—71

With Charles Kynard prominently featured on organ and discrete backing by Ray Cruso, multi-toned horn, Sonny Stitt contributes another album to his long list of solo records. The present disc is notable in that Sonny limits himself to alto sax, whereas he generally alternates between tenor and alto, and for the stylist organ player playing with Kynard. In all, this set is just one example more of the consistent quality of Sonny's playing. It just blows away from start to finish, making glorious sounds never at a loss for fresh ideas.
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- **New Tape Recorder.** New this year from Superscope Inc., U. S. distributor of Sony tape recorders, is the Model 600 Stereocorder, a 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 Stereocorder include: two V.F. meters (switchable for reading input or recorded signal), sound-with-sound (microphone and line mixing), sound-on-sound, separate monitor level with tape decks, phonographs, and tuners. The four channel features well-filtered d.c. filaments for extremely low noise and hum, measuring 72-db below rated output. Phonon input sensitivity is 1.2 v. Tape head input sensitivity is 1.6 v and tuner input sensitivity is 0.35 v. The frequency response of the S-550HI1 is 20 to 22,000 cps ± 0.5 db. The power amplifier provides 40-watts per channel of music power (56-watts continuous) at 1.5 per cent IM distortion. The S-550HI1 is priced at $174.50. Sherwood Electronic Laboratories, Chicago, Illinois, 60615.

- **FM-Stereo Receiver Kit.** The EICO Model 2555 incorporates an FM-Stereo tuner and an integrated 26-watt stereo amplifier on one compact chassis. The kit features pre-assembled front-end and l.f. strip (consisting of 4 l.f. stages and the radio 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 amplified are pre-aligned. It is claimed that the kit does not require alignment or adjustments. The model 2556 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 26-watts HIFIM music power and 28-watts continuous power total of both channels. Harmonic distortion at 10-watts per channel at 40 cps in 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, $225.05 wired. EICO Electronic Laboratory Co., Inc., 121-01 59 Ave., Flushing 54, N.Y.

- **Hanging Speaker System.** Frazier, Inc., Dallas, Texas, announces availability of the "Bel Air" speaker. The Bel Air is designed for wall mounting for people who have a space problem. It is equipped with bracket mounts on top, front, and side. If desired, solid walnut ears 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 23-1/2 in. wide; 19-1/2 high; and 24-1/2 deep. The Bel Air is available in an oil walnut finish. Frazier, Inc., 2649 Brenner Dr., Dallas, Texas.

- **50-Watt Stereo Amplifier.** As a stereo pre-amp, stereo control center, and stereo power amplifier, the Sherwood S-550HI1 is said to offer a number of professional-quality features which make it ideally suited for use in home music systems

- **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 x 10^4 cm/dyne for the M44-1 with a 15-mil diamond stylus, and 20 x 10^4 cm/dyne for the M44-7 with a 0.7-mil dia-

- **Thinnest Speaker System.** University Loudspeakers, a division of Ling-Temco-Vought, Inc., has introduced the art within "Tri-Planar." The "Tri-Planar," measuring only 1/4 in., is claimed to be the world's thinnest speaker system. The concept, sound radiating from both sides of the system, surrounds the listener. This is a complete three-way system with one of the largest woofers areas found in any system, 264 square inches. Finely crafted in oil-wax 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 15,000 cps. Power rating is 20 watts of integrated program material. The size of this system is 23-in. wide by 15-in. high by 1-1/4-in. deep. Only $79.95. University Loudspeakers, 500 East River, Oklahoma City, Okla.

- **New Product Installations.** Such as television and tape recorders. Prelude Stereo Furniture, Garden, California.
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You'll never be satisfied with anything less than McIntosh quality once you've heard it. You'll put an end to stepping up to something better in your search for the ultimate, because McIntosh is the best. There are good reasons: Exclusive, patented circuits set new standards in performance. Careful engineering and conservative design practices ensure long term dependability. Consider amplifier output stages, for example, that need no bias or balance adjustment, no tube selection or matching, to deliver rated performance. McIntosh components are devised to fulfill every present need, anticipate your future ones. Like the classics, they endure.

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MC-240: Superb, distortion-free, two channel model, conservatively rated at 40 watts per channel. Flat frequency response well beyond the limits of the audio spectrum with negligible phase shift $288.00

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Featuring the latest in solid-state circuitry, this compact unit houses two 20-watt power amplifiers, two separate pre-amplifiers, 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: concentrated 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.

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

RCA Victor LSC 2678 stereo

Leonard Pennario, RCA Victor not so candid on LPs as he was on vinyl, played with the N.Y. Philharmonic while still in the Air Force at 19, "grew steadily in artistic stature, beginning a recording career during his 14 years with the Concordia's. But Arthur Fiedler is an equally accomplished pops conductor who left someone, and perhaps never quite the same effect. Pennario, a hard man at the keys when something best-sellers was wanted, can also turn his superb technique into sudden idealism. Maybe he's awed by the surrounding—so much of Hollywood; in any case, he plays with both brilliance and real sincerity, though his pacing is a bit mannered here and there. Without a doubt he is Pennario who makes this recording, not the Boston Symphony and Fiedler. A better-than-Pops debut from start to finish.

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 710059 stereo

Supplementing the fabulous "Library of Records" music series of Haydn Symphonies, these continue one of the most welcome trends in LP's—more Haydn. At last, we have begun to understand how superbly recordable this genial composer's music is, and our tastes continue, too, to grow 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 the repertoire, but 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 book sale. It takes in so many minutes 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 power 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 top least in the slight orchestral forces they employ. Economy of means: splendidly craftsmanship-like music, first-rate sound for recording.

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

---

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...ate predecessors reflect interesting earlier faces. For instance, the boyish Mozart-like (more precisely, J. C. Bach-like) starts. 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.

Decon's Italian performers are of a different and more intimate virtuosity. Small Italian groups the first of which to hit the market was, I think, "I Musici." Very ardent, very full of semi-chamber music style with a lean, spare sound and exceptional string dynamics, the players turn out very beautiful slow movements but in their fast movements tend towards perhaps a bit dogmatically declared 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

"...in my day as a music student in college, old Georg Philipp Telemann was still a living, not a dead genius, the composer who was better Known than Bach in the Baroque period (and even for his Handel, even for his Händel). Telemann, we understood, wrote enormous amounts of music and nobody cared a fig, whereas Bach..."

Well, Telemann, in our decidedly more advance and more sophisticated and more appreciated while Bach is just as good as ever, Telemann was extraordinarily versatile as well as unimportantly versatile, even for his Händel. For instance, and forty-four Fourths in the on the record, where we have just two of Bach's three or four. Like Händel, today, he wrote something for everything, colorfully and in a playful, 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 out here is an excellent one to try. The North German group plays musically and in the German style, if a bit dogmatically so.

These are typical Telemann color-combos—exquisite, rare, for flute, oboe, clarinet, and viola d'amore, for single flute, and a monumental "concertante" suite for three oboes and bassoons—all three with string orchestra.

Judith & Doris Lang—Concert for Two Violins. Golden Crest CR 4070 mono

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

The girls made their whispered debut with one each Miller, the bearded Satan, on high- time TV. "That's just how they sound here, but listen," said Fidelman. High powered, incredibly skillful, tuned to each other like one mechanism, full of bounce and enthusiasm, then on to the piano the American can ideal, just like the ads—let's HAVE FUN: Let's run hand in hand down the bed, straight to the surf; let's lie under a green waterfall (smoking food or something), or lean raptly into a red sunset out of the everywhere. That's what girls have it!

Nevertheless, they are pianists to contend with in any league. They've long since solved all the technical problems they've ever run into. Their touch on the board is the best of them all. Their forte chorda 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 otherwise-20-fingered music they play. Their feeling for the sonority recent French music of Milhaud and Poulenc is wonderfully spontaneous—it's their stuff, all right. Fine rhythmic verve, too, throughout.

An youthful petite, tall, pretty, full of bounce, the sisters can't now be but. But, Golden Crest alertly announces, "the future looks bright for Judith and Doris Lang," Future with Mitch? Maybe. P.N. and by the way: the Lang girls. It's a very practical phrasing by remote control, one piano in the living room and the other down in the play room. Pap, Lang, an engineer, rigged a sound system so that "at a flick of a switch" each girl can hear the other's feedback, anyone? (Or maybe they play with earphones.)

French Horn Masterpieces. James Stagliano; Paul Unowsky, piano. Boston BST 1009 stereo

I question the word "masterpiece" in connection with many of the Jocely Romantique for who producers on which the French, the otherwise I find this as pleasingly hoky a record as you'll find, show off the professional sound of the instrument most admirably. Almost all of the pieces are slow and dreamy (a few fast, but few: organic) and the horn—particularly in stereo—comes from far, far away in that peculiarly spacious manner that is inescapable. Nice recording. The piano is good too—it ought to be, with the accomplished Paul Unowsky on the keyboard.

Unusuals: The Glory of Cremona. (15 famous violins played by Ruggiero Ricci) R. Ricci, Leon Pommers, pf. Deca DXE 179 mono (Bonus 7-inch LP included)

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

The big question is: How will you tell the difference? It's one thing to talk big about Strad- with (all of them) and another to use the Strad tone in the middle of fiddles by Amati, Guarneri, Bergonzi and so on, not to mention Sears knock-off—but here represented.

Well, I assure you that the differences are gratifyingly clear, as between one of these instruments and the next and between who groups, the Strads vs. the Guarneri instruments, for instance. Added 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 splendid accomplishment of this great field of craftsmanship. For here, as if in defiance of modern technology, are fifteen wood-built masterpieces, not one of which can be equaled 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 zinked with epoxy by automation, we can maybe boast about modern acoustic engineering.

The main record presents each of the fifteen violins in a different sort of work—one of them modern and most dating from well after the creation of the instruments themselves. (Funny, to hear an instrument con- structed in 1577 playing a piece by Händel, from a few years ago.) Presumably Mr. Ricci has more or less matched the sound to the instruments, though there is none that can't be played on any of the fifteen.

(Continued on page 65)

books et al

HIGH FIDELITY SYSTEMS—
A User's Guide by Roy F. Allison
AR Library Vol. 1 70 pp., illus., paper $1.00

A layman's practical guide to high fidelity installation. We think that it will become a classic work for novices (and perhaps be con- trolled secretly by professionals). From the Bergen Evening Record: "completely basic... If this doesn't give you a road map into the field of hi-fi, nothing will." From The American Record Guide: "really expert guidance... I would strongly urge this book as a prerequisite reading for anyone contemplating his first purchase." From High Fidelity: "welcome addition to the small but growing body of serious literature on home music systems." From Electronics Illustrated: "To my mind, this is the best book now available on high fidelity."

REPRODUCTION OF SOUND
by Edgar Vilichur
AR Library Vol. 2 93 pp., illus., paper $2.00

Vol. 2 explains how component work rather than how to use them, but it presupposes no technical or mathematical background. Martin Mayer writes in Esquire: "for and away the best introduction to the subject ever written—literate, intelligent and, of course, immensely knowledgeable." From HiFi/Stereo Review: "just the books to satisfy that intellectual itch for deeper understanding."

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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 $1/2Z_a$.

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 $1/2Z_a$ 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.

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.

![Fig. 12. By using a differential amplifier we need use only one section.](image)

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as being an inordinately large tip mass. Again, the term pre-distortion, though technically correct, offers calamitous 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 13 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 0.05mil mis-match in tip radius would leave. Even if 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! 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.

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.

The technique was first proposed by Mr. Vail 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, 1953.

The most noise-free recordings you have ever heard are to be made on the new all-transistorized Norelco Continental '401' Stereo Tape Recorder, the only recorder using the newly developed AC 107 transistors in its two preamplifiers. The only transistor specifically designed for magnetic tape head preamplifiers, the AC 107 utilizes specially purified germanium to achieve the extraordinary low noise figure of 3 db, measured over the entire audio band (rather than the usual single frequency). This noise figure remains stable over large collector-emitter voltage swings and despite large variations in source resistance.

Hear the new transistorized Norelco Continental '401', a 4-track stereo/tape record and playback • 4 speeds: 7½, 16, 33⅓, 45 rpm and the new 4th speed of 15⅝ ips which provides 32 hours of recording on a single 7" reel • fully self-contained with dynamic stereo microphone, two speakers (one in the removable cover for stereo separation), dual preamps and dual recording and playback amplifiers • self-contained PA system • mixing facilities • can also play through external hi-fi system • multiple facilities.


For a demonstration, visit your favorite hi-fi or camera dealer. Write for brochure A-12. North American Philips Co., Inc., High Fidelity Products Division, 100 East 42nd St., New York, N.Y. 10017.
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 impedances 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 by drivers without any resonant! These horns were installed between the back cavities and were vacuum tube equipment. Originally, 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 4.7 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.

A TON-AND-A-QUARTER OF SOUND
(from page 27)

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LISTEN

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 90-feet away. The fidelity of
reproduction at even the lowest levels
was phenomenally good. The instant-
taneous peak power inputs to the in-
dividual drivers for the lowest 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 effi-
ciency 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 lowest 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 re-
marked 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 ac-
complished. 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-LP
units. To attempt to directly mount
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formance. For top performance atten-
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track stereo tapes recorded with two
condenser microphones.

Several individuals contributed heavily
to the successful accomplishment of this
project. Primarily, gratitude is ex-
pressed 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.
**THE AUDIO BOOKSHELF**

- **Maintaining Hi-Fi Equipment**
  - Joseph Marshall
  - A valuable reference for anyone whose living or hobby is servicing hi-fi equipment. Outlines the professional approach for servicing all types of hi-fi components. Covers trouble-shooting of electronic, mechanical and acoustic problems. 224 pages.
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- **Designing and Building Hi-Fi Furniture**
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  - Written by a professional hi-fi furniture designer who has taught furniture design at leading colleges, this book is an authentic reference of value to the hi-fi fan and professional custom builder. Covers everything from types of woods to furniture finishing for the mechanically adept; design principles, styling and arrangements for the decor minded. 224 pages.
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- **Handbook of Sound Reproduction**
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- No. 123 $19.95
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 organ music. 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 strongly mixed Catholic music they sang on the first. Mr. Biggs, with an incredibly disciplined arrangement, shaped and released it 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 influence.

"Silent Night" goes the farthest, aside from the strange words and a certain wild, primitive purity, the carol is more or less as usually harmonized—no trouble at all. "A Christmas Carol" (Orchestrations by C. A. Power, London) is a remarkable, well-performed piece with a touch of the gaudy and the overdone.

African "Voluntary," written for the King by Sir Charles Clarke himself and the famous "Voluntary," supposedly by Purcell, that has taken on new life in recent years, "The Prince of Denmark's March," but remains the prototype of the trumpet Voluntary for modern ears. We have Handel, Creston, Purcell, plus a bride of Tchaikovsky 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 taste anyway, anyhow. I'll sell.

Audiophiles who like "the organ" in the Congo will find this disc highly recommended. It will sound reasonably far away.

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RECORDS

(from page 59)

A supplementary bonus 5-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 your copy—the little disc tends to fly out of its folder and may have quietly and/or haphazardly removed by previous fingers.)
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 17, New York for a 25c handling charge. A-1


M-S Stereo Paper. Gotham Audio Corp. has a large quantity of this 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 23, N. Y. A-4

Tape Recording Booklet. A newly-released booklet from Sakae Tarzian, Inc. entitled "Lower the Cost of Tape Recording," contains 32 pages of information for those interested in making tape enthusiast. Included are sections on how to have fun with your tape recorder, how to record from various sources, applying and editing, the care of your tape recorder, and tests for tape quality. Sakae Tarzian, Inc. Magnetic Tape Division, Bloomington, Ind. A-5

Cartridge Cross-Reference Manual. The East Coast 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 revolution, Sonotone-Plex needle), as well as cartridges. The Sonotone Warranty Policy is reproduced and other audio products made by Sonotone are pictured, including ceramic microphones, headsets, tape heads, speakers. In addition to regular punching, the manual features a hole punched in the top left-hand corner for handling the service equipment key or sales counter. For a free copy of Sonotone's new cartridge cross-reference replacement manual (SAC-23), write Electronic Applications Division, Sonotone Corporation, Elmford, New York. A-5

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FREE Catalog. A 24-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 includes products of Houston Radio Company, Dynemic Division of HP, Harrison Laboratories, Hewlett-Packard Company, U.S. Mail Order Co., and the Audio Business (Industrial Division). Typical instruments listed include: oscilloscopes, voltmeters, audio generators, signal generators, power supplies, electronic counters, pulse generators, microphone preamplifiers, event recorders, strip-chart recorders, X-Y recorders, impedance measuring instruments, and equipment for digital data acquisition. A-18

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WANTED: Magna Model 2 electronic crossover. H. P. Halsey, P. O. Box 47, Albany, Ga.


Television Test Instrument Catalog. A new 56-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 includes products of Houston Radio Company, Dynemic Division of HP, Harrison Laboratories, Hewlett-Packard Company, U.S. Mail Order Co., and the Audio Business (Industrial Division). Typical instruments listed include: oscilloscopes, voltmeters, audio generators, signal generators, power supplies, electronic counters, pulse generators, microphone preamplifiers, event recorders, strip-chart recorders, X-Y recorders, impedance measuring instruments, and equipment for digital data acquisition. Copies of the catalog are available without charge from Hewlett-Packard Field Offices or directly from the factory. Hewlett-Packard Co., 1501 Figue Mill Road, Palo Alto, Calif. A-18

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Audio • January, 1964

Industrial Notes...

• More Moves at University. Stan Neu, National Sales Manager for University Loudspeakers, recently announced the appointment of John Pacconi, Jr., as Special Projects Engineer. The Special Projects Division of University covers a complete line of microphones, electronic addressers and the Intelligent electronic equipment. Mr. Pacconi will be responsible for the sales of these products to distributors, dealers and o.f.m. accounts throughout the United States.

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

More recently, Maskel A. Blair, President of TVT, 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 indeed best known for his most recent service as Executive Vice President in charge of Manufacturing and Production for the Glaser-Steele Corporation.

Last, but not least, University announces the 1964 holiday promotion: Fiesta Mexicana. One day after New Year's Day, to March 15, "Very Special Men" and their wives will receive a "Very Special Airplane." The "Very Special Men" will be the highest quota distributors of University's complete line of commercial and industrial public address speakers, high-fidelity component speakers, and a complete line of microphones, and related electronic equipment. The "Very Special Airplane" will be a University charted 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 Robert K. Kahn, president of the Michigan-based electro-audio manufacturing concern. A new building, to be erected atop the tuna plant, 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. Constructions 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 L.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 free type of tape recorder Merchandising Manual for representatives and distributors has been introduced by Concord Electronic Corporation. Don Kaselar, Marketing Manager for the West Coast, concerned, said that the Merchandising Manual includes sections on success-proven dealer sales promotion, merchandising techniques, service programs and complete details on the Concord tape recorder line, in both technical and easy-to-understand layman's terms. In addition, the new manual also offers various merchandising ideas and materials as publicity releases, direct mailers, advertising mats, p.o.p. displays, glossy photo, point-of-sales literature, informative product fact books, streamers and hangups, plus other selling aids. Concord Electronics Corporation, 290 North Cahuenga Boulevard, Los Angeles 28, California.

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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 15% 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.

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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!

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