AUDIO

NOVEMBER, 1962
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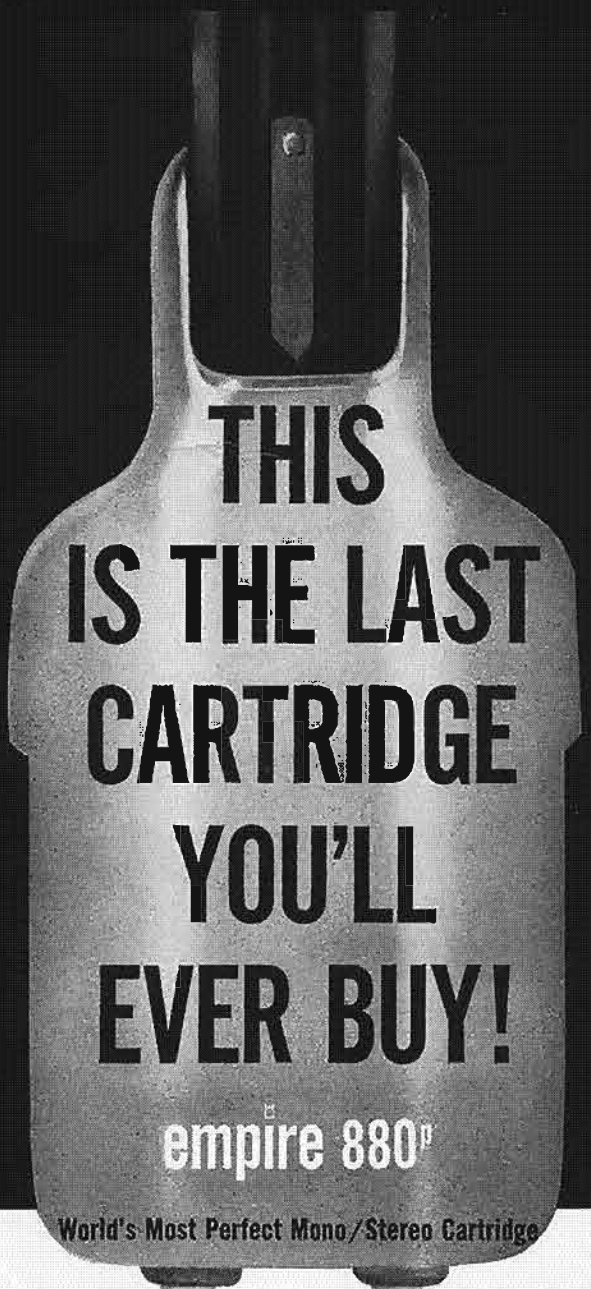

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AUDIO

NOVEMBER, 1962 Vol. 46, No. 11

Successor to RADIO, Est. 1917

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FM Receiver Tuning

Q. Whenever I tune in a local station on my FM tuner, I find three peaks of tuning. As I go from left to right and approach a station, the station seems to come into tune (but not completely) then out of tune, then into tune again (this time almost completely) then out of tune, then again in tune (but not sharply). On distant stations there are two peaks, neither in tune.

I have tried to align the tuner by following alignment instructions. By so doing, I have succeeded only in sharpening up the center peak a little more, but it is still not as sharp as I think it should be. In some cases, the left and the center peaks are equally sharp. This condition prevails whether the multiplex switch is on or off.

Can you tell me the cause of this condition? What can I do to remedy it? John J. Gordon, Levittown, Pennsylvania.

A. The situation you describe is normal operation for most FM tuners. The proper point for correct tuning is the center peak. The reason that the peaks act differently with different signal strengths is that the selectivity characteristic of the i.f. system changes with signal strength. As the signal grows weaker, the selectivity increases with the result that the signal is no longer audible when the outer peaks are reached. Further, the alignment of the detector shifts strength, moving the peak somewhat off the center position of the bandpass of the i.f. strip.

The center peak will broaden out as the signal increases in strength. The broader this peak becomes the better, for at its broadest the tuner is in full quieting and the i.f.'s are likely not to clip any of the extremes of modulation.

Projectors and Public Address Systems

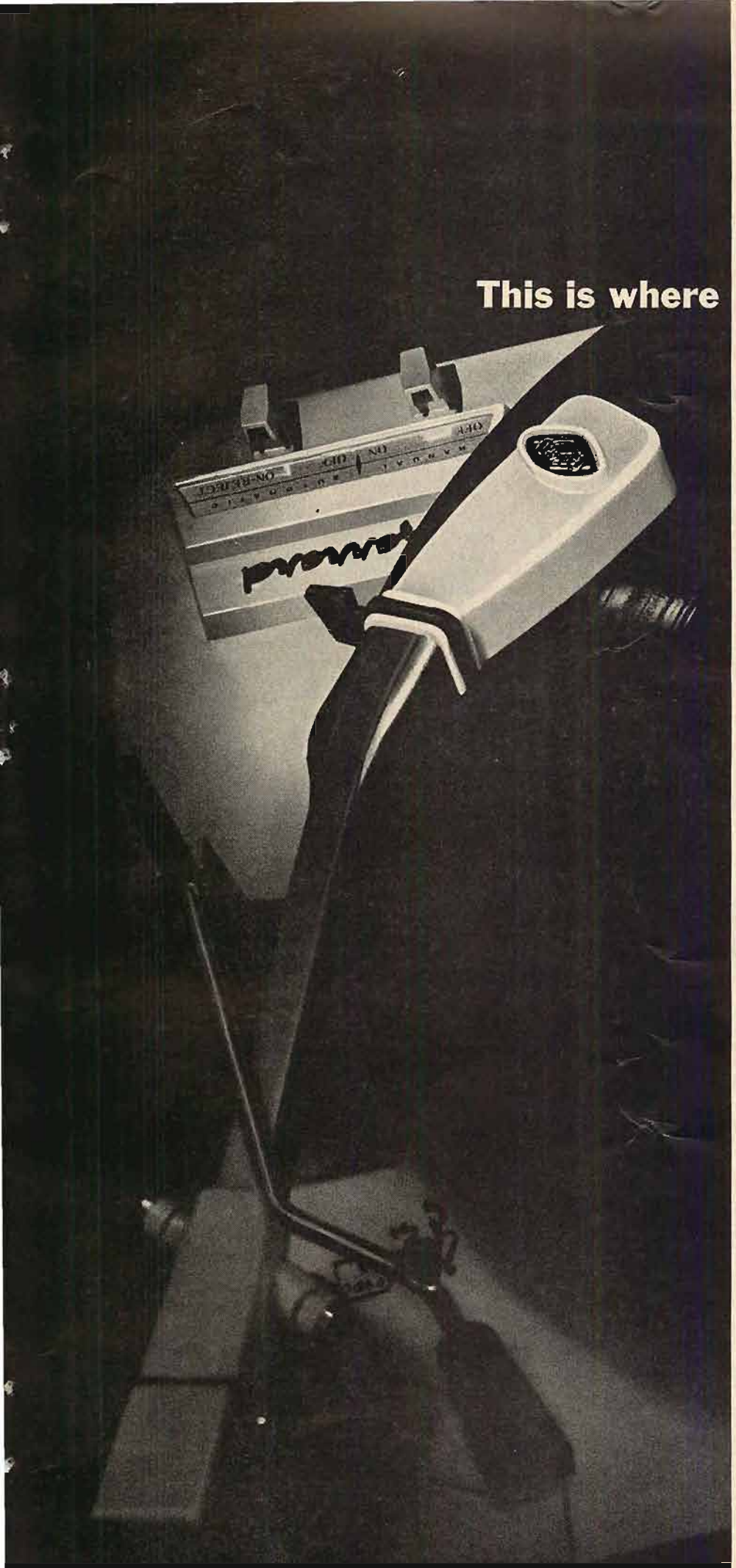
Q. I have encountered a problem for which I have been unable to work out a solution. The technical details are as follows: A motion picture projector with built in sound system is to be converted for use with an existing sound system in an auditorium. The projector incorporates a standard 10-watt amplifier using push-pull 6V6's and outputs for 8- and 16-ohm speakers. The sound system has four inputs, two high impedance and two low impedance, the low impedance being 50/150/250/600 ohms. Numerous procedures have been tried to match the projector's output to the amplifier with little success. This has included various resistance pads to match the 16-ohm output to the 50-ohm input transformer on the sound system amplifier. A transformer was tried in order to accomplish the same match. Both of these procedures produced distorted sound and appeared to drive the sound system too hard. I have thought of replacing the output transformer in the projector with a unit having a 500-ohm secondary. However, no commercial unit is available which will fit the space allowed.

It appears that the push-pull stage is driving the sound system too hard. It will probably be necessary to go ahead of the push-pull stage and use a single plate-to-line transformer. Daniel K. Hiskey Yorba Linda, California.

A. You are correct in thinking that the sound system is being driven too hard. An attennator of some kind is needed. First of all, why use the 50-ohm input? Use instead one of the high-impedance inputs. Presumably these are used for feeding phonographs and the like into the system. They possess less gain and pose less of a problem. Do not try to match impedance. Terminate the projector with a resistor of either 8 or 16 ohms as may be convenient. Then connect this input directly to the high-impedance input. Adjust the volume controls of both the projector and the sound system for best signal-to-noise ratio.

I do not recommend that you take output from a preceding stage in the projector unless you are sure that this procedure will not interfere with feedback or equalization.

It it happens that the high-impedance inputs are designed with low-level circuits rather than the high-level sources assumed here, the above procedure must be altered. A potentiometer whose value is equal to either 16 or 8 ohms can be placed across the terminals of the projector, with the signal taken from the arm of the potentiometer, and fed to the appropriate point in the projector. If the action of this potentiometer is too coarse, terminate the projector's output with a 16- or 8-ohm resistor. Connect a 100-ohm resistor to the "hot" output terminal. The other end of this resistor should be connected to one end of a 10-ohm potentiometer whose other end is grounded. Signal is taken from the arm of this potentiometer and ground and is then fed to the appropriate input terminal on the projector, preferably the



This is where your investment in a Garrard Automatic Turntable pays off

Chances are that sooner or later you will spend more on your records than you do on any record player. More, it may be, than the cost of your entire music system. Your listening enjoyment is dependent upon records and the unit that reproduces them. This is exactly why more GARRARD Type A's, for example, have been sold—and are being sold—than any other high fidelity record playing equipment, without regard to cost. Just consider this...

Most people today want to use one of the ultra sensitive cartridges developed originally for separately-sold tone arms because of high compliance. Garrard has integrated precisely such an arm in the Type A Automatic Turntable—dynamically-balanced, counterweight adjusted, designed and built with the same precision, the same balance, the same freedom from friction, the same playback characteristics and low resonance. This arm, operating in conjunction with the Type A's heavy, full-size, non-magnetic turntable — a laboratory-balanced, double-shielded motor; and (when you want it) the gentlest automatic record-handling mechanism ever designed; rewards you with the full measure of the magnificent reproduction you expect from the best recordings.

Garrard's Type A Automatic Turntable is proudly owned by a growing legion of highly critical people who, originally amazed at the $79.50 price, have come to realize this completely integrated precision instrument could have been developed only by the Garrard Laboratories. *For illustrated literature, write Dept. GS-12, Garrard Sales Corp., Port Washington, N. Y.*

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high-impedance input. This latter connection is preferable because the impedance mismatch will result in a further attenuation of the signal.

Impedance mismatch can be used in instances such as this because maximum power transfer is not desired. The impedance which must be matched properly is the impedance at the output of the projector. No other matching need be considered. In fact, we would not be concerned with matching the impedance of the output circuit of the projector were it not for the fact that it is always desirable to have the output transformer properly loaded so that the feedback loop will operate properly and there will be no chance of accidental damage to the output transformer caused by excessively high voltages in the primary circuit.

Refrigerator Interference

Q. Every time my refrigerator starts I hear loud "pops" in my speakers. The "pops" are most annoying and pronounced when I use my FM tuner. I have tried bridging the power plug with a 0.05 μf 600 v.d.c. capacitor but it only made the "pops" louder. Bernard Maugham, Bronx, New York.

A. I may not be able to be of much help because of the nature of some house wiring and the nature of refrigerator action. During certain parts of the refrigerator's cycle of operation, the unit will draw considerable current from the line. This will cause the line voltage to drop markedly when the house wiring is old or not sufficiently heavy to allow the proper operation of the various appliances now available. This sudden change in line voltage will manifest itself in clicks or "pops" as a result of the fact that the voltage on all circuits in the high fidelity system will be subject to a momentary change.

If the problem is one of eliminating "simple" transient clicks from the line, you can only do that if you can gain access to the wiring of the thermostat of the refrigerator and bridge its contacts with a series network consisting of a 0.02 μf capacitor and a 200-ohm resistor.

You may be able to gain some relief from this condition by using a line-interference filter between your equipment and the a.c. supply line. Be certain that you have bought a good filter. Some filters have been made with nothing inside them but plaster-of-Paris: This kind of filter will filter nothing at all.

You indicated that these transient clicks are most pronounced when your tuner is in use, therefore it is possible that some of the pickup is coming from the antenna circuit of the tuner rather than from coupling into the equipment via the power line. It seems logical, therefore, that the line cord of the refrigerator, and the power line itself, is radiating this energy. Therefore, some further relief may be afforded by bypassing each side of the refrigerator's line to a good ground, connecting the bypass capacitors either inside the refrigerator or at the point where the line cord enters the refrigerator. 0.1 μf capacitors, 600 v d.c., should be used as possible starting values. AE

THIS MONTH'S COVER

This month we have an opportunity to glimpse into the home of Jerome Brent, D.D.S., of Forest Hills, N. Y. In the words of Dr. Brent, "The idea in building this installation was to have a good-looking cabinet which would be unobtrusive when the doors were closed, yet contain all the components I thought necessary." The cabinet was built by Weathervane but the interior work and the installation of components were carefully executed by the owner. The entire decor of the room, of which we see only a small part, was planned by Arthur Getter, AID. Photographs by Pan-ad Associates.

The equipment consists of the following: Weathers ML1 turntable, Grado Laboratory tonearm, Shure M3D cartridge, Viking Series 75 tape deck (4-track playback head), 2 Dynakit PAM-1 preamps with DSC-1 stereo control, 2 Dynakit Mark III 60-watt power amps, H. H. Scott LT-110 tuner, Concertone 505-4 tape machine. The speakers are Tannoy 15-in. monitors in custom-built bass reflex enclosures. The Dynakits and Scott tuner were built from kits.

In addition to the components the following is built in: A matrix of pilot lights to indicate mode, a stereo output meter, a jack for earphones, a tape storage drawer, microphone jacks, and convenience outlets.

Additional phone lines hidden under the carpeting and terminating at a receptacle behind the sofa permit use of the phones at the room's optimum listening point, without the need for visible wiring. By utilizing either this input or a four-conductor extension line from the panel, a listener may wear the headphones at any point in the room. Because the panel hangs from the shelf supporting the preamplifier, Marantz switches and knobs were used for visual symmetry.

The owner had planned originally for all equipment, less the speaker systems, to be housed in a single cabinet. But it was realized that a cabinet with sufficient capacity to house the equipment and a sizeable record collection . . . and provide space for future accommodation of a tape deck . . . would appear too massive. A wall-mounted unit with the necessary record storage and equipment capacity seemed to be the answer.

The unit decided upon was designed by Contemporary Furniture Design, Inc., of New York. Of oiled walnut, it combines space for all of Mr. Jacolow's present equipment plus a tape deck with cabinetry for storage of up to 500 records, a bar, an antique glass-doored cabinet, fitted with a slotted top and bottom for heat dispersion, in which the amplifier has been housed, a three-drawer chest for silver and table linen storage and knick-knack shelves. By anchoring the unit's four uprights directly into beams, and because the cabinets suspend from horizontal pins passing through the uprights so that weight is literally forced *against* the wall rather than down, weight is no problem.

The result of all this effort is a stereo system fully capable of satisfying the most discriminating music-lover and audiofan. And it is beautiful, too. AE

LAST MONTH'S COVER

Here is the end of the story about last month's cover. Since the missing part starts in the middle of a word we will back up a little to page 60 in the October issue as follows:

all-transistorized

New Sony Sterecorder 777

the first/complete/portable/all-transistorized/high fidelity PROFESSIONAL RECORDING & PLAYBACK SYSTEM

The most advanced achievement in recorder engineering to date, the superb new remote-controlled professional Sterecorder 777 series features the exclusive and patented Sony Electro Bi-Lateral 2 & 4 track playback Head, a revolutionary innovation that permits the playback of 2 track and 4 track stereophonic or monophonic tape without track width compromise—through the same head!

Included in an array of outstanding features are individual erase/record/playback heads, professional 3″ VU meters, automatic shut-off, automatic tape lifters, an all-solenoid, feather-touch operated mechanism, electrical speed change, monitoring of either source or tape, sound on sound facilities, and an all-transistorized military plug-in type circuitry for simple maintenance. The three motors consist of one hysteresis synchronous drive motor and two hi-torque spooling motors.

Unquestionably the finest professional value on the market today, the 777 is available in two models, the S-2 (records 2 track stereo) and the S-4 (records 4 track stereo). Both models can reproduce 2 *and* 4 track tapes.* *And,* the Sterecorder 777 models will integrate into any existing component system. $595 complete with portable case and remote control unit.

**Through the exclusive Sony Electro Bi-Lateral 2 and 4 track playback head.*

Sony has also developed a complete portable all-transistorized 20 watt speaker/amplifier combination, featuring separate volume, treble and bass controls, mounted in a carrying case that matches the Sterecorder 777. $175 each.

Also available is the MX-777, a six channel all-transistorized stereo/monophonic mixer that contains six matching transformers for balanced microphone inputs and recorder outputs, individual level controls and channel selector switches, Cannon XL type receptacles, a switch to permit bridging of center staging solo mike. $175 complete with matching carrying case.

The first/complete/portable/all-transistorized/high fidelity/professional recording & playback system: $1120 complete.

Sold only at Superscope franchised dealers. The better stores everywhere.

For additional literature and name of nearest franchised dealer write Superscope, Inc., Dept. 7, Sun Valley, California.

All Sony Sterecorders are Multiplex ready! | **SUPERSCOPE** | **The Tapeway to Stereo**

LETTERS

Condenser Microphone Matching

SIR:

We take issue with the article "A condenser microphone mixer" in the October, 1962, issue of AUDIO. As the exclusive importers and representatives for the Neumann Company of West Berlin, Germany, we have spent the past four years in an earnest campaign to acquaint those Neumann microphone users who bought their units before we became the importer, with the proper network which has to be installed in all of our microphones to permit their operation with the standard amplifier inputs used in this country. This information is contained in our engineering bulletin No. 6032, which is available to anyone who requests it.

In order to understand properly the basic difference between the European (German, French, Austrian, and other parts of Western Europe) and the American standards in the professional field, it is necessary to explain that the U. S. follows a "matching" system of impedances in which the input and output of every amplifier provides for a specific impedance to which it must be connected to perform as specified. Terminating with other than rated impedance produces frequency discrimination. This is largely because the input and output transformers used take advantage of certain winding capacitances at their upper frequencies to flatten out the over-all response. This effect will work properly only if the particular transformer's impedance requirements are met.

In Europe, on the other hand, we find a voltage standard; i.e. one in which there is no significant power transferred from one output to the next input. This is done by virtue of something which we in this country call "bridging." We do this when we want to connect some input such as a monitor amplifier across a 600-ohm line without deteriorating the dbm level in that line. This can *only* be done, however, if the 600-ohm line is actually terminated with a 600-ohm resistor. Here is where the European method differs. They can go from one impedance (usually about 40 ohms) right to a higher impedance (usually 1000 ohms or more) *without* connecting a 40-ohm resistor across the output of the first amplifier.

You will find that microphone inputs on German consoles are rated at about 1200 ohms and further state that you may connect *any* impedance to them which is ⅕ of that impedance (240 ohms) *or less*. Likewise, all condenser microphones (they contain amplifiers and therefore come under this heading) are switchable to either 50 or 200 ohms and are indicated to be operated into *no less* than 5 times their impedance, or 250 ohms for the former and 1000 ohms for the latter adjustment *or more*. The transformers and circuitry surrounding them are so designed that an impedace match is not only not needed, but *not wanted*.

Now let us look at the problem of connecting a Neumann U-47 microphone, or any Neumann microphone for that matter, to an input of 250 ohms on an American console. On the one hand the microphone wants to see a *minimum* of 250 ohms (when set for 50 ohms itself) while the input of the preamp *must* see exactly 250 ohms. To accomplish this we use two series resistors between the two. These are already installed on any Neumann microphone sold in the last four years in this country. They *do not* constitute a pad! The Models U-67, U-47, and U-48 are also considerably more sensitive, as Mr. Dilley points out, and for this reason these units combine a loss pad with the above mentioned network. We are in wholehearted agreement with Mr. Dilley that it is regrettable that this available gain must be wasted at this point and we welcome in principle the design of a mixer which provides for inputs of this magnitude without overloading. It must be stressed, however, that this is only the case with these three microphone models and not with our other condenser units such as the SM-2, KM-54a, KM-56, M-49b, M-50b, M-269. All of these provide a level only some 8-db higher than domestic dynamic or ribbon units which a normal console input should be able to handle.

I trust that this general explanation has served partially to clarify an age-old problem with condenser microphones. We are delighted with Mr. Dilley's idea of such a mixer and we are sure that he will so change his input circuits as to conform to these conditions. Failure to do so will produce premature overload of the microphone amplifier if the microphone's 200-ohm output is connected to the console's 250-ohm input, and a high-frequency peak if the input of the preamp is under-terminated with the microphone set for 50 ohms.

STEPHEN F. TEMMER
Gotham Audio Corp.,
2 West 46th St.
New York 36, N. Y.

(Continued on page 79)

YOU SUPPLY THE FREQUENCIES . . . KODAK TAPE SUPPLIES THE RESPONSE

Listen! The dramatic crescendos and crystal-clear highs are the result of the fine, tight magnetic domains that are characteristic of the new KODAK Sound Recording Tape. But frequency response with a minimum distortion is just a part of the story. Kodak tape has a coating so uniform that it never varies more than 14-millionths of an inch.

New KODAK Sound Recording Tape is manufactured to the same super-critical standards as is Kodak film. Standards that have never been exceeded in any coating process. The result is remarkable uniformity from roll to roll, and unusually high sensitivity. Kodak tape is lubricated on both sides to prolong its life as well as that of the recorder head.

KODAK Sound Recording Tape is available in all standard lengths. And there is a built-in splicer on the reel. Try this fine new sound recording tape today.

EASTMAN KODAK COMPANY, ROCHESTER 4, N. Y.

LIGHT LISTENING

Chester Santon

Sounds of Victory
London Tape LPM 70052

This month's occasion for rejoicing among tape fans is the news that London Records has issued a band recording that surpasses one of its most famous sound specialties of the past season. Slightly more than a year ago, the tape, called "Pass in Review" kicked off the Phase 4 series on this label with a resounding thump. That recreation of a military parade swaggering past from one speaker to another struck this "observer" as a particularly successful example of sound in motion whose audio quality raised a tantalizing question. The record and tape version of "Pass in Review" revealed in no uncertain terms that London was now capable of turning out a terrific product even when going through the maze of electronic gear called for in the multi-track Phase 4 process. The tantalizing question: how would a brand new painstaking recording of a band sound under London conditions of optimum simplicity? We have our answer in this release. If you don't get around to hearing it by some means or other, you're missing what to me is the first convincing demonstration that four-track tape can now genuinely compete with stereo disc in terms of frequency response. Pick any tape issued before this one featuring a full-size military band and unroll it past a carefully aligned playback head. Then follow it with this Sounds of Victory reel. Only then will you realize that LPM 70052 has bona fide, honest-to-goodness, alive and kicking highs that are not the product of treble preemphasis. UST can take a bit more credit for this feat than London itself but both are to be congratulated on the scope of their accomplishment. The Band of the Grenadier Guards is the lucky group that's going to enjoy the close attention of tape's boosters in the *months* to come. Among the military marches and combat tunes featured in this release, the *Guadalcanal March* from Richard Rodgers' "Victory at Sea" will probably enjoy greatest popularity as a demonstration of what this tape can deliver.

Mantovani: Song Hits from Theatreland and Carnival
London Tape LPK 70054

Quite apart from their other virtues, the Twinpak reels rolling out of the four-track facilities of United Stereo Tapes are now serving an unforeseen purpose. As some of the previously released tape albums are being teamed up to form Twinpak pairings equivalent to two normal albums, a fresh opportunity arises to gauge advances in the UST duplicating process. There isn't a tape fan anywhere in need of reminder that the duplicating process has long been the bottleneck in the production of commercial tapes. The "A" side of this Twinpak, "Song Hits from Theatreland," first appeared on a Mantovani tape as an individual release (London LPM 70044). Going from the earlier release to this Twinpak reel is more than moderately instructive. The first thing I noticed when making the comparison was that the newer tape has been given a considerably reduced over-all signal level. At the same time, the dynamic range of the more recent reel has been allowed to follow more closely the natural rise and fall of the orchestra's volume. There is far less evidence of the peak limiting that kept *most* of the earlier tape in the upper half *of its volume* range. Tape noise has been lessened enough on London LPK 70054 so that the music level is permitted to sink far below the minimum point decreed for LPM 70044. Without limiting circuitry to bat down the peaks, the highs on the later tape are sweeter and cleaner. No matter how impressively low in distortion the most recent limiters may be, four-track tapes manage to sound better without them. Even the hobbyist who has confined himself to disc playback is familiar with the fact that his friends who are tape fans have been getting better results with their own four-track tapes recorded on the premises than they have with the general run of four-track commercial releases. This latest Mantovani reel should help to convince both camps that store-bought tapes are now getting mighty close to the recorded-at-home product.

Lester Lanin and his Orchestra
Epic BN 628

This record provides my first opportunity to check the quality of Columbia's "Electronically Re-Channeled For Stereo" sound in an album devoted to something other than Broadway shows. Not too long ago, the "South Pacific" and "Kismet" original cast albums were reissued on Epic's parent label and were greeted with considerable enthusiasm in this corner because they were the first good examples of psendo stereo I've come across. The first problem facing any firm that engages in this sort of rescue operation is the condition of the mono master tape. Although this album is the earliest Lanin item in the catalog (it was allegedly recorded in the course of the Monte Carlo Ball in New York City in the spring of 1956 when Prince Rainier and Grace Kelly made their first public appearance after announcing their engagement), the master tape certainly has no trouble delivering the range of sound to which today's stereo cutters have become accustomed. Since both the Columbia and Epic labels are processed in essentially the same plant, the technicians have elected to follow a simple device in identifying each label's electronically re-channeled stereo. This Epic release carries the difference signal (L–R) in the right channel. Comparison of the two channels of this recording provides a particularly effective and revealing glimpse of the workings of the Columbia re-channeling process and offers a good explanation of the results they obtain. Naturally, stereo depth here does not impress to the extent of the real thing but separation is fully up to snuff. The dance repertory played here by Lester Lanin is the hard-core society stuff that established his reputation on records and sparked a revival of interest in this type of dance music.

Showboat
Columbia OS 2220

It was slow in appearing but here at last is a stereo recording of the familiar Jerome Kern classic that packs as much punch in its sound as do the songs themselves. Not that the woods have been full of stereo versions of this famous musical of life along the Mississippi. Until this release of "Showboat" came along, the only stereo recording on a major label has been the RCA Victor production starring Ann Jeffreys and Howard Keel. That release offered less musical impact than several of the old mono sets. You don't have to look far to find an explanation for this state of affairs. Any record producer, if pressed for a reason, will hasten to admit that "Showboat" isn't the easiest of musicals to cast. The public, even at this late date, tends to associate some of the roles with illustrious theatrical stars of the past. In view of the fame that later came to most of the members of the original cast, it's a bit hard to believe that Florenz Ziegfeld first brought the show to New York in 1927 with a cast that boasted no established stars in the lineup. The status of Charles Winninger and Helen Morgan underwent quite a change after their appearance in "Showboat." When Ziegfeld revived the show in 1930, Dennis King and Paul Robeson were the only replacements in the original cast. The record industry had its first convenient opportunity to record a Broadway "Showboat" cast when the musical had its second major revival in 1946. Columbia's 78-rpm album starring Jan Clayton, Carol Bruce, Charles Fredericks, and Kenneth Spenser was considered important enough at the time to merit inclusion among the first few batches of recordings to be chosen for transfer to Long Play when the new speed came along. For many years, the 1946 revival cast on Columbia LP 4058 was pretty much the standard reference point among show fans searching for a "Showboat" score on records. Although out-distanced in sound quality by all the "Showboat" recordings of more recent years, the 1946 disc has been most valuable in preserving a link with the past. The latest Columbia release starring John Raitt, Barbara Cook, Anita Darian, and William Warfield models itself for the most part on the traditional approach of the older release. To mold the entire production, Columbia has been fortunate in acquiring the services of veteran conductor Franz Allers. His many years at the helm of the pit orchestras of the great Lerner and Loewe Shows ("Paint Your Wagon," "My Fair Lady," and "Camelot") give him a head start in a score such as this. The big numbers in the show, *Make Believe, You Are Love,* and *Why Do I Love You?*, are in fine hands during the smooth duets of Barbara Cook and John Raitt. The Merrill Staton Choir rounds out the cast of singers and the whole production definitely benefits from the advances made in Columbia's new Stereo "360 Sound."

Music of Leroy Anderson
RCA Victor LSC 2638

The experiments in Boston's Symphony Hall continue apace. Recent releases by the Boston Pops reveal that RCA is still trying to arrive at a miking arrangement that it hopes will offer a more competitive sound in today's volatile stereo market. The pressure being exerted by some of the streamlined newer labels is a factor not easy to dismiss at any large company today. It will hardly surprise anyone who has followed the fortunes of the record industry for the past decade and a half that the mass market remains a basic consideration in the policies of the major outfits. The Boston Pops Orchestra, long one of the top sellers in the Victor catalog, is a pretty good barometer of the trend toward mass-market sound now underway at that label. Certainly the latest Pops recording makes less demand on stereo playback equipment than former discs issued by Arthur Fiedler. The mikes appear to be only a few yards above the instruments. At this rate it should be possible to get "Hi Fi" presence on equipment that is less than middling. A significant increase in signal level on the record accompanies the decision to move the microphones toward the heart of the orchestra. This new medicine unfortunately has a side effect that is far from favorable in terms of the room ambience that should be a part of any well-made stereo record. The first two bands of this album devoted to Leroy Anderson favorites could quite easily be confused with a typical mono Pops disc played through both channels of a stereo setup. Without the usual hall sound always associated with the Boston Pops before these experiments got underway, the ear takes some time to get used to the new sound. A further complication that tends to give the first two bands (*Fiddle-Faddle* and *Blue Tango*) a mono tinge is the fact that the strings no longer stretch across the entire distance that separates the loudspeakers. Instead, the strings appear to be tied up in a knot of sound at the center of the listening area. It's not until the listener reaches Band

(*Continued on page 58*)

How to install
(1) an FM stereo tuner with Multiplex,
(2) an AM tuner with variable bandwidth,
(3) a stereo master control center, and
(4) a 65-watt stereo power amplifier,
all in 20 seconds:

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FREE! $1.00 VALUE! The Fisher Handbook, a lavishly illustrated 40-page reference guide, idea book and component catalogue for custom stereo installations.

FISHER RADIO CORPORATION
21-29 44th Drive
Long Island City 1, N. Y.

Please send free 40-page Handbook, complete with detailed specifications on the R-200 tuner.

Name_____

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THE FISHER

*PRICES SLIGHTLY HIGHER IN THE FAR WEST. EXPORT: FISHER RADIO INTERNATIONAL, INC., LONG ISLAND CITY 1, N. Y. CANADA: TRI-TEL ASSOCIATES, LTD., WILLOWDALE, ONT.

AUDIO ETC.

Edward Tatnall Canby

What's New, What's Fantastic?

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Two Dimensions

What was new, then, at this year's New York show? The eternal question! The eternal official answer is always the same, of course. *Everything.* Like what's new in this year's 1963 autos. Totally new, as they always are. So say the ads. In actuality, most of the typical 1963 auto is old, repeated out of respectable, solid, long-time designing. Maybe 95 per cent. And it is the old, of course, that makes our 1963 hi-fi product the mature product it is. At a good guess, we get maybe 5 per cent genuinely significant innovation each year, not counting minor improvements. Good. As with solid income from good investments, there should not be much more than that in a mature industry such as ours.

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Then, the pioneer products in the field were designed to emphasize the same sort of thing that the pocket transistor radio had featured—as well as satellite and missile transistorization. Unbelievably small size. Light weight. Low current drain. Low heat production. Low-impedance outputs, minus transformers. These things were surely revolutionary, but they came to us then along with a package of very serious problems. Hi-fi out of transistors wasn't going to be so simple, it began to appear. The early equipment was, to sum it up in non-engineering terms, erratic and untrustworthy despite noble efforts. The missile-computer-satellite designs didn't seem to work very well in our rather special area.

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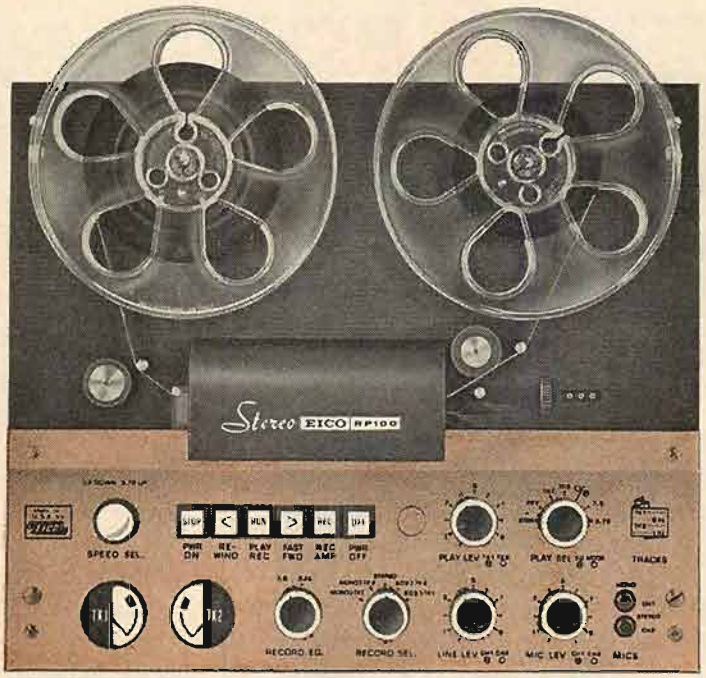

9 New Features Now In The New EICO RP100 Transistorized Stereo / Mono 4-Track Tape Deck

A great tape recorder made greater:

1. **New** professional studio recording hysteresis-synchronous capstan motor: 24 stator slots for ultra-smooth drive, ultra-quiet and vibrationless professional bearing system.
2. Two **new** take-up and rewind reel motors, both extra-powered for effortless operation.
3. **New** cored-out steel capstan flywheel with all the mass concentrated at the rim for improved flutter filtering.
4. **New** optimally designed capstan drive belt brings wow down to negligibility.
5. **New** relay provides instantaneous extra power to the take-up reel motor at start to minimize tape bounce. Provides near-perfect stop-and-go operation and eliminates any risk of tape spillage when starting with a nearly full take-up reel.
6. **New** automatic end-of-tape stop switch cuts off take-up reel motor power. Also permits professional editing techniques, whereby tape being edited out runs off the machine while you are listening to it.
7. Playback preamps remain "on" during stop-standby mode to permit cueing.
8. Recording level adjustment during stop-standby.
9. Shock-absorbent helical spring tape lifters practically eliminate tape bounce at start of fast winding.

And All These Well-known RP-100 Features:

Separate stereo 1/4 track record and playback heads permitting off-the-tape monitor and true sound-on-sound recording; **separate** transistor stereo record and stereo playback amplifiers meeting true high fidelity standards; monaural recording on 4 tracks; digital turns counter; electrodynamic braking (no mechanical brakes to wear out or loosen); all-electric push-button transport control (separate solenoids actuate pinch-roller and tape lifters); unequalled electronic control facilities such as mixing mic and line controls, two recording level meters, sound-on-sound recording selected on panel, playback mode selector, etc. Modular plug-in construction.

Wow and flutter: under 0.15% RMS at 7½ IPS; under 0.2% RMS at 3¾ IPS. **Timing Accuracy:** ± 0.15% (±3 seconds in 30 minutes). **Frequency Response:** ± 2db 30-15,000 cps at 7½ IPS, 55db signal-to-noise ratio; ± 2db 30-10,000 cps at 3¾ IPS, 50db signal-to-noise ratio. **Line Inputs Sensitivity:** 100mv. **Mike Inputs Sensitivity:** 0.5mv.

Semikit: Tape transport assembled and tested; electronics in kit form $299.95

Factory-assembled: Handwired throughout by skilled American craftsmen $399.95

An original, exclusive EICO product designed and manufactured in the U.S.A. (Patents Pending)

Carrying Case $29.95
Rack Mount $9.95

EICO®

FM-AM Stereo Tuner ST96
Kit $89.95 Wired $129.95
Includes Metal Cover and FET

70-Watt Integrated Stereo Amplifier ST70 Kit $99.95* Wired $149.95*
40-Watt Integrated Stereo Amplifier ST40 Kit $79.95* Wired $129.95*
* Includes Metal Cover

FM Multiplex Autodaptor MX99 (Patent Pending)
Kit $39.95
Wired $64.95
Cover Optional $2.95

New Stereo FM MULTIPLEX TUNER ST97
Semi-Kit $99.95 Wired $149.95
Includes Metal Cover and FET

Another brilliant example of EICO's no-compromise engineering, the new EICO ST97 combines the features of station-monitor quality and fringe-area reception capabilities with exceptional ease of assembly for the kit-builder. No test or alignment instruments are needed. The two most critical sections, the front-end and the 4-IF stage circuit board, are entirely prewired and pre-aligned for best performance on weak signals (fringe area reception). The front-end is drift-free even with AFC defeated. The four IF stages and 1MC-wide ratio detector achieve perfect limiting, full-spectrum flat response, very low distortion, and outstanding capture ratio. The 10-stage stereo demodulator—EICO's famous zero-phase-shift filterless detection circuit (pat. pend.)—copes successfully with all the problems of high fidelity FM stereo demodulation and delivers utterly clean stereo outputs. Excellent sensitivity, selectivity, stability, separation and clean signal add up to superb fringe-area reception. The automatic stereo indicator and station tuning indicator travel in tandem on twin slide-rule dials. **Antenna Input:** 300 ohms balanced. **IHFM Usable Sensitivity:** 3μV (30 db quieting), 1.5μV for 20db quieting. **Sensitivity for phase-locking (synchronization) in stereo:** 2.5μV. **Full Limiting Sensitivity:** 10μV. **IF Bandwidth:** 280kc at 6 db points. **Ratio Detector Bandwidth:** 1mc p-p separation. **Audio Bandwidth at FM Detector:** Flat to 53kc discounting pre-emphasis. **IHFM Signal-to-Noise Ratio:** —55db. **IHFM Harmonic Distortion:** 0.6%. **Stereo Harmonic Distortion:** less than 1.5%*. **IHFM IM Distortion:** 0.1%. **Output Audio Frequency Response:** ±1db 20cps-15kc. **IHFM Capture Ratio:** 3db. **Channel Separation:** 30db. **Audio Output:** 0.8 volt. **Output Impedance:** low impedance cathode followers. **Controls:** Power, Separation, FM Tuning, Stereo-Mono, AFC-Defeat.

Over 2 MILLION EICO instruments in use. Most EICO Dealers offer budget terms. Add 5% in West.

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- ☐ Send free 32-page catalog & dealer's name
- ☐ Send new 36-page Guidebook to HI-FI for which I enclose 25¢ for postage & handling.

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*Actual distortion meter reading of derived left or right channel output with a stereo FM signal fed to the antenna input terminals.

Listen to the EICO Hour, WABC-FM, N. Y. 95.5 MC, Mon.-Fri., 7:15-8 P.M. Export Dept., Roburn Agencies Inc., 431 Greenwich St., New York 13

practically zero cycles to practically megacycles. Noise 'way down and out. And the indications are that, this time, we can count on reliability too.

Not for nothing has the literature been full of transistor circuitry these last few years.

The external attributes of transistors are still present and advantageous, though now of secondary importance. Size still counts for something; a transistor preamp-control unit is perhaps two thirds or even a half the size and weight of an equivalent tubed model. Enough. We aren't shooting missiles and satellites and we don't yet depend on solar batteries. The other attributes are also brought to your notice in these new models. No output transformers, again. (But a whoppingly heavy power transformer.) Low heat, which is important in a power amplifier, of course, though not so vital in a preamp, which normally runs cool. Low current: useful enough. But quality is the transistor by-word. And quality is definitely a new dimension in transistor hi-fi.

Ultra-compliance

To be sure, there was one continuing trend at New York this fall which almost rates as Trend No. 3, that towards the ever smaller, lighter, higher-compliance pickup cartridge. This has been going on for quite a while. This year's emphasis is on more of the same.

Now, everybody's compliance figure, if it is to look like anything, just be wangled up into the 20's (20×10^{-6}). And everybody's stylus force must be down in the less-than-a-gram region, combined with a suitable arm. One 1963 cartridge goes all-out (following after the sensational ADC cartridge) to claim a quarter-gram playing force and a compliance of 25. I saw a brace of impressive displays and picked up some persuasive literature concerning this one but, since the cartridge itself didn't seem to be in evidence, I decided it could not quite constitute a Trend—yet.

Just where all this cartridge compliance business is leading us to I'm not sure. People's big, clumsy hands haven't changed. Records are still a foot wide and most arms still feature the wide-range half-inch mounting holes inside big shells, or "heads." The whole system *except* the stylus and generator elements remains big and clumsy and even dynamic balancing plus viscous mounting hasn't made up for it. Not for manual-play, anyhow.

Manual-play

It seems to me that a really lightweight, low-mass over-all system must necessarily be "no touch"—i.e., automatic, eliminating the fingers; yet in a practical sense this can never be. Record buyers won't stand for it. We still want to be able to pick up the pickup and lower it ourselves. We want to choose our musical passages to taste, visibly and quickly. We still, most of us, have an obstinate preference for direct action, with the fingers, as opposed to any sort of indirect lever-lowering of the stylus. We were born with fingers to use, weren't we? We don't like to fuss around with levers.

The fly-weight pickup system, therefore, must stick to finger action, or to a close

1 ONE GOOD THING

LEADS

TO ANOTHER

FM stereo multiplex came first. Next came our "Astro." Good things were getting even better. The 708A "Astro" is an all-in-one stereo center with *five* integrated components in a compact 6" x 15" x 13½" package: FM, FM multiplex, AM, stereo preamp, stereo amp.

It's so advanced in concept, circuitry, features and facilities that we suspect it will remain current for the next ten years. For example, consider its circuitry. Transistors in the power stage *completely eliminate heat problems.* As a result, the "Astro" plays cool—more than 30% cooler than conventional units. In this respect, the "Astro" is the first truly practical stereo center because excessive heat generated by ordinary all-in-one units shortens life and effectiveness of the sub-components, causes drift, sets up noise and distortion.

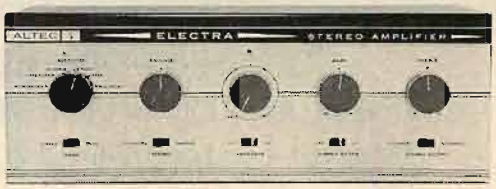
As another example, consider its unique *binaural* headphone facilities that offer the privacy of *silent listening* at anytime, without disturbing others. For convenience, the headphones may be plugged in permanently; a separate switch on the front panel activates the headphones.

Or, consider the fully professional tape recording monitor. With it, you may monitor the source two ways *during* recording: the instant signal enters the record head or directly from tape, the moment it is recorded.

An automatic switching circuit electronically distributes mono and multiplex signals to their respective channels while a stereo light provides visual indication on type of reception. These examples are only a sampling of what the "Astro" has to offer. In this case, seeing *and hearing* is believing. Price: $597.00 including cabinet and excise tax.

One good thing leads to another. For the listener who prefers a separate tuner or needs only stereo FM to complete an existing system, there's the new 314A "Electra Emperor" Stereo Tuner. It is identical in quality and features to the FM and multiplex sections of the "Astro" and is styled to match perfectly with our newly improved "Electra" Stereo Amplifier. Among its distinctive features, it provides a "full-time" monophonic output for feeding an additional single-channel system on the patio or anywhere in the house. The "Emperor" is priced at $359.00 including cabinet and excise tax.

The new 315A "Electra Empress" Stereo Tuner is the moderately priced version of the "Emperor." An outstanding performer at $256.00 including cabinet and excise tax.



The 353B "Electra" Stereo Amplifier is recommended for use with either of these new stereo tuners. The resulting system will reward you with a quality of sound possible to achieve only with such perfectly matched and balanced components. The 353 is a dual channel power and control amplifier with 14 stereo or mono inputs, 6 outputs for all known sources, even microphones and tv. A matricing network is provided for center stereo speaker and for driving auxiliary speakers anywhere in the home. Price: $225.00.

For complete information and specifications, see your Altec Distributor or write Dept. A-11.

ALTEC LANSING CORPORATION

LTV A Subsidiary of Ling-Temco-Vought, Inc.

1515 South Manchester Ave., Anaheim, Calif.

simulation of it, comfortable in the hand. Either that, or go all-automatic, eliminating the fingers completely, changer-style. No compromise is possible. Nobody, say, wants to fuss with a miniature manual lathe, maybe with one little crank to move the arm across the record and another to lower the stylus into the groove, ever-so-gently. It might work; but few will enjoy it. Fingers are easier, if clumsier.

That's why so many people turn naturally to records and to manual-play. No winding, no re-reeling, no number-scales to set, no blind back-and-forth searching by ear. Records are quick and direct. It doesn't matter that most people can't hit a visible band separation without making four or five jabs at the record surface, and the accidental gouge is commonplace. We want at least to be able to *try* for the instant perfect hit. Sometimes we make it, too.

Don't go around, then, thinking up ways to eliminate manual play. You'll eliminate the disc record as well. Its biggest selling point is its visible instant readiness to play at the beginning, the middle, or the end. Not even the perfected record changer has got around this; record changers now feature "manual play" as a competitive advantage.

Not even the Edison cylinder was able to sell the indirect-lowering stylus system once the disc and its freely moving pickup arm had appeared on the scene. That was nearly 75 years ago.

Electron Beam with Feedback Tracking?

As for the ever-increasing compliance and ever-decreasing stylus mass, I think maybe we're heading towards infinities. An infinitely compliant stylus point—the limp rag stylus. It just drags along, trailing out behind. Alternatively, the stylus of zero mass. Somebody's bound to arrive at *that*, sooner or later. I might as well anticipate.

How about an electron-beam stylus? Just take the guts out of an electron microscope and aim your cathode ray at the groove walls.

Of course you'll have to track the groove somehow. Why not a self-correcting feedback lathe circuit, locking the electron beam into the groove? Otherwise you'll have to fit a supplementary mechanical tracker for your electron stylus, and it'll have to be decoupled from the sensing unit, which mustn't vibrate physically, natch. It has to float, imperturbably; let the electrons do all the "vibrating." Rather like decoupling your car from washboards and potholes, this. Not so simple. I like the feedback tracking idea better.

Electrons are good! They could be a big improvement over the ancient and honorable (but seldom successful) beam-of-light pickup. If I'm right, that idea goes back well into the 19th century, but it still doesn't work too well. The thing about an electron beam is that it is already a current, whereas a beam of light is a mere electromagnetic radiation. The difference is subtle, I admit. (Does anybody really know the difference?) But difference or no, the electron beam doesn't need a photosensitive cell in its circuit to generate electricity. It *is* electricity. All it needs is a

(Continued on page 81)

THIS IS NO COMPACT!

54 inches high
9 feet around the middle

That's a lot of speaker system. Enough for what pleases you. It can whisper or it can bellow. It does both superbly, and anything in between. So much so that Hollywood's famous United Recording Corp. (sound studio for record, tape, film, and tv industries) employs 15 of them. As does Ray Heindorf, musical director of Warner Bros.' production "The Music Man" and holder of 2 Oscars, who has four right in his living room.

No, this is definitely not a compact. It's a giant, this A-7 "Voice of the Theatre" by Altec. A full-size speaker system with quality to match. That's why it belongs in your home. Unless you are willing to settle for a compact "book shelf" speaker . . . and compact sound. Of course if you are a critical listener, you'll want your sound brought to life by Altec; sound so realistically reproduced, you'll find its equal only in the concert hall.

That much the A-7 will give you, and more. Almost in direct proportion to your own desire for perfection. If you insist on hearing the "full sound," the most subtle contribution of each instrument, the effortless reproduction of massive orchestrations at concert-hall listening levels, then the A-7 is for you.

Now here is a hint: you can't make it any smaller, but you can make it a lot prettier. All it takes is a bit of effort, some grille cloth, some veneer or paint and you can transform the A-7 into a custom furniture piece. For built-in installation, there's nothing so perfect. At only $285.00 each, it's a wonderful do-it-yourself project . . . for the critical listener.

However, if you prefer your A-7 sound coming from a more civilized version, we have several solutions, in walnut or mahogany. There's the 831A "Capistrano," a full-size beauty that offers speaker components identical to the A-7 in a classically styled cabinet. It stands 30" high, 47" wide, and is priced at $399.00.

The modern 838A "Carmel" is also a full-size, floor-standing system. It features two 12" low frequency speakers (instead of the one 15-incher in the A-7) and the same high frequency section. It's priced at $324.00 with decorator base (shown) extra; standard model comes with round legs. The "Carmel" is also available with one low frequency speaker in a model called the 837A "Avalon," priced at $261.00.

ALTEC 838A "CARMEL"

ALTEC 831A "CAPISTRANO"

NEW! ALTEC 841A "CORONADO" SPEAKER SYSTEM

Apartment-size version of the full-size Altec speaker systems, the "Coronado" is styled to match a pair of "Carmels" when used as the center speaker in an Altec 3-channel stereo system. Recommended for small apartments where space will not tolerate larger speakers. The "Coronado" is 30" H, 18" W, 14" D and is priced at $199.50.

Go ahead, convince yourself! The A-7 (and its prettier mates) are ready to tantalize you now, at your Altec Distributor's. Or, for latest stereo catalog, write Dept. A-11A.

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With a Heathkit Catalog you can relax and enjoy Christmas shopping—gift giving without ever leaving your living room! You'll find a Heathgift for everyone on your list, regardless of interest, from beginner to experienced technician. And you give so much more with Heathgifts, for you save two ways—by buying direct from Heath and by buying in kit form. Savings that total 50% or more!

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NEW 23″ High Fidelity TV Kit—None Finer at Any Price!

SAVE $10, order GR-52,
TV chassis & cabinet.....only **$249.95**

SAVE $6, order GR-62,
TV chassis & wall mt.....only **$189.95**

OPTIONAL U.H.F. TUNER: Add at any time! Tunes U.H.F. Ch. 14-82. Mounts inside TV chassis. Complete with knobs and adapter strip. Factory assembled and aligned, ready to install.

GRA-22-3, no money dn., $5 mo.....**$27.95**

An outstanding TV value! Exclusive Heathkit advanced-design features include latest TV circuitry to bring you *both* Hi-Fi picture and sound! Incorporates the finest set of parts & tubes ever designed into a TV receiver. Easy to build too! . . . all critical circuits (tuner, I.F. strip & Hi-voltage sections) are supplied as factory-built, aligned and tested sub-assemblies, ready to install. The rest is easy with two precut, cabled wiring harnesses and circuit board. 70 lbs.

Kit GR-22, no money dn., $16 mo. . **$169.95**

BEAUTIFUL MODERN CABINET: Styled to match Heathkit AE-20 Hi-Fi Cabinets in rich, walnut solids and veneers. Complete with picture tube mask, chassis mounting board and extended-range 6″ x 9″ speaker for GR-22 TV set. Measures 36″ W x 32⅛″ H x 20½″ D.

GRA-22-1, no money dn., $9 mo.....**$89.95**

"CUSTOM" TV WALL MOUNT: For rich, attractive custom wall installations. Includes cut and drilled board for TV chassis. Unfinished white birch. Measures 19$\frac{7}{16}$″ H x30$\frac{7}{16}$″ W x 1$\frac{11}{16}$″ D. 13 lbs.

GRA-22-2, no money dn., $5 mo.....**$25.95**

NEW Deluxe CB Transceiver

4-tone selective call circuitry; 5 crystal controlled transmit & receive channels; variable receiver tuning; built-in 3-way power supply for 117 v. ac, 6 or 12 v dc; and more! Most complete CB unit ever designed!22lbs.

Kit GW-42, no money dn. **$119.95**

NEW Advanced Transistor Stereo Amplifier

Smooth power—superb dynamic range! 100 watts IHFM Music Power rated, 70 watts Heath rating. 13 to 25,000 cps response @ rated output. 28-transistor, 10 diode circuit. 28 lbs.

Kit AA-21, no money down, $13 mo.**$134.95**

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Send for this Heathkit organ demonstration record . . . listen to the beautiful voices, rich mellow tone and astounding range of expression offered in this sensational instrument. Send just 50c to cover cost of handling and postage on this 7"—33⅓ rpm record. **Ask for record GDA-232-3.**

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A Real 2-Manual Organ for Only $329.95

The exclusive Heathkit version of the all-new Thomas Transistor Organ now, for the first time, offers you a real two-manual organ at the market-shattering low price of only $329.95 in easy-to-build kit form! Compares in features and performance with assembled units costing well over $700. Features two 37-note keyboards; 10 true organ voices; 13-note pedal bass; variable vibrato; expression pedal; variable bass pedal volume; manual balance control; correctly positioned overhanging keyboards; built-in 20-watt peak amplifier and speaker system; beautifully factory assembled and finished walnut cabinet.

Kit GD-232 (less bench) . . . no money dn., as low as $22 mo. . . . **$329.95**

NEW 10-Transistor FM Car Radio

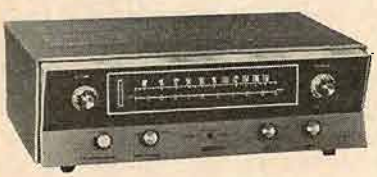
88 to 108 mc coverage; better than 1.25 microvolt sensitivity; AFC for drift-free FM reception; tone control. Factory-assembled tuning unit; easy circuit board assembly. 7 lbs.

Kit GR-41 . . . no money dn., $7 mo. . **$64.95**

NEW FM Portable Radio

10-transistor, 2-diode circuit; vernier tuning; AFC for drift-free reception; tone control; 4" x 6" speaker; built-in antenna; prebuilt tuning unit. Battery lasts to 500 hrs. 6 lbs.

Kit GR-61 . . . no money dn., $6 mo. . . **$54.95**



NEW FM/FM Stereo Tuner

Stereo Indicator light; phase control for max. separation and lowest distortion; adjustable AFC for drift-free reception; bar-type tuning indicator; filtered outputs for stereo tape recording. Factory assembled tuning unit. 16 lbs.

Kit AJ-12 . . . no money dn., $7 mo. **$69.95**

NEW Heathkit SSB "Six Pack"

A brand new SSB exciter and linear amplifier for six meter operation; 125 watts P.E.P.! Only $289.90 for the pair . . . less than the cost of most transverters. Loaded with extras for maximum efficiency and operating convenience!

Kit HX-30 Exciter **$189.95**
HA-20 Linear **$99.95**

World's Biggest VTVM Value!

Measures AC volts (RMS), AC volts (peak-to-peak), DC volts, Resistance and DB. Has 4½" 200 ua meter, precision 1% resistors and 11 megohm input. Slim, all-purpose test probe incl. 5 lbs.

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EDITOR'S REVIEW

RECORD DISTORTION

When FM stereo first became a reality a year-and-a-half ago, a problem was highlighted which caused much consternation in the recording industry, and also some consternation amongst audiofans. It was discovered that many stereo records were not suitable for simultaneous mono and stereo broadcast, as is the case with FM stereo. It seemed that a great many stereo records produced unacceptable levels of IM distortion when the left and right signals were summed for mono. We haven't heard too much about this topic recently, apparently because the stations have been choosing their recordings carefully.

Engineers, however, have been very busy on this problem. One well-known engineer who has been working on it is E. R. Madsen of Bang & Olufsen, Denmark. In this issue we are presenting the fruit of his labors wherein he presents the reason for this distortion, and proposes a method to reduce it substantially.

We don't wish to steal Mr. Madsens' thunder, but we would like to second the motion. His proposal is that we standardize the vertical angle for both the disc cutter and the playback stylus; he points out that it is the difference between these angles which produces both harmonics and intermodulation. The angle he proposes as an international standard is 15 deg. Actually, in the United States, the RIAA (Record Industry Association of America) has adopted a voluntary standard to this effect in their Bulletin E3. It reads:

> 4. The reproducing stylus motion shall be tangent to, or lie in a plane which passes through the record center, and which is inclined at a nominal angle of 15-deg., clockwise, to a normal to the record at the stylus tip, as viewed from the record center.

This standard can, of course, go a long way towards solving the problem. However, it *is* voluntary and a number of companies may be reluctant to adopt it. This is natural since in some cases it requires modification of equipment or even purchase of new equipment, and even if the 15-deg. standard were adopted by every manufacturer in the United States, what about the records and cartridges that come from Europe? In the classical field we would guess that European-made records occupy a sizable portion of the market-place.

Our feeling is that all record companies and cartridge manufacturers will co-operate in agreeing upon a standard cutting and playback angle in time. Those of us who have spent so much time and money to reduce distortion in the rest of our system, will most certainly support this proposal, and hope that it will be effected as soon as possible.

NEED FOR EDUCATION

In the Letters column this month issue is taken with Mr. Dilley ("A condenser microphone mixer," October, 1962) concerning his recommendations for matching impedances with condenser microphones. The people who took issue were right of course—a condenser microphone needs to look into an impedance at least five times higher than its own; actually the microphone is being bridged rather than matched. On the other hand it is quite understandable for an engineer to attempt to follow the standard procedure which is observed in about every other area where he faces similar problems. Every other type of microphone needs to be matched. What he missed was that he was not trying to transfer power, which is the point of impedance matching. But the problem is that there is no way of knowing this from the specifications of the device, since the words of description are precisely the same as with other types of microphones. (Of course the manufacturers of condenser microphones do supply technical bulletins with their products.) In other words it goes against the entire background and training of most audio engineers to bridge where he has always matched, especially when the words associated with the two different procedures are exactly the same. We offer no solution to this difficulty other than what the condenser microphone people are already doing—educate the user.

TRANSISTORS IN TRANSITION

Like old age and taxes, transistors appear to be here to stay if we read the signs correctly. At the recently concluded High Fidelity Show in New York the transistor straws were in the wind wherever one turned. We are not talking about medium-quality equipment either; most of the new transistor amplifiers and tuners were in the high-priced high-quality category. We expect to see almost every major manufacturer exhibiting transistor equipment by next year. What convinced us of this was that a major manufacturer long considered the stronghold of tube orthodoxy has taken the plunge; he exhibited a transistor amplifier this year (developmental model). From now on it is just a question of time, although there are some who have felt that the changeover to transistors has been inevitable for a long time. Anyhow, this is one changeover which will not obsolete existing equipment.

Another trend we noticed at the show was a heightened interest in tape equipment on the part of the audiofan, and reflected by the introduction of new tape machines by companies which had not been in this field before. Also there seemed to be more playback decks available than heretofore.

A surprising, but inevitable, development was the relative lack of excitement over multiplex equipment. Apparently audiofans have accepted FM stereo and are now concerned with other aspects of the problem. For instance there was great interest in antennas and other equipment for receiving the stereo signal. It has become obvious to most if not all audiofans that the range of multiplex transmission is not as great as standard FM transmission. We will devote editorial space to this problem in the future.

(Continued on page 93)

*Throughout the entire world... more people listen to stereo records reproduced by the STANTON Stereo Fluxvalve than any other magnetic pickup!

*More stereo records are quality controlled and reviewed by professionals using STANTON Stereo Fluxvalves.

*More high quality phonograph consoles use STANTON Stereo Fluxvalves than any other magnetic pickup.

*More commercial background music systems use STANTON Stereo Fluxvalves than any other magnetic pickup.

*More automatic phonograph systems use STANTON Stereo Fluxvalves than any other magnetic pickup.

And now...new dimensions for stereo from the world's most experienced manufacturer of magnetic pickups–

STANTON 481

Calibration Standard Stereo Fluxvalve*

Model 481AA STANTON Stereo Fluxvalve—an ultra-linear professional pickup for use with ultra-light-weight tone arms capable of tracking within the range from 1/4 to 3 grams. Supplied with the D4005AA V-GUARD diamond stylus assembly.
AUDIOPHILE NET PRICE **$49.50**

Model 481A STANTON Stereo Fluxvalve—an ultra-linear professional pickup for use with manual tone arms, recommended tracking force is from 2 to 5 grams. Supplied with the D4007A V-GUARD diamond stylus assembly.
AUDIOPHILE NET PRICE **$48.00**

Model 481E STANTON Stereo Fluxvalve Set—same as the Model 481A but includes two additional V-GUARD styli: the D4010A 1 mil for LP's and the D4027 2.7 mil for 78's.
AUDIOPHILE NET PRICE **$60.00**

STANTON 400

Professional Stereo Fluxvalve*

Model 400AA STANTON Stereo Fluxvalve—an ultra-linear professional pickup for use with ultra-light-weight tone arms capable of tracking within the range from 1/4 to 3 grams. Supplied with D4005AA V-GUARD diamond stylus assembly.
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AUDIOPHILE NET PRICE **$39.00**

Model 400C STANTON Stereo Fluxvalve—an ultra-linear professional pickup for use in automatic record changers, recommended tracking force is from 4 to 7 grams. Supplied with D4007C V-GUARD diamond stylus assembly.
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"Fine audio components from the Professional Products Division of"

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*The hermetically sealed STANTON Stereo Fluxvalve is warranted for a lifetime and is covered under the following patents: U.S. Patent No. 2,917,590; Great Britain No. 783,372; Commonwealth of Canada No. 605,673; Japan No. 261,203; and other patents are pending throughout the world.

News from Bell Telephone Laboratories

WE'RE "FINGERPRINTING" VOICES...TO FIND BETTER WAYS OF TRANSMITTING THEM

Acoustics scientists at Bell Telephone Laboratories study voices to learn how one voice differs from all others, what makes yours instantly recognizable to friends and family, and what the elements of a voice are that give it the elusive qualities of "naturalness."

To enable us to examine speech closely, we devised a method of making spectrograms of spoken words. We call them voiceprints. They are actual pictures of sound, revealing the patterns of voice energy. Each pattern is distinctive and identifiable. They are so distinctive that voiceprints may have a place, along with fingerprint and handwriting identification, as an important tool of law enforcement.

The shape and size of a person's mouth, throat and nasal cavities cause his voice energy to be concentrated into bands of frequencies. The pattern of these bands remains essentially the same despite modifications which may result from loss of teeth or tonsils, the advancement of age, or attempts to disguise the voice.

Study of voiceprints and recognition factors is part of our exploration of new techniques to extract and transmit the minimum essentials of a person's voice and from these reconstruct the original voice at the receiving end, retaining its factors of naturalness.

Our ultimate goal, as always, is to learn how to improve your telephone service and make it a better value.

BELL TELEPHONE LABORATORIES

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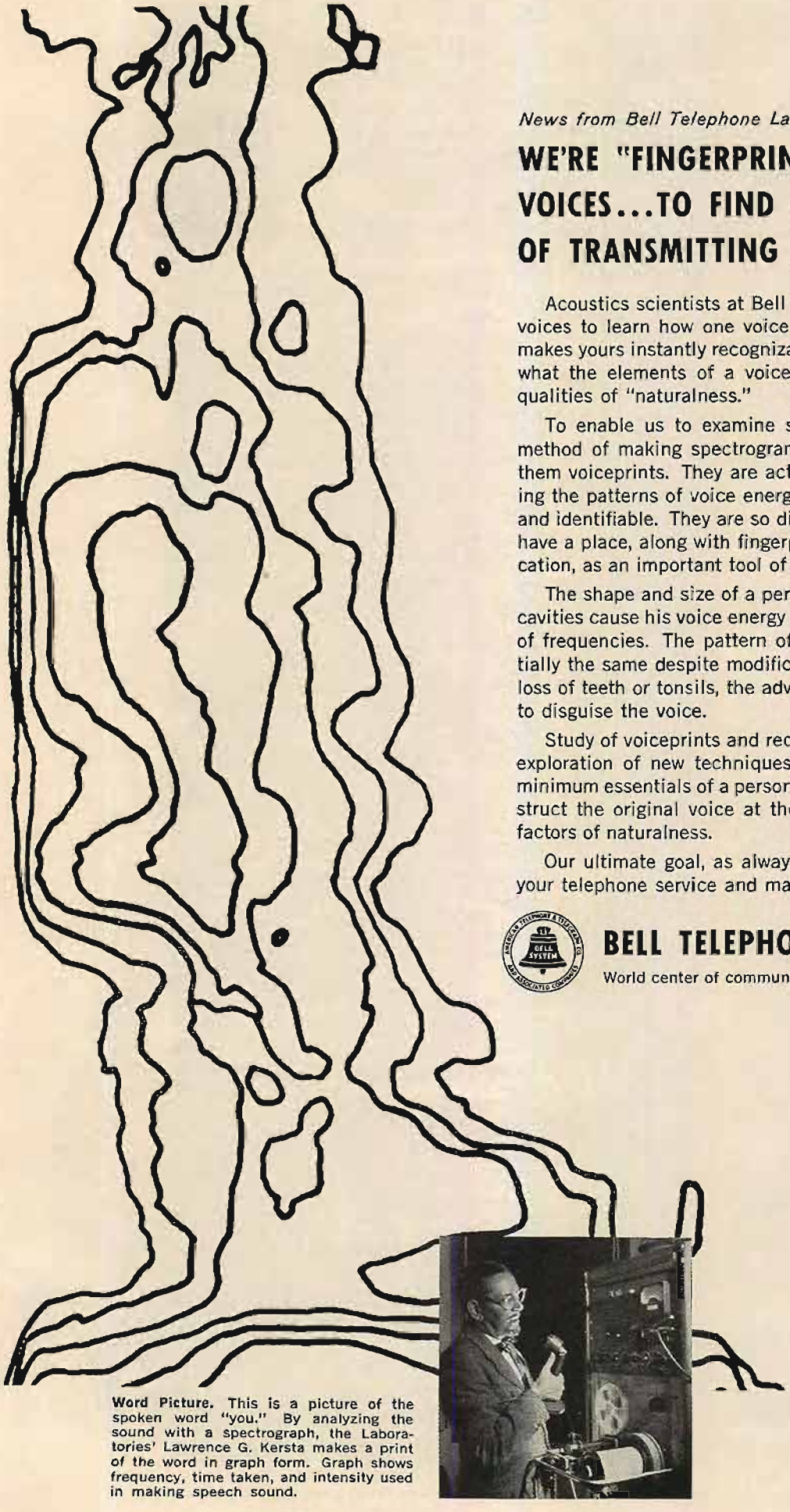


Word Picture. This is a picture of the spoken word "you." By analyzing the sound with a spectrograph, the Laboratories' Lawrence G. Kersta makes a print of the word in graph form. Graph shows frequency, time taken, and intensity used in making speech sound.

Vertical Tracking Angle— A Source of IM Distortion

An analysis of the distortion resulting from the discrepancy between the vertical angle at which the record is cut and the vertical angle of the playback stylus. A proposal is made to standardize these angles.

E. R. MADSEN*

PROBLEMS CONCERNING THE reproduction of stereo records have been considered from the viewpoint of reproduction quality previously. M. S. Corrington and T. Murakami of R.C.A. Victor have analyzed the relationships and found that when using the 45/45 system and a 90-deg. groove angle with the ideal playback cartridge, there is no cross-modulation between the two channels. Intermodulation and harmonic distortion are identical for the two channels and are the same as they appear with a normal hill-and-dale record. If the records are cut with a groove angle of 90 deg. between the two channels, and the two axes of the cartridge are at right angles to the movement of the two respective grooves, there will be no crosstalk from one channel to the other. These are ideal conditions. In the following discussion it will be shown how unevenly and confusingly the various makes of records are cut — a confusion that not only makes for listening variations of the many records, but also gives quite a few headaches to the playback cartridge designer. These problems could be avoided if agreement could be reached on standardization of disc cutting procedures.

Perhaps the historical background is partly responsible for the wide disagreement on methods. It should be remembered that the first experiments with stereophonic phonograph records began about 1930. At first the vertical-lateral system was used, although even at that time mention was made of the 45/45 system now in use. In a way the two systems are identical, since by suitable phasing of the two information channels, it is possible to change from one system to the other, making it practical to cut with either system using the same cutting apparatus. Correspondingly, a pickup constructed for the one system can, by means of suitable phasing, be used to play the other system.

* *Chief Audio Engineer, Bang and Olufsen, Denmark.*

PICKUP	STYLUS ANGLE φ
SHURE	40°
ORTOFON	25°
B & O	30°
FAIRCHILD (GL)	35°
FAIRCHILD (NY)	35°
GENERAL ELECTRIC	25°
RONETTE	12°
DECCA	0°
PICKERING	15°
ELAC	23°

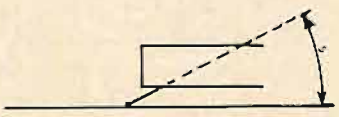


Fig. 2. Stylus cantilever angle in a variety of cartridges.

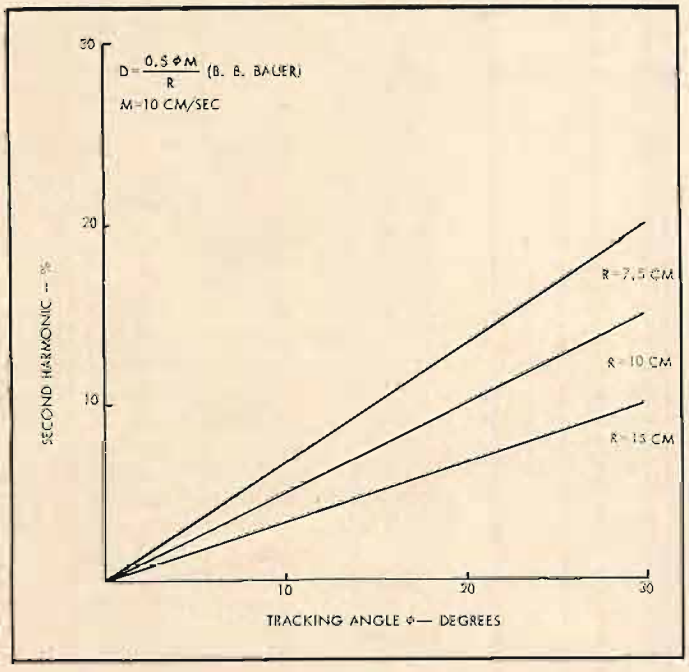


Fig. 1. The percent of second harmonic as a function of tracking angle and modulation.

This is not the place to discuss the advantages and disadvantages of one system versus the other, but merely to point out that from the historic development, equipment to record and play back stereo records has been largely derived from the vertical-lateral system. It is this existing equipment which impedes work in creating agreement on standards for the 45/45 system which has been accepted.

Stereo phonograph records only became a reality after the development of the Westrex stereo disc system. Stereo records were first made available to the general public in the United States. The fundamental work on the method of constructing stereo playback cartridges therefore came from C. C. Davis' and J. G. Frayne's description of the Westrex system which was publicized in the spring of 1958. In June, 1958, the al-

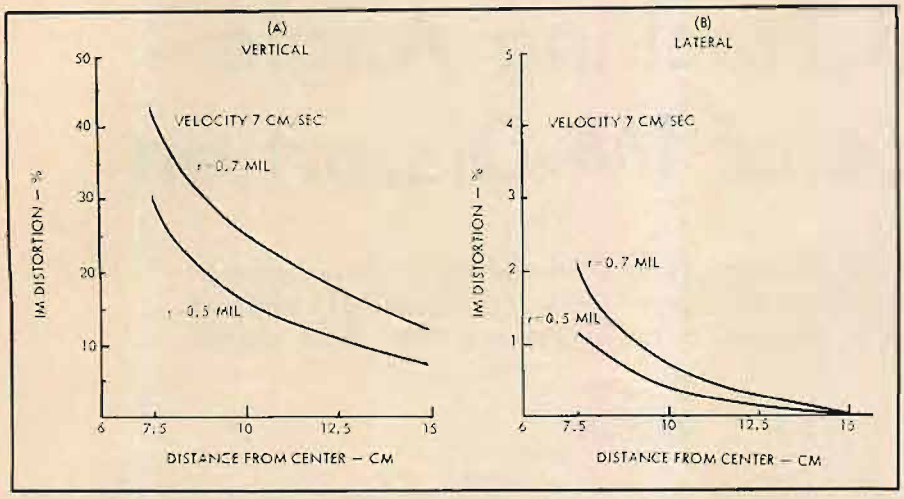


Fig. 3. Vertical and lateral IM distortion as a function of the distance from the center of the record and stylus-tip radius.

ready mentioned work of Corrington and Murakami in the *R.C.A. Review,* which weighed the merits of the vertical-lateral and the 45/45 system in regard to distortion, favored the latter system.

Since it is impractical to place the axis of revolution of the stylus cantilever exactly at the surface of the record, a vertical tracking distortion will arise unless there is a very close agreement between the angle used by the cutting head and by the pickup. What is normally referred to as the vertical movement of the tip of the cutting stylus is in reality a variation of a considerable angle from the vertical. In the Westrex system, this angle is set at 23 deg.

Calculations have been made of the harmonic distortion which appears when playing a laterally-modulated phonograph record with the incorrect tracking angle. According to B. B. Bauer ("Tracking angle in phonograph pickups," *Electronics,* March, 1945) the formula for the second harmonic when using the wrong tracking angle is

$$D = \frac{0.5\varphi M}{R}$$

When: φ is the variation in tracking angle in degrees
M is the modulation amplitude in cm/sec
R is the radius from the groove to the center of the record in cm.

It can be seen that the distortion is independent of the frequency, and only dependent on the modulation and the distance of the stylus from the center of the record, and of course the tracking angle. The formula is computed for a laterally cut groove with a record rotation speed of 33⅓ revolutions per minute. *Figure* 1 shows the tracking angle distortion at different places on the record, with a modulation of 10 cm/sec. In a well-constructed tone arm the variation from the correct tracking angle can be held to within 1 deg., plus or minus; in other words, in a good playback cartridge it can be demanded that the second harmonic be less than 1 per cent with normal modulation.

Bauer's formula can also be used for a vertically cut groove but additional information is required, because the harmonic distortion will depend here to a great extent on the frequency and on the radius of the stylus. It should be noted that the harmonic distortion is always greater for a vertically cut groove than for a lateral cut. At 1000 cps it will be about 5–6 times as great. Here I refer to the basic work of J. A. Pierce and F. V. Hunt in the *Journal of the Acoustic Society of America,* 1938.

Of the same magnitude, indeed sometimes worse, is the distortion obtained when playing with the wrong vertical tracking angle.

Distortion measurements have been made on a number of test records, using a B & O stereo pickup. The results are shown in Table I. The average figures for the right and left channel, recalculated for all records to 33⅓ rpm and with a modulation of 10 cm/sec, and a distance from groove to record center of 10 cm (about the middle of the record) are shown at the far right. On the basis of these measurements, and after comparison with the curves of *Fig.* 1, the presumed cutting angles for the vertical cutting are indicated.

Harmonic distortion resulting from an incorrect tracking angle consists mostly of second harmonic. The third harmonic is about 12–15 db down from the second.

We can see from Table I that the lateral distortion is unimportant in comparison with the vertical so that we may assume the tracking angle is correct for it. Vertical modulation shows considerable second harmonic distortion, however, dependent on the make of record. In order to compare the various records, recalculation (average value for both channels at 33⅓ rpm) has been made in

TEST RECORD	FREQUENCY (cps)	GROOVE RADIUS (CM)	MOD. (CM/SEC)	SECOND HARMONIC (%)				AVG. VALUE R = 10 CM M = 10 CM/SEC LEFT + RIGHT / 2	CALC. CUTTING ANGLE
				LAT.	VERT.	LEFT	RIGHT		
OR 1006	400	8-10	6.3	2	10	6	8	11	8°
OR 1005	400	8-10	6.3	0.9	7.5	5	6	8.7	13°
E-V 695 D (78)	1000	7-9	6	0.55		1	1	3.1	24°
WESTREX 1 A/B (78)	1000	14.5	5.5	0.8	1.4	1	0.9	5.5	19°
DECCA 99102 A/B	1000	10	1			1.6	1.6	16	0°
DG 99102 A/B	1000	14.5	8			6	6	11	8°
RGA 12/5/71	1000	14.5	3.8			0.8	0.8	3	24°

TABLE I. Distortion measurements of a number of test records.

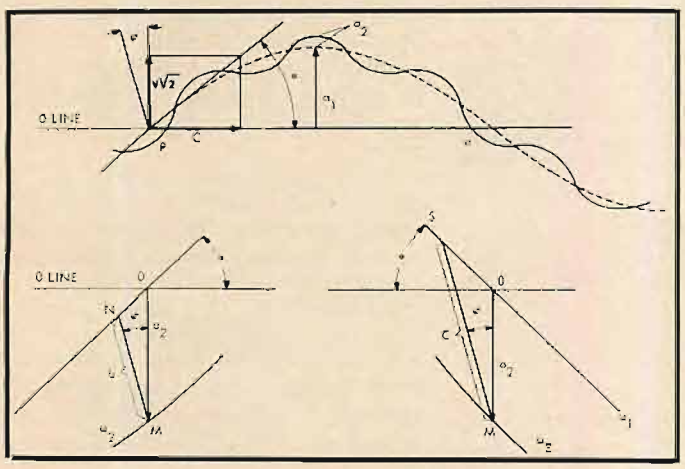


Fig. 4. A double-modulated groove and the result of incorrect tracking angle.

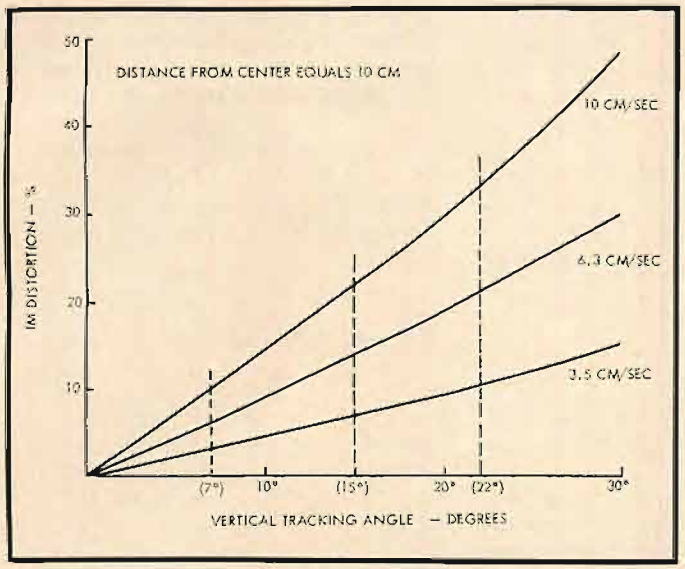


Fig. 5. IM distortion as a function of vertical tracking angle and recording level.

PICKUP		B	D	F	O	R	S	
LATERAL	3.15°	4	15	18	4.5	7	5	ORTOFON 1006 A (8°)
VERTICAL	3.15°	37	7.5	55	40	20	40	ORTOFON 1006 A (8°)
LEFT	3.15°	25	10	40	30	10	30	ORTOFON 1006 A (8°)
RIGHT	3.15°	28	10	30	25	12	25	ORTOFON 1006 A (8°)
LATERAL	6.3°	5	16	24	5	15	8	ORTOFON 1006 A (8°)
VERTICAL	6.3°	60	8	65	60	40	75	ORTOFON 1006 A (8°)
LEFT	6.3°	40	12	55	35	50	50	ORTOFON 1006 A (8°)
RIGHT	6.3°	50	12	60	40	30	50	ORTOFON 1006 A (8°)
LATERAL	3.15°	10	15	23	10	10	10	ORTOFON 1005 A (15°)
VERTICAL	3.15°	25	12	60	40	12	45	ORTOFON 1005 A (15°)
LEFT	3.15°	15	10	40	15	12	25	ORTOFON 1005 A (15°)
RIGHT	3.15°	20	10	50	25	12	30	ORTOFON 1005 A (15°)
LATERAL	6.3°	10	16	23	10	10	10	ORTOFON 1005 A (15°)
VERTICAL	6.3°	40	25	72	40	20	70	ORTOFON 1005 A (15°)
LEFT	6.3°	20	15	28	25	20	50	ORTOFON 1005 A (15°)
RIGHT	6.3°	25	15	25	35	30	50	ORTOFON 1005 A (15°)

*CM/SEC

TABLE II. Intermodulation of a number of cartridges.

the next-to-last column. The difference is obvious between records from Decca, at the one extreme, with RCA, Westrex, and Electro-Voice at the other.

From the viewpoint of the playback cartridge designer, a fairly large vertical cutting angle would be preferable, as it is necessary to allow space for the moving elements, whose center of rotation must lie above the record surface.

The angle of the stylus cantilever to the record surface of several pickups has been determined by measurement and is shown in *Fig.* 2. It is evident that there is as much difference here as with the various cutting angles for the records—the result of a lack of standards for recording.

As mentioned earlier, the most important harmonic distortion is second harmonic due to the incorrect vertical tracking angle. In the case of groove modulation with two tones, an intermodulation product appears as well. As far as is known no previous theoretical calculation has been made of the size of this product as a function of the tracking angle. An attempt to make such a calculation will therefore be made here.

If you first assume a correct vertical tracking angle, there is considerably more intermodulation distortion in playing a vertically modulated groove than is the case with a laterally modulated groove. Corrington and Murakami give the following formula:

$$IM = \frac{800\pi u_1 r}{v^2}$$

where: u_1 is the lowest frequency recorded amplitude in ips

r is the radius of the stylus in thousandths of an inch

v is the record speed in ips.

With a 33⅓-rpm record,

$$v = \frac{2R33\frac{1}{3}}{60}$$

R is the radius from the stylus tip to the center of the record.

In *Fig.* 3 the intermodulation distortion is shown respectively vertically and laterally with a stylus tip radius of 0.5 mil and 0.7 mil and a recording speed of 7 cm/sec at various distances from the center of the record.

As can be seen, the intermodulation is about 10 times as large in the vertical channel as in the lateral. Intermodulation in the lateral cutting appears as modulation of the even harmonics, and in vertical cutting it appears as modulation of the odd harmonics. It looks severe, and it is not improved by an incorrect vertical tracking angle.

In *Fig.* 4 a vertical double-modulated groove is diagrammed. We imagine the groove to be traced by an ideal stylus, and try to investigate what will happen due to a wrong vertical tracking angle. This groove is considered to be cut with a vertical cutting angle of 0 deg.

The angle for zero transmission of the lowest frequency is α, the amplitude of the low frequency is a_1, and for the high frequency a_2. The minimum and maximum values which will be obtained for a_2 will be found at the points of zero transmission, which are p and q. The difference between these values of a_2 at points p and q, divided by the average amplitude of a_2, multiplied by 100 will equal the percentage of intermodulation of the odd harmonics.

In *Fig.* 4 the areas about points p and q are shown magnified. a_2 is the amplitude for the high frequency, as it would be with the correct delineation ($\varphi = 0$), b is the size at point p with delineation under the angle φ, and c the size at point q with delineation under angle φ.

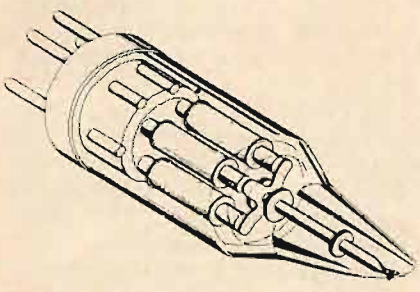


Fig. 6. Principle of the B & O cartridge.

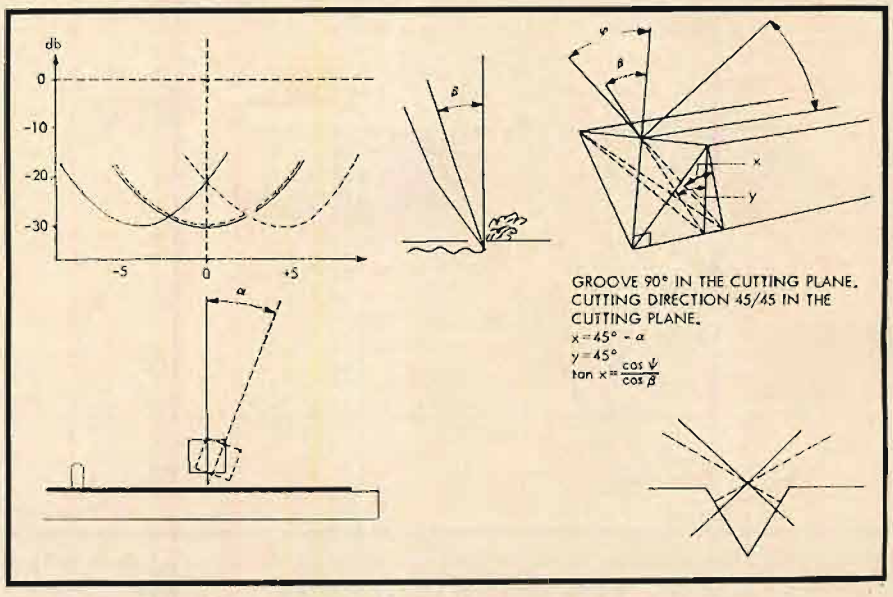


Fig. 7. Some geometrical relationships in the stereo groove.

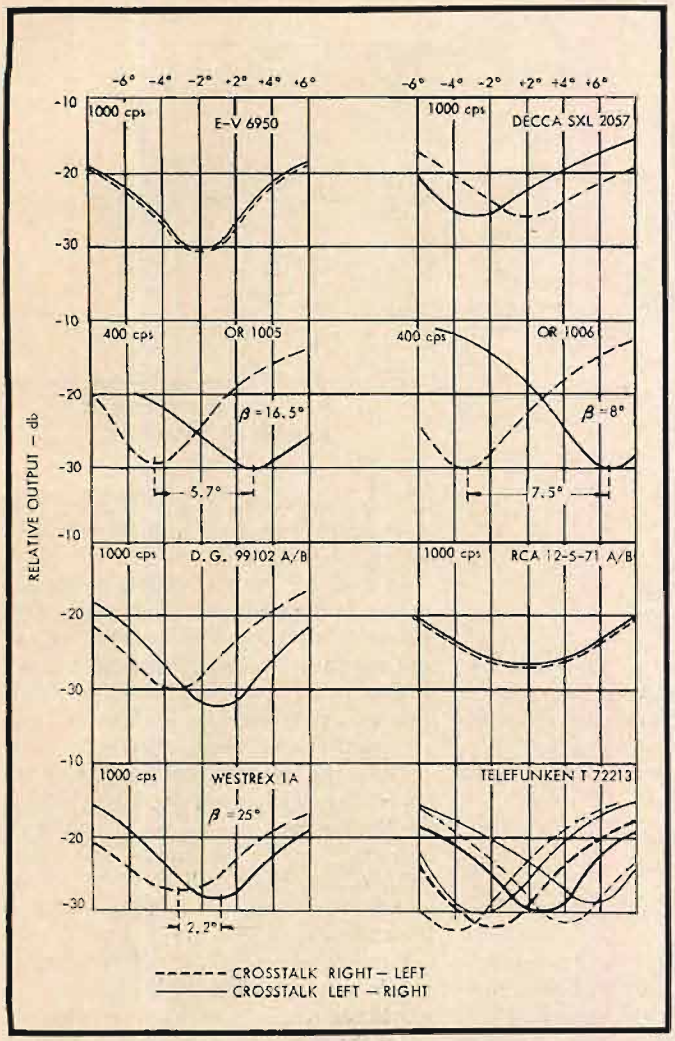


Fig. 8. Crosstalk curves for a variety of test records.

The percentage of intermodulation is expressed as:

$$IM = \frac{c - b}{a_2 Z} 100\% \qquad \text{Eq. (1)}$$

Z is a factor that determines the average amplitude of a_2 with delineation under the angle φ.

For small values of φ however, $Z \cong \frac{1}{\cos \varphi}$. For larger angles the correct value of Z can be obtained with the integration of a_2's delineation value under the angle φ over a wavelength of the low frequency, which gives:

$$z = \frac{\cos \alpha}{\sqrt{\cos (\alpha + \varphi) \cdot \cos (\alpha - \varphi)}}$$

With the help of the sine relation used on triangle MNO, we obtain

$$b = \frac{a_2 \cos \alpha}{\cos (\alpha - \varphi)}$$

and used on triangle MSO,

$$c = \frac{a_2 \cos \alpha}{\cos (\alpha + \varphi)}$$

Inserting the values for b, c, and Z in Eq. (1), we obtain

$$IM = \left[\sqrt{\frac{\cos (\alpha - \varphi)}{\cos (\alpha + \varphi)}} - \sqrt{\frac{\cos (\alpha + \varphi)}{\cos (\alpha - \varphi)}} \right] \cdot 100\%$$

α, which is the angle for the zero transmission of the low frequency, is found from

$$\tan \alpha = \frac{v \sqrt{2}}{c}$$

where v is the effective recording speed in cm/sec, and c the groove speed in cm/sec.

Development of the above assumes a considerable difference in the two frequencies, and that the sine curve for the lowest frequency in the points considered can be thought of as a straight line.

The above gives a basis for the determination of the degree of intermodulation as a function of the tracking-angle fault.

Figure 5 shows IM calculated for three different recording levels and a distance from the record center of 10 cm. The calculation is valid for intermodulation of the odd harmonics.

A calculation of the intermodulation of the even harmonics shows that these are unimportant in comparison with the modulation of the odd harmonics.

If *Fig.* 1 and *Fig.* 5 are compared it is seen that considerable harmonic and intermodulation distortion appears if the vertical cutting angle and the vertical tracking angle of the pickup are not the same.

On the basis of two intermodulation test records produced by Ortofon, measurements have been made of a number of playback cartridges. The results are in Table II. The principle of the B & O pickup is shown in *Fig.* 6.

The results are anything but encouraging. From the measured values it is possible to predict with reasonable accuracy what angle the stylus cantilever makes with the record surface, if all the data for the record is known.

The variations in vertical cutting angle

(*Continued on page 88*)

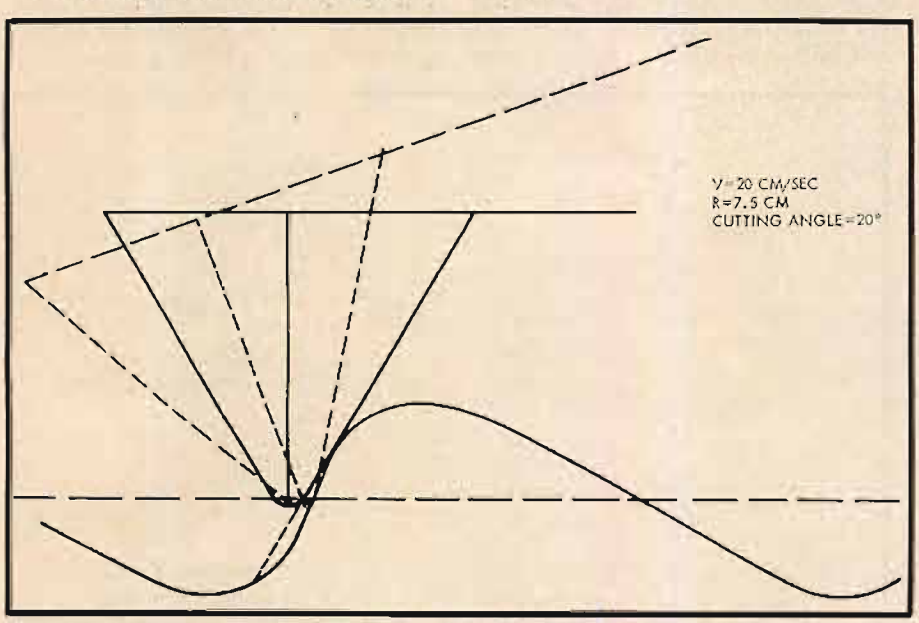


Fig. 9. Graphic representation of what happens when the stylus angle is different than the cutting angle. This indicates that the sylus should be tipped back rather than forward as is commonly believed.

Let's Talk About Tape Synchronization

HAL MARGARGLE*

The commercially available techniques for coordinating a tape recorder with motion picture film are described and analyzed and a new technique is proposed.

EVER SINCE THE ARRIVAL of magnetic film and tape in this country in commercial quantities the motion picture producer has used it for sound recording. The first recorders utilized regular film stock magnetically coated and, of course, sync was no problem because of the "perf" holes. In the quest for more portability, and ever more economy, the synchronized ¼-in. tape systems reared their ugly heads. The author is not sure which system arrived first but his initial contact was with the 60-cps Rangertone method.

It may be well to mention here that some producers use perforated ¼-in. tape but our discussion will include only the electronic means. We could also mention that a lot of the "old guard" and some of the young old guard, including the writer, looked askance towards these new systems. However, because of the many millions of feet already used, we must concede that tape for motion picture recording is here to stay.

The greatest advantage of tape is its easy adaptation to location, or field, recording. This article is weighted towards the portable uses, although studio recording will be mentioned also.

Rangertone System

The Rangertone system developed and marketed by the late Col. Richard H. Ranger is perhaps the simplest of all to use during the recording operation. It uses a separate head mounted in the tape path (see *Fig.* 1) with the slit running 87-deg. out of azimuth from the normal recording slit. The energy for this head is applied, without bias, via a small filament-type transformer with a series resistor used to adjust the head current. With a suitable system of relays and pushbuttons, or switches, the head is used for recording, and subsequently for sync playback. A simple pilot light is used as a fairly accurate recording indicator. The newer head kits check the signal by providing a cable which plugs into the regular amplifier of the recorder. Some kits use a miniature meter

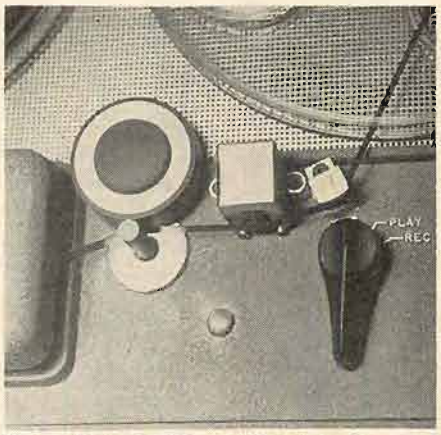


Fig. 1. Rangertone sync head mounted on an Ampex 600.

to sample the current. All in all it is a reliable method and normally should require a minimum of maintenance.

The disadvantages, however, could be formidable because the slit length is finite, and the actual part of the tape utilized is very small. This shows up as a chronic problem of track placement. If the head is knocked or altered in position just slightly and the recorded tape must be played back on another standard machine, trouble results. The head of the playing machine either has to be moved or it must have a manual adjustment of the vernier type to adjust to the sub-standard track. Most sound-service studios utilize the vernier-adjust method. The waveform on the tape is far from a pure sine wave, probably because no bias is used, and in some cases can cause trouble during playback if the shaping circuits are not functioning properly. If the tape does not make intimate contact with the complete head surface near the slit, the hum problem is aggravated and can ruin an otherwise good recording with the harmonics of 60-cps noise. Good tape contact is sometimes hard to achieve because the original tape machine was probably designed for a specific number of heads, and the "foreign" Ranger head upsets the tape path. In rare occasions some recorders have to be adjusted to an unfavorable playback frequency response to allow for the sync head. In most cases the installation of the sync head can be time-consuming and hair-pulling job. Many of the newer tape machines have provisions for the addition of one or more extra heads which makes installation simpler.

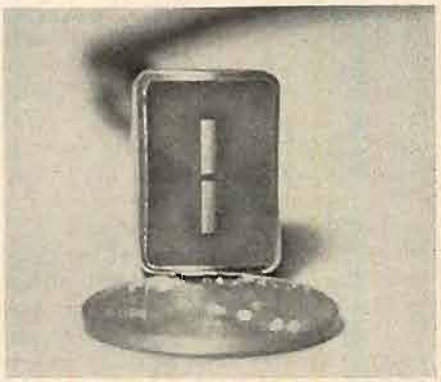


Fig. 2. Pilot-Tone Head. Note size (that's a penny it's resting on) and the 20-mil gap length.

Pilot-Tone System

A newer scheme similar to Rangertone is the Pilot-Tone Sync System. Developed in Germany and used extensively for German television, it has now been accepted by a large producer on this continent. It utilizes a special head with the slit oriented exactly perpendicular to the slits of the audio heads with a gap length of 20 mils (see *Fig.* 2). The center of this rather wide gap is placed in the center of the tape. The sync recording is made using bias that is obtained from the local bias oscillator of the tape recorder. The sync signal is obtained from a stepdown transformer, as with most other systems, or a generator mounted on the camera in the case of battery-operated units. The signal-to-noise ratio decreases about the same as Ranger's "published" figures when measured without, and then with, the applied sync signal. This system enjoys the same disadvantages as Ranger in that it necessitates a special head installation, sometimes in an impossible position, and has the added disadvantage of requiring additional equipment to obtain the high-frequency bias used. The track place-

* *5705 Misty Drive, Lanham, Md.*

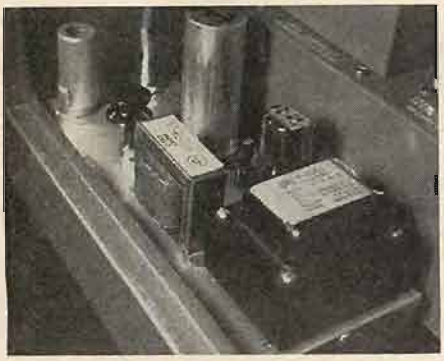


Fig. 3. 14,000-cps carrier generator used in the Fairchild Pic-Sync system. This unit is shown in the cabinet of an Ampex 300.

ment problem is, alas, also present and should be even more acute than with Ranger's diagonal-slit recording.

Echelon-Head System

We can now discuss still another method using a separate head, the echelon head system. In this system the head is mounted in a fashion similar to the sync heads with the exception that the sync signal is recorded on the top and bottom or, if you will, outer edges of the tape. The original method utilized a push-pull arrangement but later was changed so that the signal is impressed equally both top and bottom with the two slits being slightly displaced from each other in time only. The recorded signal can be used either with or without bias. This method has many of the advantages of the previously mentioned systems. The problem of hum pickup does not appear to be as troublesome as with the Ranger system, but there is some susceptibility to tape disfiguration. When using the large NAB reels, the edge of the tape sometimes gets a crimp that tends to make the sync-signal area somewhat critical, whereas it would not affect a full-track audio recording. In common with all special-head systems, the echelon-head method is plagued with tape deformation and excessive dirt problems, and a disadvantage to some users is the fact that each machine must have a special installation. Producers with a number of tape machines would rather take along a "black box" with any machine that is available. This brings us up to the all-electronic systems utilizing the mechanical and electro-mechanical parts already on the recorder.

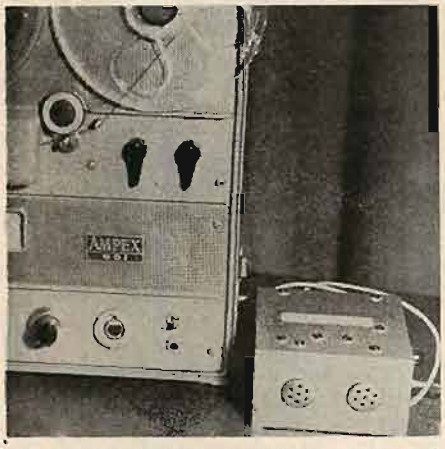


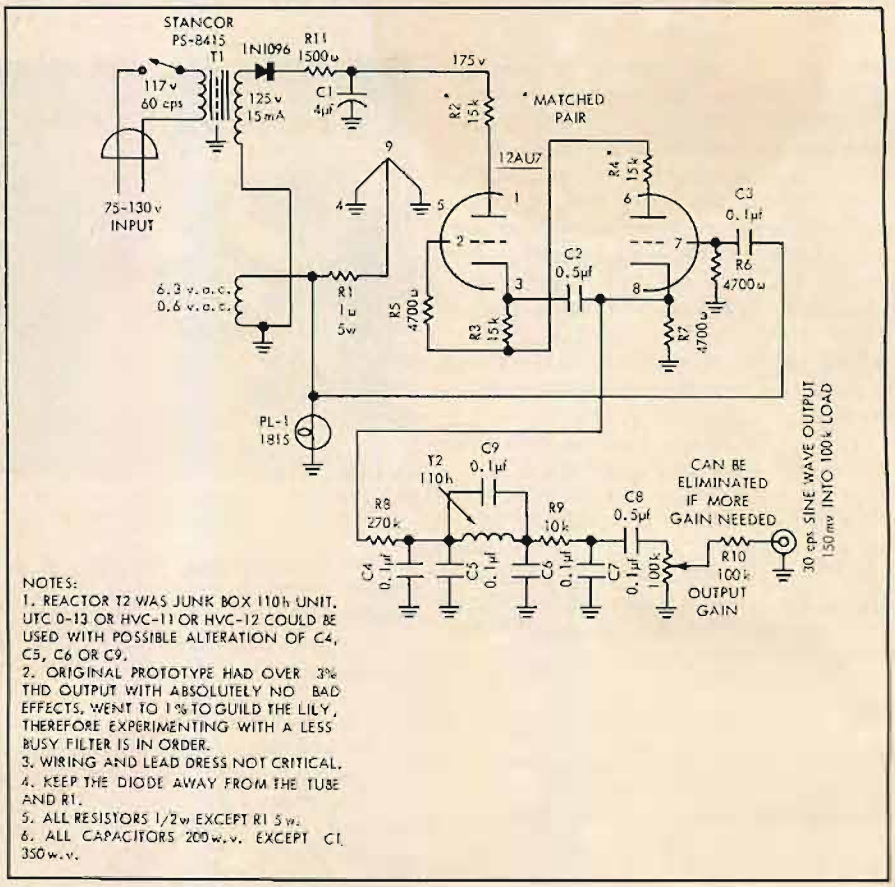
Fig. 4. 30-cps sync generator connected to an Ampex 601. Note that the "black box" is gray in this instance.

Pic-Sync System

The most popular application of this method is the Fairchild Pic-Sync system. Here a 14,000-cps carrier signal is used, modulated at a 60-cps rate with an 80-per-cent-modulated envelope. This signal is injected into the record amplifier at almost any point but usually after the normal high-frequency tape pre-emphasis (see *Fig.* 3). The manufacturer recommends using a level of from 32 to 38 db below 100 per cent modulation of the tape. In practice most recordists use a level around – 20 VU, probably because they can then "see" it on the normal VU meter. 14,000 cps is certainly an audio frequency and can be heard, but because of the normal 6000- to 8000-cps cutoff of photographic recording channels, it is not very objectionable even at the higher level. One problem here, as with all systems where the sync is recorded along with the regular sound, is to keep any program material from affecting the sync signal. In practice some cymbal crashes and even some excessively sibilant voices do just this. For that problem a filter is usually used to eliminate the 14,000 cps from the audio going into the record amplifier before the sync-signal injection. This means another black box or even modification of the recorder. Recorders used only for voice frequencies generally do not need the filter and are able to make acceptable recordings without it. Many studio recorders use the 14,000-cps carrier system and merely bridge the recorder at the output of the low-pass filters which normally feed the photographic recorders. The author chooses to eliminate the 14,000-cps carrier by resonant means in order to preserve the frequency response of the program up to, and beyond, 10,000 cps. In practice the carrier system works very well in the studio but some recordists have apprehensions about the sync generator malfunctioning in the field. Other disadvantages are: it is almost a necessity to record at 15 ips for stability at the carrier frequency; when recording on one machine and playing back on another, both must be right on azimuth and the 14,000-cps signal must be accurate for complete compatibility. Some studios have vernier peaking controls to "search" for the maximum signal on incoming tapes to be transferred. Then, of course, it is well known what happens to frequencies over 10,000 cps when dirt or deformed tape is encountered.

We should perhaps pause a moment

(*Continued on page 86*)



NOTES:
1. REACTOR T2 WAS JUNK BOX 110h UNIT. UTC O-13 OR HVC-11 OR HVC-12 COULD BE USED WITH POSSIBLE ALTERATION OF C4, C5, C6 OR C9.
2. ORIGINAL PROTOTYPE HAD OVER 3% THD OUTPUT WITH ABSOLUTELY NO BAD EFFECTS. WENT TO 1% TO GUILD THE LILY, THEREFORE EXPERIMENTING WITH A LESS BUSY FILTER IS IN ORDER.
3. WIRING AND LEAD DRESS NOT CRITICAL.
4. KEEP THE DIODE AWAY FROM THE TUBE AND R1.
5. ALL RESISTORS 1/2w EXCEPT R1 5w.
6. ALL CAPACITORS 200w.v. EXCEPT C1 350w.v.

Fig. 5. Schematic of 30-cps sync generator.

Perhaps two years from now the quality of this tape may be duplicated... perhaps never! Soundcraft Golden Tone—a physically perfect tape... a musically perfect sound. A bold claim? Yes. Warranted? Yes. Here's why. Golden Tone is a very special tape... designed just for those who demand the finest performance from today's advanced recorders. Unless you have the discerning ear and the exacting equipment which ordinary tapes can't satisfy, there is no reason for you to buy Golden Tone.

A special magnetically-active FA-4 oxide formulation increases Golden Tone's high frequency output by 25%. Its signal-to-noise ratio is 7 db better than other brands, to give your recordings **the greatest dynamic range possible with a tape.** Precision-slit Golden Tone is free of edge burrs and skew. These physical defects can be cruelly exposed by the narrower tracks in 4-track recording. Microscopic burrs prevent the tracks on the edge of the tape from making intimate head contact, resulting in loss of "highs."

Skew, another hidden defect, produces cross-talk and loss of recording level. Golden Tone's oxide formulation and base are balanced to prevent cupping or curling, an effect which can also prevent tape to head intimacy. Golden Tone's oxide surface is Micropolished. This patented Soundcraft process removes any surface irregularity, prevents drop-outs, protects high frequency response and minimizes head wear.

From this physically perfect tape, comes musically perfect sound. Golden Tone costs more, but it is worth more. It is produced in small quantities with infinite care and rigid quality control. It is the world's finest tape for those who demand the ultimate in sound reproduction. Offered for the first time anywhere—a long play Golden Tone tape on 1 mil Mylar*, TENSILIZED by DuPont—will not stretch or break. Also on ½ mil "Mylar" and 1½ mil Acetate Bases.

GOLDEN TONE BY REEVES SOUNDCRAFT CORP.

HERMAN BURSTEIN*

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

Splicing Problem

Q. I am supervisor for a small studio for electronic music at a university. In our work we employ two Viking Super Pros. The production of electronic music involves much tape splicing. Our work has been hampered by splicing problems which I have had difficulty solving. We use Scotch 1.5-mil tape and splicing tape. Our editing is done on an EdiTall splicing block, and the splices appear to be very good. The problem is that when a splice meets and leaves the head group, a temporary waver occurs in the program material. It appears that the leading edge of the splicing tape presents a resistance, hence a slight jar, as the pressure pad is met. Tapering the leading edge of the felt has only produced a slight improvement. Would you have any suggestions to offer?

A. Are you applying the splicing tape so that it makes a 45-deg. angle with the tape or is it at a 90 deg. angle? The 45-deg. angle would seem to be preferable, enabling the splicing tape to make gradual rather than immediately total contact with the pressure pads. You could try applying a tape lubricant, such as is available in a number of audio stores, to both the pressure pad and the spliced portion of the tape.

In subsequent correspondance with this individual, it turned out that he also obtained an improvement by causing the tape to approach the heads at a more gradual angle. This would require installation of new tape guides.

Mixers

Q. Is it possible to purchase mixers that will handle a high-level (tuner) as well as low-level (mike) source? Can a high-level source be fed into a mixer designed only for mikes? If I want to mix only two inputs, what is the advantage of a mixer over a simple Y-adaptor?

A. There are mixers designed to work with mikes alone, and others that will accomodate low-level sources on some inputs and high-level sources on other inputs. If you feed a high-level source such as a radio or piezoelectric pickup into a low-level input, there is danger of overloading the first stage, with consequent distortion. But if you first reduce the signal of the high-level source so that it is of about the same order as a microphone signal—not over 20 millivolts or so—and then feed it into the low-level input of the mixer, you would be all right so far as distortion is concerned. On the other hand, you would be reducing the input signal in relation to the noise produced by the first stage of the mixer.

The advantage of a mixer over a simple Y-adaptor is that you isolate the inputs, so that when you change the level of one input you affect the level of the other inputs very little if at all.

Preamp A with Deck B

Q. My question concerns the advisability of purchasing a tape preamp by one manufacturer for use with a tape deck (including heads) made by another. I am interested in a four-track, dual-speed system with both record and playback features. I prefer the tape preamp made by Manufacturer "A," since it contains completely separate record and playback channels, enabling monitoring of the recorded signal while recording. Also, this preamp is available in kit form. However, I believe Manufacturer "B" makes a better tape deck, at least from the mechanical viewpoint. The preamp has adjustable bias and erase currents, eliminating one potential problem. However, I note from your articles on equalization that the tape head characteristics together with the preamp equaliea tion circuits determine the over-all system response. Therefore, I foresee the possibility of a mismatch here. Is this so much of a problem as to preclude the possibility of mixing these components? Would a comparison of record and playback head gaps be enough to assure a similarity of tape heads, or are impedances and other factors critical?

A. The following factors are involved in matching tape electronics to the heads so far as recording is concerned:

1. *Proper bias current.* This should be the maximum amount that is consistent with preserving treble response to about 15,000 cps at 7.5 ips and to about 8000–10,000 cps at 3.75 ips. Insufficient bias increases distortion.

2. *Proper erase current.* Current should be enough to make the head erase effectively, but not so much as to over-heat the head, with consequent damage to the head and/or tape (if the tape is permitted to remain in prolonged stationary contact with the head).

3. *Constant audio current through the record head at all audio frequencies, apart from the effect of the record equalization circuits.* The rising impedance of the record head as frequency goes up will attenuate the high frequencies, unless the head impedance is small compared with the resistance of the tube that drives the head plus other circuit impedances. (For this and other reasons, when separate record and playback heads are used, the record head is designed to have a low impedance). If the impedance of the record head is not low at all frequencies compared with the sum of other circuit impedances, a "constant current" resistor is introduced between the driving tube and the record head. The value of this resistor depends upon the impedance of the record head.

4. *Proper audio current through the record head.* In home tape machines it is generally accepted that the maximum audio current going through the record head should be that which produces 3 per cent distortion on the tape at frequencies in the range of 250 to 400 cps. For a given amount of signal voltage applied to the record head driver, the amount of current flowing through the record head and therefore the amount of magnetic flux ultimately applied to the tape depends on the impedance of the record head.

The following are considerations in playback:

1. *Treble response.* When playback heads used to have a gap of about 0.00025-in., there was a resulting treble loss of about 4 to 6 db at 15,000 cps at 7.5 ips. Playback equalization was sometimes tailored to make up part or all of this loss. If the gap were appreciably wider than 0.00025-in., it was all the more likely that playback equalization included compensation for gap loss. However, now that playback heads generally have gaps of about 0.0001-in., treble loss due to gap width is minimal, and playback equalization is not adjusted to compensate for this factor. In other words, you do not have to worry about matching the playback head to the tape amplifier so far as treble loss due to gap width is concerned. However, you still have to worry about treble loss due to excessive capacitance of the cable running from the head to the amplifier.

2. *Bass response.* At low frequencies the entire playback head and not merely its gap tends to respond to the magnetic flux emanating from the tape. This depends upon the size and contour of the head and upon the angle and extent of tape wrap about the head. The effect often is to augment response at the very low end. This in turn reduces the amount of bass playback equalization that is required. Thus the playback equalization may have to be tailored to the specific head which is employed.

All the foregoing factors have to be considered in deciding whether to use the electronics made by one manufacturer with the tape deck of another manufacturer. Your decision will depend on whether you have the means of checking bias current and erase current, whether you are able to ascertain that the record level indicator provides a correct indication of maximum permissible recording level, whether you have reason to believe that the record electronics are compatible with the impedance of the record head, and whether you are able to adjust the playback equalization, if need be, in view of the bass characteristics of the playback head.

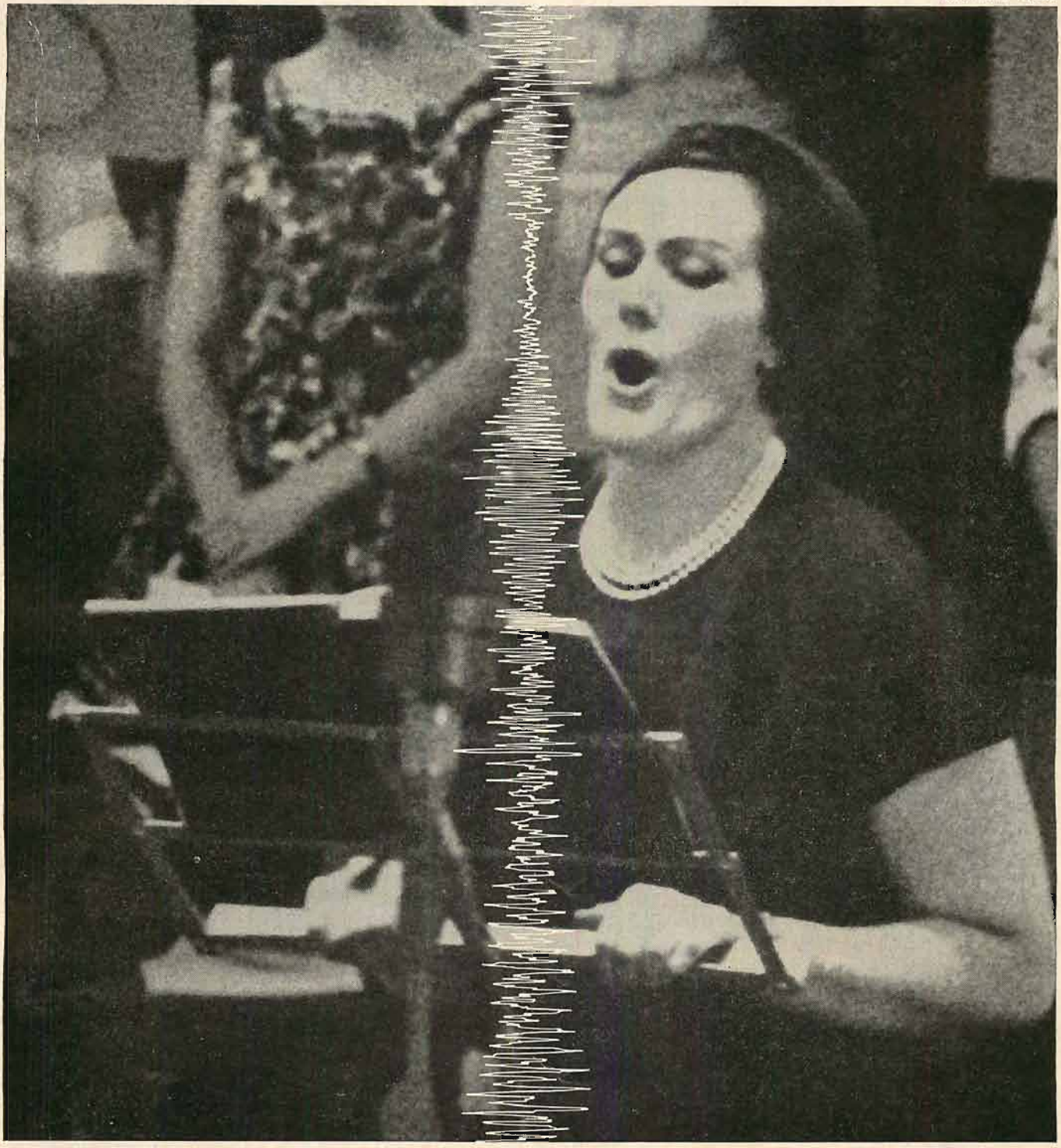
"Slow Removal"

Q. It is recommended that a demagnetizer be slowly removed from the heads or other metal parts to a point three feet away in order to achieve complete demagnetization. I would like you to define "slow removal" in terms of the number of seconds, or minutes, that should be taken to move the demagnetizer three feet.

A. I have no idea as to the minimum time that will result in complete demagnetization. But I guess that if you allow 10 seconds or more for the demagnetizer to travel the three feet you will be on the safe side. At least half of the time should be spend covering the first foot. That is, the closer the demagnetizer is to the head, the slower it should travel.

(Continued on page 80)

PHOTO: LONDON RECORDS



What brings a recording studio into your living room? AMPEX Fine Line 1200.

Ampex tape recorders are used by professional recording studios throughout the world. And now: the Fine Line 1200 brings you an Ampex 4-track stereo recorder/player. For the home. The difference in performance standards? None. At 7½ ips, the Fine Line 1200 has the same frequency response and low noise rating as Ampex professional models. There are three professional heads on the 1200: one for record, one for playback, one for erase. And there's a professional tape guidance system to keep the tape in precise position over these heads. You'll never have cross-talk. Just high fidelity sound. The Fine Line 1200 offers the finest recording and playback of stereo sound in the home. See it at your Ampex dealer. It comes with the new "Four Star" one year warranty. From the only company providing recorders and tape for every application: Ampex Corporation, 934 Charter St., Redwood City, Calif.

AMPEX

A High-Quality Transistorized Stereo Preamplifier

ERHARD ASCHINGER

Complete design and construction information about a transistorized stereo preamp designed to professional standards.

PART ONE OF THREE PARTS

IT HAS LONG been the intention of the author to design and build a complete semi-professional stereo reproducing system for home use, meeting or exceeding the high-quality standards usually associated with professional equipment. Naturally, the entire system was to be fully transistorized, easily expandable, and as versatile as possible in design.

Though the project seemed to be a rather difficult task in the beginning, it was found to be surprisingly simple to design the required high-quality audio equipment—a certain minimum amount of care and consideration provided.

As shown in *Fig.* 1 the different functions to be performed by the system have been divided among a number of separate units (building-block technique). These units are constructed in rack-mounted, fully interchangeable chassis modules.

Several preamplifier-equalizer units are provided to produce uniform signal levels and frequency characteristics from stereo signals delivered from various sources. Equalizers for reproduction from monophonic sources are included as well. Separate tuners are employed for AM and FM broadcast reception. The "stereo control center" unit combines a stereo source selector, bass and treble tone controls, a loudness contour control, and variable low-pass and high-pass filters. A special unit labeled "stereo converter" includes a phase-switching circuit, a stereo-dimension control, and a stereo-balance control. This unit is followed by the master level control, the power amplifiers and the stereo speaker systems. While all low-level amplifiers are powered by a common regulated power supply, the power amplifiers have a supply unit of their own.

For maximum versatility the impedance level between amplifiers has been set at 600 ohms per channel, unbalanced. The "standard signal level" between amplifiers for the average amplitude of music program material is 245 mv across 600 ohms, that is −10 dbm. The highest occurring peak values are about 10 db above this level, corresponding to 0 dbm.

All units of the system are fully transistorized. Very stringent requirements have been put on the individual units as to frequency response, distortion, interchannel balance, and noise. In order to obtain optimum performance characteristics, especially concerning the reproduction of pulses and transients, no transformers and chokes have been employed in audio-frequency circuits.

The various problems arising from the above mentioned demands could only be solved by careful circuit design and, in some places, by rather complex circuity. The performance characteristics finally achieved, however, prove the effort worth while. This article will deal with the development of the stereo phono preamplifier and its supply voltage filter only.

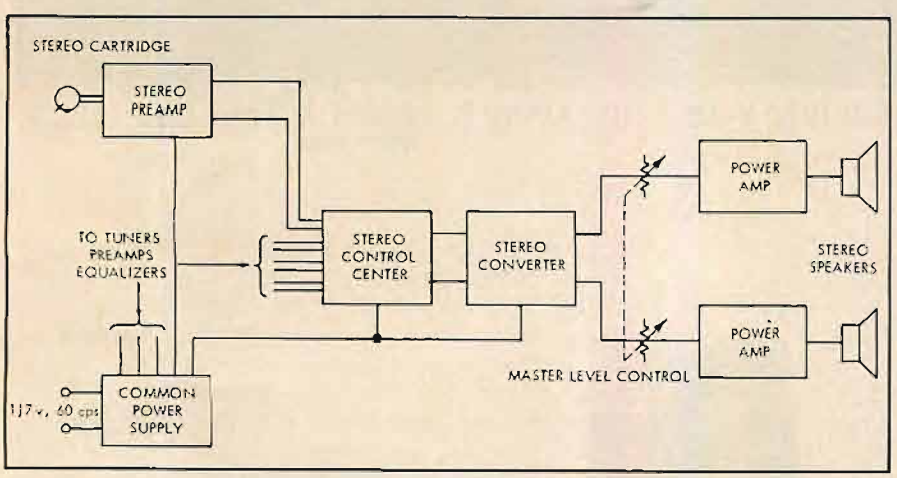


Fig. 1. Block diagram of complete stereo system.

Functions of the Preamplifier

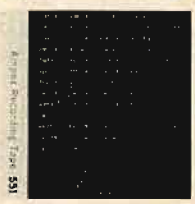
To achieve maximum fidelity of sound reproduction the stereo cartridge employed is of the high-quality, moving-magnet type (Audio Dynamics Corporation ADC-1). Since this is a velocity sensitive device it has a virtually flat output voltage *versus* frequency characteristic (at constant stylus velocity). For various reasons, which shall not be discussed in detail, a nonlinear recording velocity *versus* freguency characteristic (at constant input voltage) is employed in disc recording. To ensure flat over-all frequency response this recording characteristic has to be compensated for by a special unit in the reproducing system.

Thus the stereo preamplifier has to perform two different functions: First, it has to amplify to a suitable level the very small signal voltages delivered by the stereo cartridge; second, it has to provide the correct playback frequency response to compensate for the recording characteristic.

Since the RIAA recording characteristic (corresponding to DIN 45547 in Germany) is standard in stereo disc recording, the equalizer was designed to feature the RIAA playback curve only. There is only one major recording com-

What can make any tape recorder sound a little more like an Ampex? AMPEX tape.

Any sound sounds thrillingly alive on Ampex recording tape. Into each reel goes the same engineering excellence that has made Ampex tape recorders the standard by which all others are judged. It offers greater dynamic range, superior high frequency overload characteristics. Even the packaging is distinctive. In each box is the exclusive Signature Binding to make your tape library look as good as it sounds. It comes in two types: premium-quality Ampex 500 series and popular-priced Ampex-Irish 300 series. At your tape dealer. From the only company that is providing recorders and tape for every application: Ampex Corporation, 934 Charter Street, Redwood City, California.



pany that uses its own non-standard recording characteristic, the Deutsche Grammophon Gesellschaft. If desired, DGG playback equalization facilities may be added simply by switching in two additional circuit elements.

Performance Specifications

Each channel of the stereo preamplifier-equalizer has to meet the following requirements:

Input and Output Impedances. Since the lowest permissible load resistance of the ADC-1 stereo cartridge is 33,000 ohms per channel, the input impedance of the preamplifier, R_I, has to be equal to or greater than 33,000 ohms at all frequencies. The selected output resistance, R_o, is 600 ohms.

Signal Level. The selected standard signal level between units for average music program material is 245 mv into a load resistance, R_L, of 600 ohms, that is, −10 dbm. This level corresponds to a mean recorded velocity of 5.5 cm per sec in stereo disc recording. The highest signal amplitudes will be about 10 db above standard signal level, resulting in a maximum signal level of 0 dbm, Thus, the preamplifier has to be capable of delivering an output voltage, v_o, of 775 mv into a load, R_L, of 600 (0 dbm).

Voltage Gain. The output voltage of the ADC-1 cartridge, at f = 1000 cps and a stylus velocity of 5.5 cm per sec, v_i, is 7.0 mv (per channel), the corresponding standard signal level required at the output of the preamplifier, v_o, is 245 mv.

At 1000 cps, this being the 0 db reference point of the desired playback curve, the voltage gain of the preamplifier has to be

$$|g_v| = \left|\frac{v_o}{v_i}\right| = \frac{245 \times 10^{-3}}{7.0 \times 10^{-3}} = 35,$$

or $g_v = 20 \log 35 \approx 31$ db.

Frequency Response. The frequency response of the equalizer has to follow the RIAA playback curve with maximum tolerable deviations of −3 db at frequencies below 50 cps and ±1 db within the rest of the frequency range. The lower cutoff frequency of the amplifier, f_o, has been fixed 10 cps.

Distortion. For maximum signal level at the output (v_o = 775 mv into R_L = 600 ohms; 0 dbm) the maximum permissible IM distortion figure is 0.5 per cent. (50 cps and 5000 cps, 4:1); and harmonics 0.1 per cent max. at all frequencies.

Noise. The signal-to-noise ratio has to be equal to or greater than the highest figure obtainable with similar units employing vacuum tubes. Thus signal-to-noise ratio is 70 db minimum (referred to standard signal level) and corresponding output noise level is −80 dbm minimum.

Interchannel Balance, Channel Separation. Since the quality of stereo reproduction largely depends upon the two stereo channels being completely identical, frequency response, gain, and noise figures of the two channels have to be balanced to within ±1 db. Channel separation has to be in excess of 40 db.

CIRCUIT DESIGN

The preamplifier features two completely identical, independent stereo channels. All the following considerations and calculations, however, apply to one channel only, unless otherwise specified.

The required voltage gain of 31 db at f = 1000 cps could easily be realized by a single transistor stage. However, to meet the additional requirements concerning frequency response, distortion, and impedance levels, a three-stage circuit is needed. The different functions to be performed by the equalizer have been divided among the individual stages. Stages one and two provide the required voltage gain and frequency response, the first stage being designed for minimum noise. The third stage delivers the required output voltage across the specified output impedance into an external load of 600 ohms.

To obtain high voltage gain, all stages are operated in common-emitter connection, although transistor cutoff frequency is rather low in this configuration. High voltage-gain figures require large collector resistors, which, in turn, call for relatively high collector-supply voltages. For reasons of stability as well as for good low-frequency response all stages are directly coupled; capacitive coupling is employed at the input and the output of the unit. Operating points are stabilized against changes in transistor parameters, supply voltage, and temperature.

An audio-frequency feedback loop around the first two stages provides for high stability of performance characteristics, independent of transistor parameter variations, low distortion, proper impedance levels, as well as the required voltage gain, and frequency response. The type of feedback to be applied depends upon the desired effect on the input and output impedances of the two-stage amplifier. Whereas the input resistance of the first stage should be as high as possible to avoid loading of the stereo cartridge, the output resistance of stage two has to be made very low to ensure linear frequency response of stage three. Both conditions can be complied with by employing negative voltage series feedback. Since a passive linear-feedback network, incapable of inverting phase, is to be used, the necessary 180-deg. phase shift is obtained by taking the feedback signal from the collector of stage two and feeding it into the emitter lead of the first stage, in series with the input signal. As will be seen later, this feedback loop offers a very elegant and simple way to realize the desired RIAA frequency response.

The required voltage gain at 1000 cps being 31 db, the maximum gain is 51 db at less than 50 cps, according to the RIAA playback equalization. For reasons explained in detail later, the required amount of feedback at this frequency is 9 db. Thus, the necessary voltage gain of the amplifier without feedback is 60 db "at all frequencies," that is, with a frequency response as flat as possible over a frequency range as wide as possible. This condition is not too stringent since the over-all frequency response of the equalizer will be determined mainly by the feedback network.

The required over-all voltage gain can be divided among the three stages in quite a number of ways. The solution selected by the author for his own unit is only one of them, a highly suitable one, however. Since stage three is not included in the feedback loop, flat frequency response and low distortion have to be obtained by very strong local feedback. The voltage gain of this stage, therefore, is only slightly above unity, it is made variable within a very small range to allow exact adjustment of over-all gain of the equalizer. Stage one is designed for low noise, its voltage gain has to be rather high to avoid second-stage noise problems. The selected voltage gain figures are g_{vI} = 33 db, g_{vII} = 23 db, g_{vIII} = 4 db, and $g_{v\,tot}$ = 60 db.

The exact gain figure of each stage is obtained by applying a suitable amount of local feedback by means of an unbypassed emitter resistor. This feedback also provides for good frequency response and low distortion of the individual stage.

The preamplifier is powered by a regulated power supply delivering 27 volts d.c. ± 0.5 per cent. The different collector supply voltages required by the individual stages are obtained from a special transistorized ripple-filter section.

SELECTION OF COMPONENTS

In the design of high-quality equipment it is mandatory to employ top quality components only, regardless of price. However, by judicious selection of components and appropriate circuit design, it is possible to keep the costs within reasonable limits without sacrificing quality.

Stereo Cartridge

The selection of a suitable stereo cartridge is of great importance if it has to drive a transistor input stage. Needless to say, only high-quality cartridges

(*Continued on page 37*)

(*from page 32*)

should be considered, having excellent specifications for frequency response, distortion, channel separation, compliance, and low dynamic mass. These considerations usually limit the choice to cartridges of the moving-magnet or moving-coil types. Since a common-emitter stage shows a distinct minimum of semiconducter noise at a generator resistance of about 800 to 1000 ohms (as illustrated in *Fig.* 2), the internal d.c. resistance of the stereo cartridge should be in that order to obtain maximum signal-to-noise ratio. This significant condition further narrows down the choice. From the remaining limited number of appropriate cartridges, the author selected the Audio Dynamics Corporation ADC-1 stereo cartridge as previously noted.

The electrical specifications of the ADC-1 cartridge are (per channel):

D.c. resistance	500 ohms
Inductance	400 mh
Output voltage at 1000-cps	7.0 mv at a
Stylus velocity of	5.5 cm/sec
Lowest permissible load resistance	33,000 ohms

To achieve optimum performance, the preamplifier has been designed especially for operation in conjunction with the ADC-1 cartridge. However, if a different type of cartridge is used, the same considerations and calculations can be made using the respective new values.

Transistors

All transistors employed are of pnp germanium-alloy type units. The very small input signal from the stereo cartridge requires the use of low-noise transistors in the first two stages, a large-signal transistor is used in the third stage. The transistors should have a common-emitter cutoff frequency, f_{ae}, equal to or greater than 15,000 cps and a common-emitter current transfer ratio, β equal to or greater than 50.

Noise Considerations. Noise generated in a transistor amplifier normally consists of hum introduced by inadequate filtering of the collector supply voltage, thermal noise generated in ohmic resistances, transistor noise.

In the following, hum shall be considered completely absent since it is rather easy to obtain a collector supply voltage sufficiently free from a.c. ripple.

Thermal noise in resistors cannot be avoided, in our case it is insignificant, however, unless extremely "noisy" resistors are used.

At low frequencies transistor noise essentially consists of semiconductor noise, following the "1/f law." With low-noise transistors it is a major factor only up to about 1000 cps. The noise figure of a transistor is at its minimum in the mid-frequency range where it is determined by thermal noise due to the base resistance and by shot noise. In the high-frequency range the noise figure is deteriorated by loss of gain and transit-time effects. Since the RIAA playback curve requires a bass boost of 6 db per octave from 500 cps down to 50 cps and a treble rolloff starting at 2120 cps, semiconductor noise becomes the only significant factor.

To achieve predictable results, the maximum permissible noise figures of first and second stage transistors shall be calculated in advance.

First-stage noise.

The voltage gain of the entire preamplifier at 1000 cps is 31 db. According to the RIAA playback curve the voltage gain assumes its maximum value of 51 db at less than 50 cps. For a maximum permissible output noise level of −80 dbm the maximum permissible equivalent input noise signal level, therefore, is −131 dbm, corresponding to an input noise voltage, $v_{Ni\ max}$ of 0.213 μv.

The noise figure of a transistor is defined as the ratio of the total noise power at the output of the amplifier to the noise power which is due to the thermal noise in the source resistant. Referred to the input, this gives $F = \frac{v_{Ni}^2}{v_{NR}^2}$.

The thermal noise generated in the source resistance, R_G, is $v_{NR}^2 = 4kT\,\Delta f R_G$ where k is the Boltzmann constant,

T the absolute temperature,
R_G the source resistance, and
Δf the noise bandwidth.

Because of the shape of the RIAA playback curve only the frequency range up to about 1000 cps needs to be considered.

The maximum permissible noise figure of the input stage transistor is thus

$$F_{I\ max} = \frac{v_{Ni\ max}^2}{4kT\,\Delta f R_G}$$

With $v_{Ni\ max} = 0.213 \times 10^{-6}$v
$k = 1.380 \times 10^{-23}$w-sec/°C
$T = 298$°K $(t = 25$°C$)$
$\Delta f = 1000$ cps

and $R_G = 500$ ohms (ADC-1 cartridge) we have

$$F_{I\ max} = \frac{0.213^2 \times 10^{-12}}{4 \times 1.380 \times 10^{-23} \times 298 \times 1000 \times 500} \approx 5.52 \text{ or } 10 \log 5.52 \approx 7.42 \text{ db.}$$

Second-stage noise.

In order to prevent the high first-stage signal-to-noise ratio from being deteriorated by noise generated in the second stage, the signal-to-noise ratio of the second stage has to be higher than that of the first stage. It has been found that a difference of about 6 db is a suitable and safe value. The permissible maximum noise output level due to second-stage noise will then be −86 db. The maximum voltage gain of stages two and three, occurring at less than 50 cps, is 27 db, the maximum permissible noise level at the input of the second stage will thus be −113 dbm, corresponding to an input noise voltage of 1.73 μv.

The maximum second-stage noise figure is, therefore, given by

$$F_{II\ max} = \frac{v_{NI\ II\ max}^2}{4kT\Delta f R_G}.$$

R_G is formed by the output resistance of stage one. With $R_G = R_{oI} = 21{,}500$ ohms and $f = 1000$ cps we may write

$$F_{II\ max} = \frac{1.73^2 \times 10^{-12}}{4 \times 1.380 \times 10^{-23} \times 298 \times 1000 \times 21.5 \times 10^3}$$

$F_{II\ max} \approx 8.46$
and $F_{II\ max} \approx 10 \log 8.46 \approx 9.27$ db.

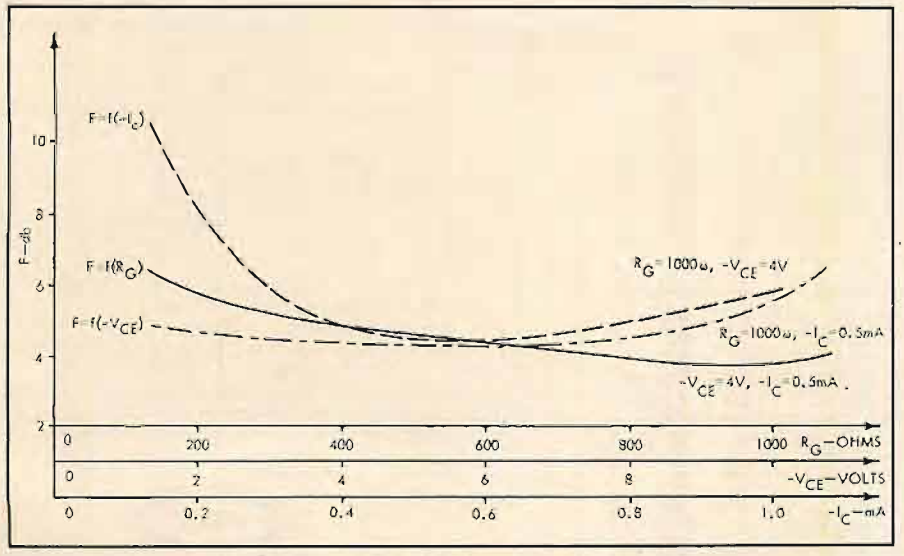


Fig. 2. Noise characteristics of the RCA 2N175.

(*Continued on page 81*)

AUDIO DYNAMICS CORPORATION

Introduces Three Remarkable New Loudspeaker Systems

ADC14. ADC-16. ADC-18. From now on, three names that must be reckoned with when high fidelity loudspeakers are the subject.

The engineering assignment was as simple as the engineering was difficult: *"Create Audio Dynamics loudspeaker systems that will satisfy the most finicky audio engineer, the most discriminating lover of music, the most tasteful housewife."*

Now, after years of painstaking development, *Audio Dynamics Corporation*—creators of the unexcelled ADC stereophonic phonograph cartridges—feels that its speakers have met those criteria.

Revolutionary Audio Engineering

All three of these loudspeaker systems feature a revolutionary rectangular woofer, developed especially for ADC by the British Engineer, Raymond Cooke of KEF Electronics.

High frequencies are handled by a unit of advanced design. A 1½" air stiffened mylar diaphragm is driven from a 1½" voice coil. The small size of the radiating surface gives very wide dispersion, while the low mass and high flux density insure remarkable transient response.

Exceptional High Fidelity

No hyperbole could possibly do justice to the sound reproduction characteristics of these loudspeakers. Lack of cone breakup and doppler distortion and the very low and highly damped fundamental resonance combine to provide the "transparent," effortless, bass associated with a live performance. Treble response is smooth and has very fine dispersion. The excellent response to transients gives startingly faithful reproduction of the attack and decay characteristics of the various instruments.

As with other ADC products these systems remove yet another veil between the listener and the music.

Stunning Cabinetry

The enclosure forms an integral part of the over-all speaker design.

Peter Quay Yang, the noted designer, was commissioned to create cabinetry to conform to ADC's strict engineering requirements and yet be attractive at the same time.

The results: shimmering walnut cabinetry that will be a point of attraction in any home. The ADC-14 cabinet measures 25" x 13½" x 12½" ; the ADC-16, 27½" x 17" x 12½" ; the ADC-18, 40" x 17" x 12½" . We know of no more handsome high fidelity speakers than these ADC's.

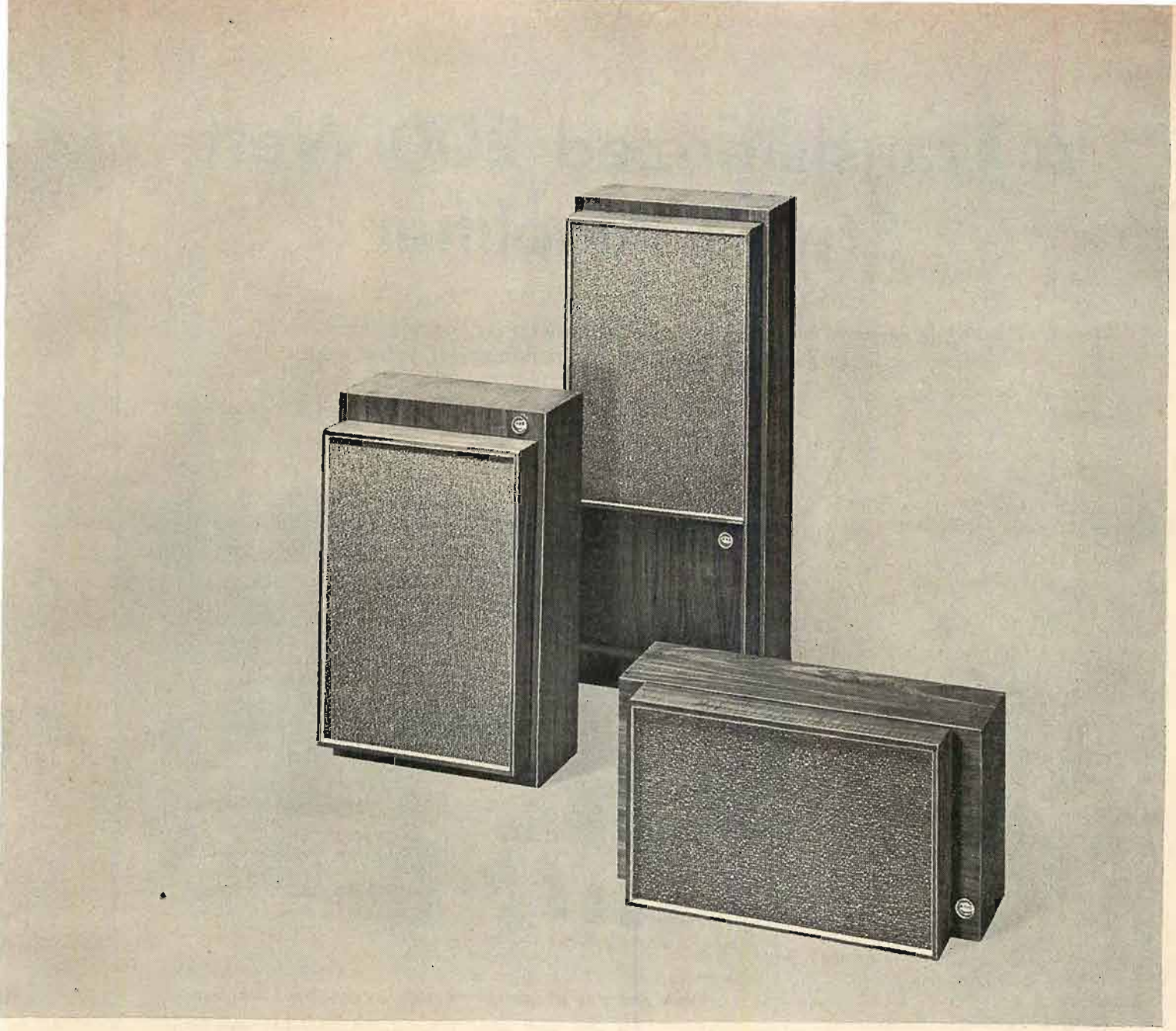
The speakers are not inexpensive. The ADC-14 retails for $175. The ADC-16 retails for $220. The ADC-18, the largest in the group, retails for $250.

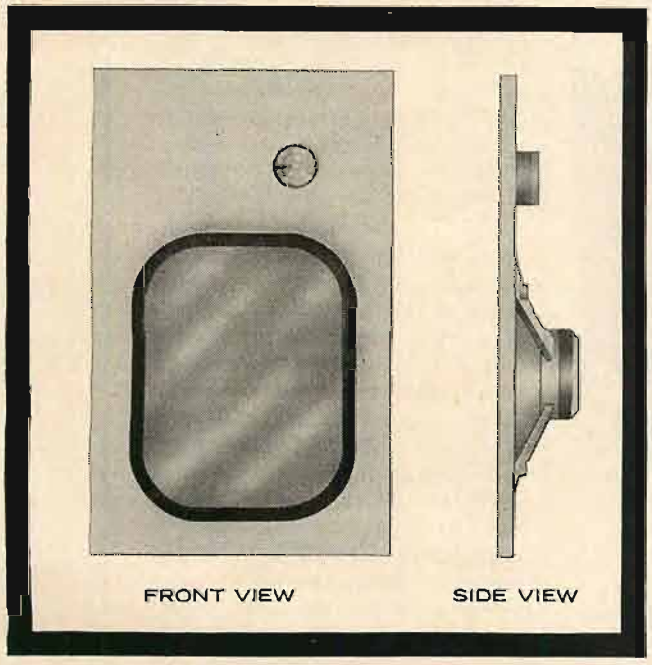
These remarkable loudspeakers are now in stock at leading high fidelity stores. We invite you to look at them, listen to them —and decide for yourself if what we claim is true.

ADC

AUDIO DYNAMICS CORPORATION

Pickett District Road, New Milford, Connecticut





The rigid rectangular woofer diaphragm 16" x 12" in models ADC 16 & ADC 18 *(a slightly smaller woofer is used in the ADC 14)* is molded from feather light expanded plastic and is surfaced with aluminum. It has a radiating area twice that of a 12" woofer, resulting in very efficient coupling to the air. The rigidity of the diaphragm enables it to act as a perfect piston throughout its range. There is no cone breakup. An exclusive high compliance double surround of molded cambric cloth is used to terminate the outer edge. The construction gives positive centering combined with the renowned damping properties of a cloth surround. The 9 lb. ceramic magnet assembly provides a high flux density and by careful equalization of leakage fields extreme flux linearity is achieved.

Engineering Specifications

Frequency Response ADC-18.....20-20,000 c.p.s.
Frequency Response ADC-16.....30-20,000 c.p.s.
Frequency Response ADC-14.....38-20,000 c.p.s.

BASS UNIT MAGNET STRUCTURE

Flux Density 12,700 Oersteds
Total Flux 165,000 Maxwells

TREBLE UNIT MAGNET STRUCTURE

Flux density 15,000 Oersteds
Total Flux 53,500 Maxwells
Impedance.....Due to unusually smooth impedance curve these units will operate with any amplifier impedance from 8 to 16 ohms.

Power Requirements.....Due to their relatively high efficiency these speakers will perform under domestic listening conditions using an amplifier rated as low as 10 watts. They may, however, be used quite safely with amplifiers rated up to 65 watts, R.M.S.

A Transistorized 200-Watt Stereo Amplifier

72 db negative feedback around a 4-transistor d.c.-coupled output stage reduces harmonic distortion to hundredths of 1 per cent.

RICHARD S. BURWEN*

ACHIEVING REALLY LOW DISTORTION in transistor power amplifiers takes a lot more negative feedback than the usual 15 or 20 db. The two-channel power amplifier shown in *Fig.* 1, 2, and 3 (developed for Lafayette Radio Electronics Corp.) incorporates 72 db of feedback in a loop around five stages to achieve total harmonic distortion in the low hundredths of 1 per cent. This extremely high feedback is made possible by the use of an all d.c.-coupled circuit to eliminate phase shift caused by interstage transformers. The amplifier uses a novel single-ended push-pull class-B output stage containing four power transistors for each channel. Each output stage delivers 100 watts of music power or 80 watts of continuous sine wave power to a 4-ohm load or 50 watts continuous sine wave to an 8-ohm load. Heat sink area, however, is provided only for the intermittent duty operation required in reproducing music.

* *Consulting Electronics Engineer, 14 Scotland Road, Lexington 73, Massachusetts.*

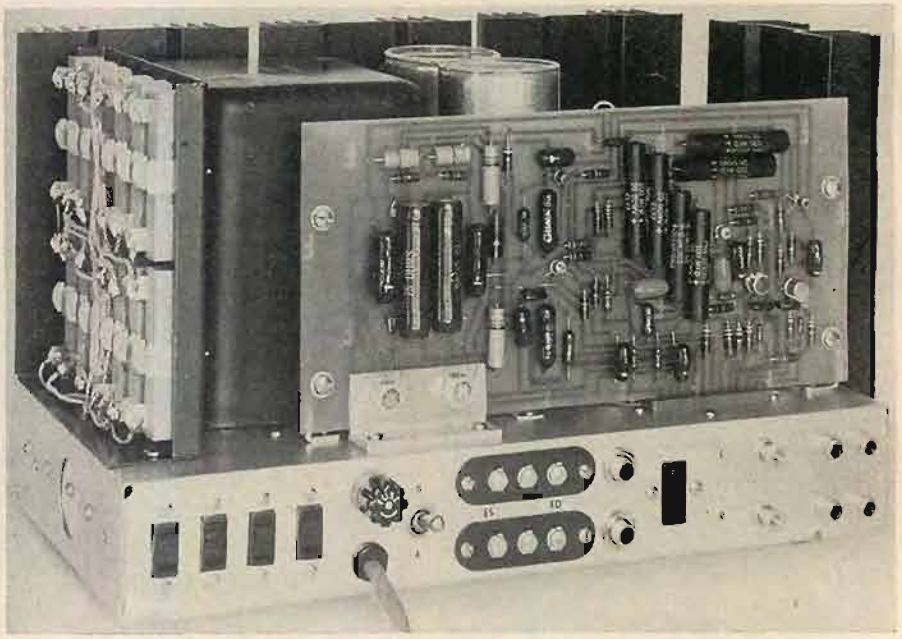


Fig. 2. Rear view of amplifier showing the plug-in circuit board.

Due to the elimination of coupling capacitors and transformers the amplifier can be overloaded occasionally without noticeable distortion. Above the overload point it clips cleanly and, since it recovers almost instantly, in contrast with vacuum tube amplifiers, subsequent signals below the overload point pass undistorted. Because of its excellent overload characteristics the amplifier is designed with an unusually high voltage gain of 40 db so that it can be operated at higher average output levels.

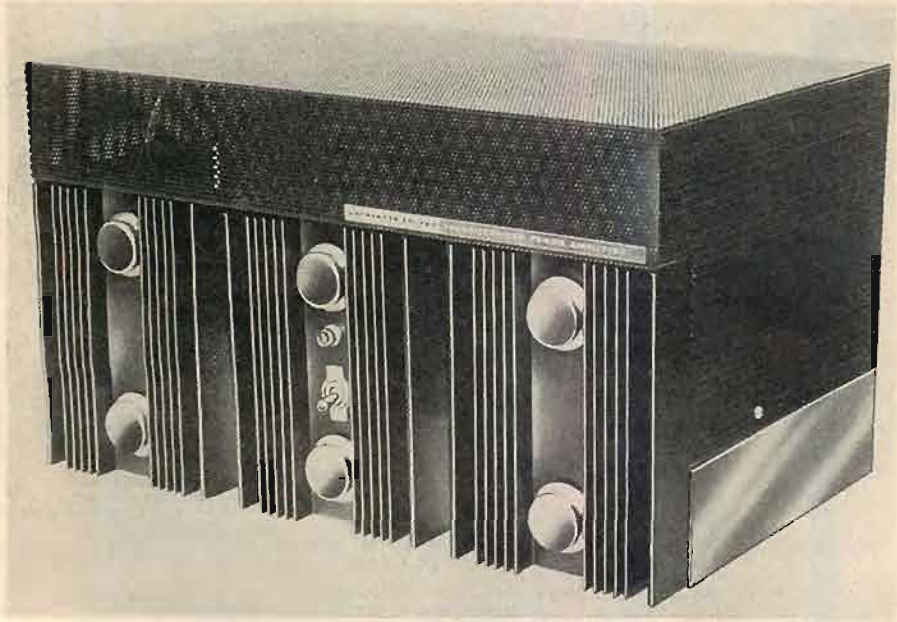
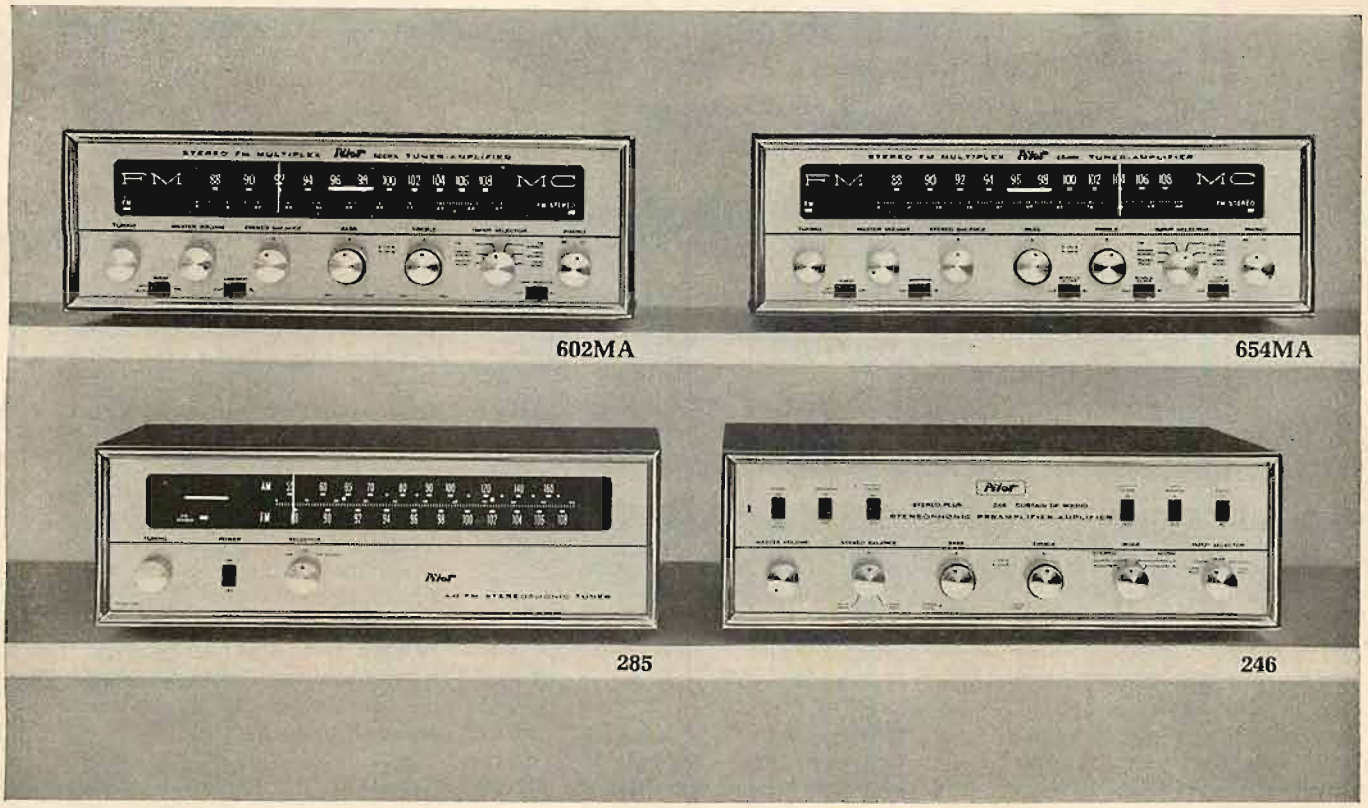


Fig. 1. Transistorized 200-watt stereo power amplifier (Lafayette Model LA-280).

Noise is −90 db even with the high gain, and the frequency response extends to 100,000 cps. The input circuit contains two inputs: a 0.2-volt 25,000-ohm input for transistor preamplifiers and a 1.5-volt 175,000-ohm input for vacuum tube preamplifiers.

One unusual feature of this amplifier is that it "likes" electrostatic speaker loads. Instead of causing oscillation, a capacitive load at the electrostatic speaker output terminals actually makes the amplifier more stable. This high stability is made possible by the use of an isolation network with separate electrostatic speaker output terminals which iso-



Hear here.

Hear the astonishing new sound... the clean, rich, surrounding sound... the pure, simple, ear-catching sound ...of PILOT. Hear it reproduced with all the dimension and depth that characterize the very best in modern stereophonic high fidelity.

Hear your favorite music with the 30-watt **602MA FM Stereo Receiver,** which includes PILOT's unique Multiplex circuit (better than 30 db separation); automatic FM Stereo indicator; record changer, turntable, tape transport and recorder connections; and complete control versatility, including rumble and scratch filters—only 249.50 with cover. (The 602SA, with added AM, is just 299.50.)

Hear your music favorites with the 60-watt **654MA FM Stereo Receiver** (top-rated by HIFI/STEREO REVIEW), including FM Multiplex, automatic FM Stereo indicator light and 14 controls...for only 329.50 with cover.

Hear your favorite broadcasts with the **285 FM Multiplex-AM Tuner,** only 159.50...combined with the 60-watt **246 Integrated Stereo Amplifier,** top-rated by an independent consumers' laboratory—with 12 stereo inputs and 14 controls, 199.50.

Whichever PILOT component you happen to select, you're assured of a quality instrument that is second-to-none. And you're also assured of incomparable sound enjoyment that must be heard to be believed. Where? At your PILOT dealer, of course.

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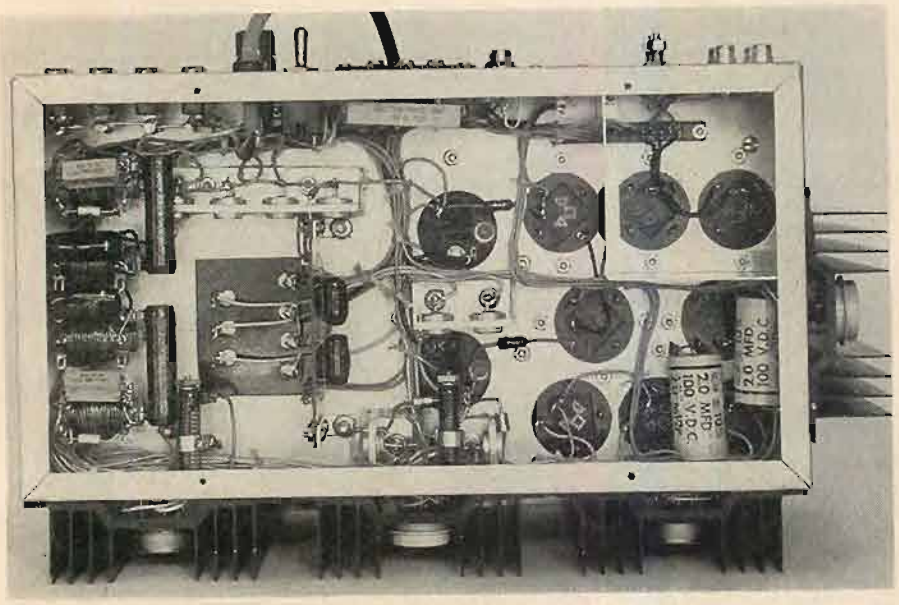


Fig. 3. Bottom view of chassis.

lates the load capacitance from the main feedback loop. Any value of load capacitance can be connected across these terminals without causing appreciable ringing.

The amplifier is ruggedly constructed and the main etched circuit board mounted vertically on top of the chassis plugs in for easy maintenance.

Output Stage

Since the output stage, *Fig.* 4, is d.c.-coupled to the speaker, it requires separate +35-volt and −35-volt unregulated power supplies. Each supply has a pair of 25-amp silicon rectifiers feeding a 5000-μf output capacitor. Hum and modulation caused by these supplies are eliminated by the extremely large negative feedback.

Figure 5 shows a simplified schematic of the output stage in which transistors Q_5 and Q_6 in the left channel are replaced by a single transistor Q_A, and transistors Q_7 and Q_8 are replaced by Q_B. The drive signal appears between the base and emitter of Q_A. When Q_A conducts heavily it effectively connects the load through CR_4 across the +35-volt supply, thereby delivering a positive output approaching +35 volts. When Q_A is driven towards cutoff, rectifier CR_4 disconnects its collector from the load R_L and allows the current through R_A to "turn on" transistor Q_B. When Q_B conducts heavily, the output across R_L approaches −35 volts and none of the load current goes through Q_A. This output circuit is not symmetrical, but it has the advantage that it does not require small-signal driver transistors to handle the 70-volt peak-to-peak swing. It is almost impossible to burn out a driver transistor due to an overload on the output stage.

Sine-wave distortion in this type of circuit is obviously very high because the gain during the negative half cycle is many times the gain during the positive half cycle. When Q_A drives the output positive it "sees" a load R_L, and the current gain from the base of Q_A to the output is that of transistor Q_A. During the negative half cycle transistor Q_A conducts current only through R_A and drives transistor Q_B as an emitter follower. Therefore the current gain during the negative half cycle is nearly that of Q_A and Q_B multiplied. The output then looks something like a negative-going half-wave rectified sine wave. What makes this open-loop distortion tolerable is the tremendous amount of negative feedback.

To see the effect on the over-all performance, the closed loop distortion can be easily computed using the basic equation for gain, G, with feedback in terms of the open-loop gain, A, and the feedback factor β:

$$G = \frac{A}{1 - A\beta}$$

During the positive half cycle the open loop gain is 200,000, or 106 db, and A is 0.01 corresponding to a 40-db closed-loop gain. Then the closed-loop gain is within 0.05 per cent of being exactly 100 or 40 db. Even if the open-loop gain increased to infinity during the negative half cycle, the maximum change in closed-loop gain, G, would be 0.05 per cent since the gain approaches exactly 100 as A increases to infinity. Thus with 66-db of feedback the negative half cycle is a maximum of 0.05 per cent larger than the positive half cycle. The distortion due to this waveshape looks like a full-wave rectified sine wave having a peak-to-peak value of only 0.012 per cent. The predominating second harmonic component, as derived from a Fourier analysis, is only 0.0053 per cent. In practice the feedback does not increase to infinity during the negative half cycle, but only to about 96 db.

Using this type of output stage causes the error signal inside the amplifier to be practically a half-wave rectified sine wave to produce a sinusoidal output. Yet the output distortion is very minute. When measuring the error signal, an ordinary a.c. vacuum tube voltmeter indicates about half the value it would on a full sine wave. The computed average feedback factor from error- and input-signal measurements is therefore 6 db higher than its value of 66 db during the positive half cycle, or 72 db. It can be seen from this computation that it is the amount of feedback occurring during the low-gain half cycle that really counts in reducing distortion.

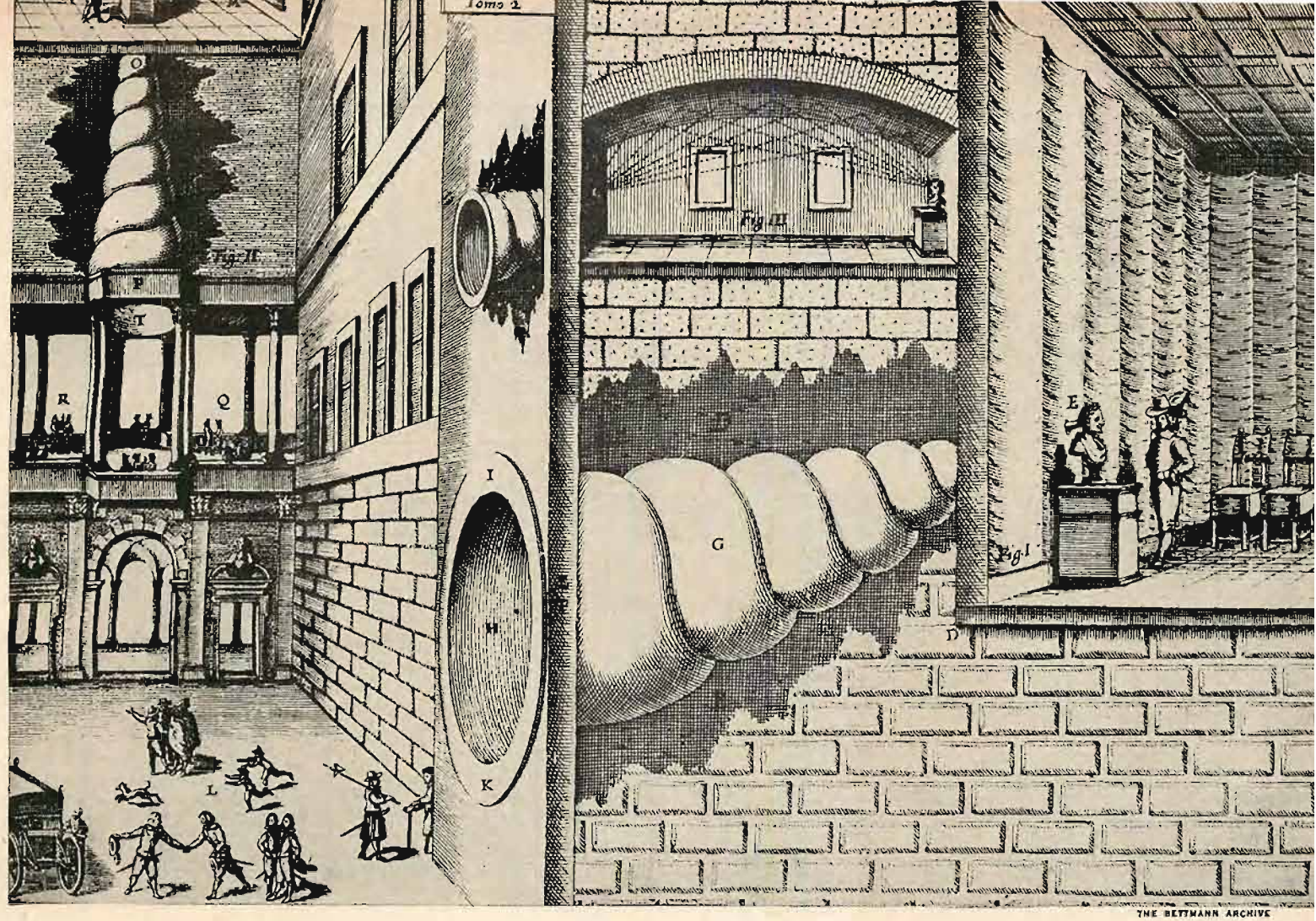
Why start out with such high distortion when there are a number of more symmetrical circuits that can be used? Of numerous circuits tested this type of output stage produced gain and phase shift characteristics that made possible the greatest amount of stable feedback during the low-gain half cycle. The advantage appears especially at the edge of overload where nearly all driver and output combinations have drastically increased high-frequency phase lag which tends to cause oscillation.

The complete power stage, *Fig.* 4, uses four power transistors per channel to provide nearly twice as much output voltage and power as the circuit shown in *Fig.* 5. In the complete stage the common-emitter power transistor, Q_5, drives an identical transistor, Q_6, through its emitter. The base voltage of Q_6 is fixed by means of resistive divider R_{23}, R_{24}, and R_{25} which divides the total voltage equally between Q_5 and Q_6 at maximum negative swing. Since Q_6 is driven more or less as a common-base amplifier, its collector current is very close to that of Q_5. Thus the combination of Q_5 and Q_6 is able to drive twice the load impedance that could be driven by Q_5 alone.

During negative half cycle, the collector signal from Q_6 drives Q_7 as an emitter follower through stabistor CR_3 in the same manner in which Q_A directly

Table I Summary of distortion measurements.

	FREQUENCY	LEFT CHANNEL		RIGHT CHANNEL	
	cps	POWER(WATTS)	HARMONICS(%)	POWER(WATTS)	HARMONICS(%)
4-OHM LOAD	15	64.8	0.0180	64.0	0.050
	100	90.0	0.0130	90.0	0.042
	1000	81.0	0.0110	85.0	0.044
	10,000	39.0	0.3500	45.0	0.220
8-OHM LOAD	15	45.0	0.0095	46.0	0.016
	100	48.0	0.0070	46.0	0.011
	1000	49.0	0.0070	45.0	0.007
	10,000	40.0	0.0110	40.0	0.095



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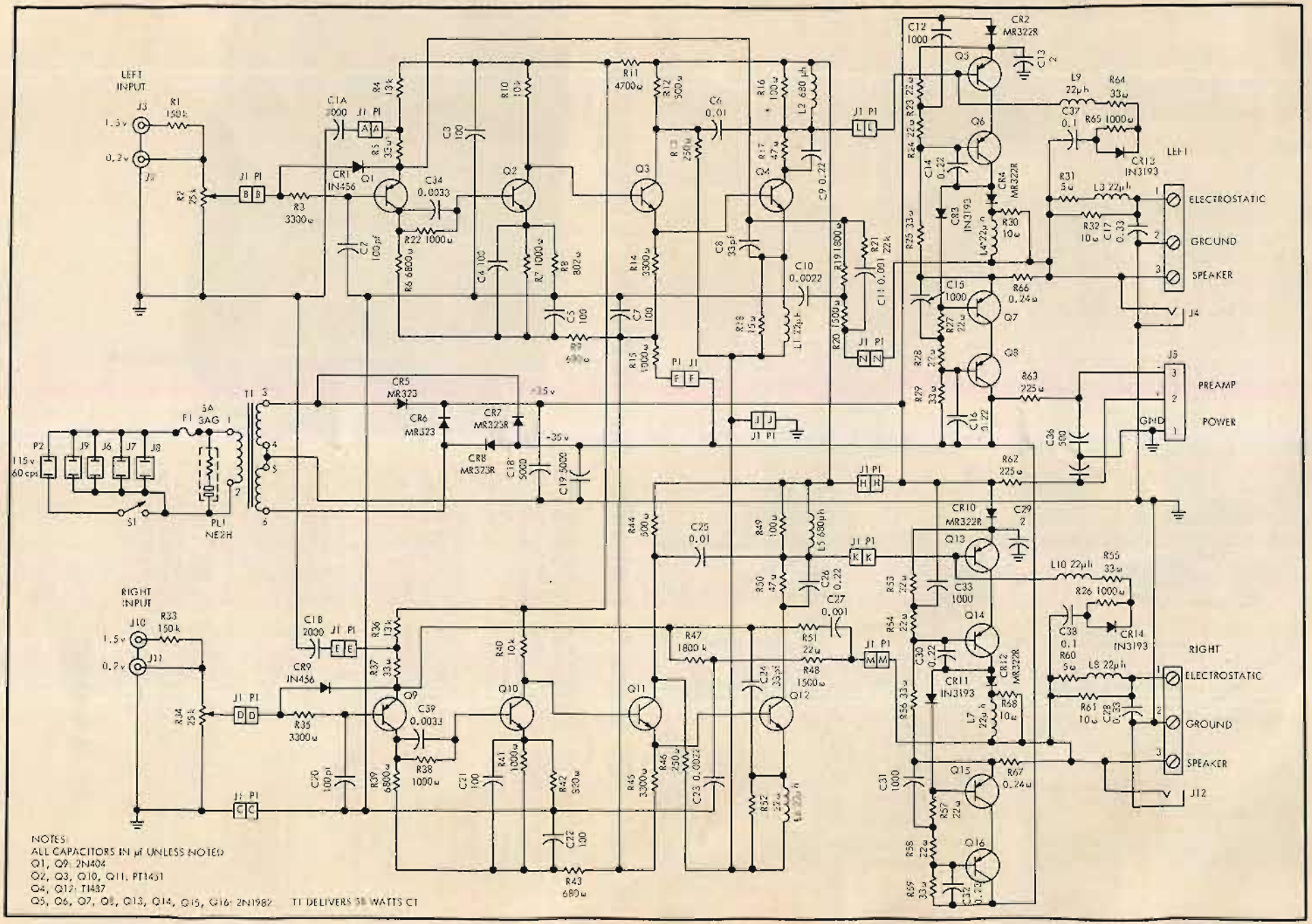
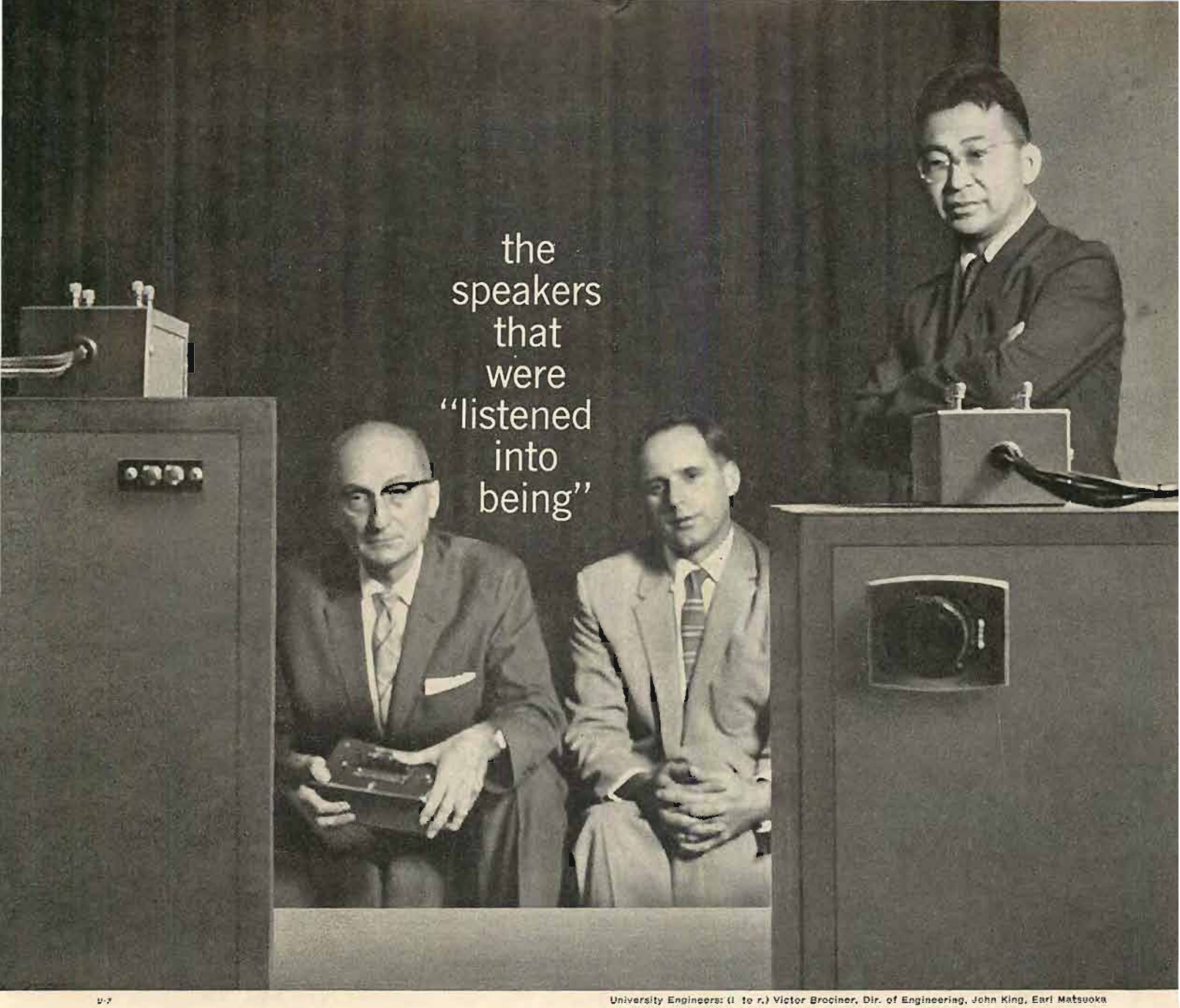


Fig. 4. Schematic of 200-watt amplifier.



University Engineers: (l. to r.) Victor Brociner, Dir. of Engineering, John King, Earl Matsuoka

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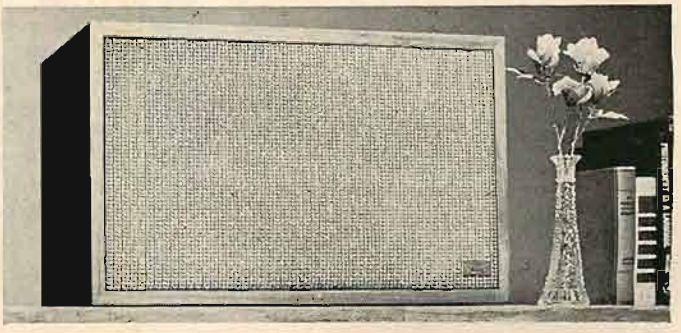

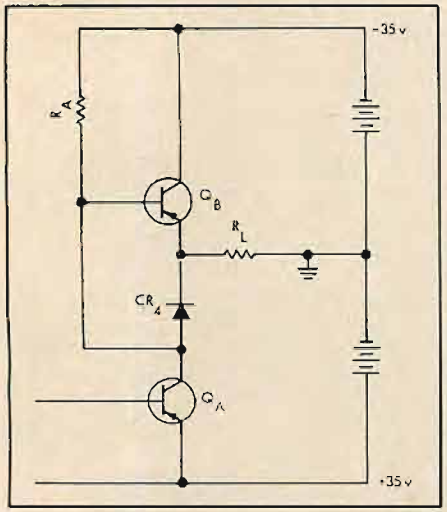

Fig. 5. Simplified representation of output stage.

drives Q_B in *Fig.* 5. Rectifier CR_4 performs the same function as in *Fig.* 5, disconnecting the collector of Q_6 from the load during negative outputs. Q_8 is an emitter follower which swings the collector of Q_7 so as to divide the total voltage at maximum positive swing equally between Q_7 and Q_8. Its base input voltage is determined by the divider R_{27}, R_{28}, and R_{29}. Capacitor C_{15} is used to bootstrap the drive signals for both Q_7 and Q_8 so as to provide enough current drive at full negative output to saturate Q_7 and Q_8. Similarly C_{16} increases the current drive to a value sufficient to saturate Q_6 at full positive output.

In spite of the high open-loop nonlinearity previously discussed, it is still necessary to minimize crossover distortion. Otherwise the closed-loop distortion will increase with small signals and this is very undesirable. There must be no region where neither Q_6 nor Q_8 are contributing to the output.

Normally the no-signal collector current through Q_5 and Q_6 is 450 ma. This current flows almost entirely through CR_3 and the divider R_{27}, R_{28}, and R_{29}. Similarly, at no signal, Q_7 and Q_8 conduct 450 ma through R_{23}, R_{24}, and R_{25}. Thus, at no signal, all four transistors are biased into a region of high gain. Crossover distortion then is determined by the current through CR_4 at no signal since this rectifier conducts only when the output is driven positive. The no-signal current through CR_4 is determined by the voltage drop across it which in turn is determined by the voltage across CR_3 less the base-to-emitter drop of Q_7 less about 5 mv dropped across R_{66}. The actual 0.5 volts across CR_4 at no signal produces a current of about 20 ma, an amount sufficient to reduce the crossover distortion to a tolerable level.

Since the current through a rectifier of this type increases about 9 times for every mv increase in forward voltage, it tends to increase greatly with temperature due to the −2.5-mv per degree Centigrade temperature coefficient of the base-to-emitter diode in Q_7. In addition there is a similar temperature coefficient in CR_4, but this is compensated by the temperature coefficient of CR_3. The current is prevented from increasing too much at high junction temperatures by emitter degeneration across a 0.24-ohm resistor, R_{66}.

Temperature stability of the power stage is maintained not only by this emitter degeneration, but also by the main feedback loop. Unity d.c. feedback from the output to the input causes the average output voltage to remain at zero, independent of drifts in the output stage and other stages of the amplifier.

The output circuit as described so far works well at low frequencies, but gets into trouble at high frequencies due to the slow recovery time of rectifier CR_3. As the output swings from positive to negative a transition must occur where Q_5 and Q_6 conduct very lightly, while Q_7 and Q_8 begin to conduct. Q_7 cannot conduct unless it becomes forward biased by the current through R_{27}. Since CR_4 acts as a very large capacitance it takes time for the forward conduction voltage across CR_4 to decrease far enough to allow some of the current through CR_3 to be diverted into the base of Q_7.

With the square wave input, the output switches from negative to zero and then remains constant until CR_4 discharges, at which time Q_7 and Q_8 can start conducting, driving the output positive. This momentary step in the output lasts for 10 to 20 μs and produces very poor results at high frequencies. To remedy this charge-storage problem, a 22 μh choke, L_4, was added in parallel with resistor R_{30}. During the time when Q_5 and Q_6 conduct, L_4 stores enough energy to drive the base of Q_7 negative causing Q_7 and Q_8 to conduct rapidly. L_4 is released by the cutoff of Q_5 and Q_6. This choke increases the power bandwidth of the amplifier by more than 3 to 1.

When using audio power transistors the only way to achieve full output above the β-cutoff frequency, typically 4000 cps, is to provide added drive in both the turn-on and cut-off directions over that needed at low frequencies. It is the maximum rate of swing available that limits the high-frequency power output. To aid in turning on Q_5 quickly, high base current is supplied by a 15-watt silicon driver transistor, Q_4. Its current capability is increased above 10,000 cps by capacitor C_9 connected across the collector-dissipation-limiting resistor, R_{17}. Transistor Q_4 can conduct up to 0.7 amperes peak at high frequencies.

Since Q_4 can only turn on Q_5, substantial back-bias current must be supplied to cut off Q_5 quickly. During the time Q_4 and Q_5 are conducting, energy is stored in r.f. choke L_2 and, when Q_4 cuts off, the discharge of energy from L_2 helps to cut off Q_5. The choke provides greater turn-off current than would be available if only the 10-ohm resistive component of L_2 in parallel with resistor R_{16} were used to back-bias Q_5. Back-bias voltage is provided by the 1-volt drop across stabistor CR_2 due to the emitter current of Q_5.

Due to the heavy turn-on current available for Q_5, the output can swing from full negative to full positive in about 12 μs, whereas a swing from full positive output to full negative can take as long as 30 μs even with the help of L_2 and L_4. When there is no load connected, the output can swing very much faster in the positive direction than in the negative direction. An overshoot due to phase shift in the feedback loop can therefore be rapidly corrected if the overshoot is negative, but only can be corrected slowly if the overshoot is positive. This effect tends to produce a positive spike in the output, immediately upon recovery from an overload in the negative direction, when there is a high-impedance load. To reduce the amplitude of this spike a nonlinear network, L_9, R_{64}, R_{65}, CR_{13}, and C_{37}, was added. The network provides negative feedback from the output to the base of Q_5 in proportion to the rate of swing in the positive direction, thus limiting the drive to Q_5. Because of rectifier CR_{13}, the network has practically no effect when the output swings in the negative direction. This network therefore tends to equalize the rise and fall times of the output circuit.

The transistors used in the output stage are hefty germanium alloy junction types (Tung-Sol 2N1982) having a maximum thermal resistance of 0.5-deg

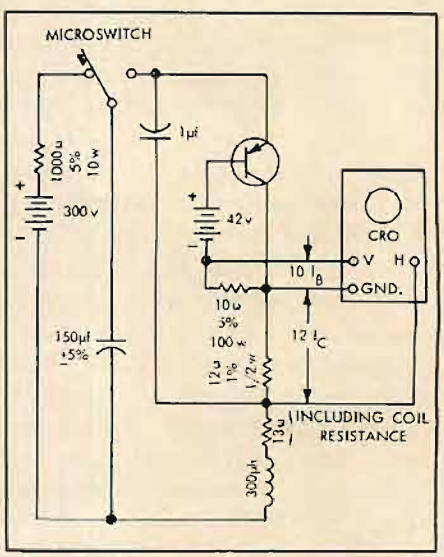

Fig. 6. Test circuit for determining safe operating area of power transistors.

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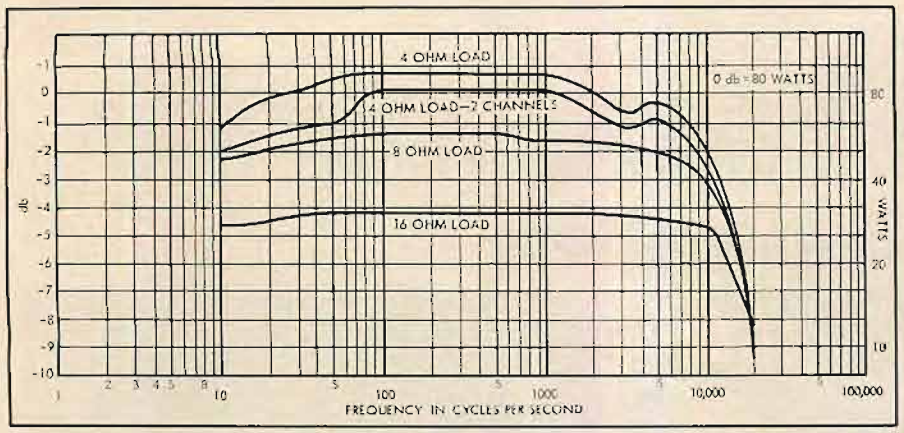

Fig. 7. Maximum power output versus load impedance and frequency.

Centigrade per watt from junction to case. The type and size of transistor required is determined not so much by the requirement to deliver sinewave power to a resistive load, but by the requirement to handle extremely high energy pulses when delivering square waves to an inductive load. Consider what happens when the amplifier is required to deliver a step in output from full negative to full positive swing to a 4-ohm speaker system. Such a condition might occur when switching inputs in a preamplifier control unit or when tuning in an FM station.

Assume the speaker system is fairly efficient and has a bass resonant frequency of 60 cps. At low frequencies the electrical equivalent circuit is the d.c. resistance of the voice coil, typically 3 ohms, in series with a parallel resonant circuit tuned to 60 cps. At very low frequencies the inductive component of the resonant circuit is most significant and might amount to 22 mh. Just before switching, the amplifier could be delivering −30 volts at −10 amperes to the voice coil. Right after switching the inductive component of the load tends to keep the current in the same direction while the output is now +30 volts. Since the current is in the wrong direction, it is not transistors Q_5 and Q_6 that conduct but rather transistors Q_7 and Q_8, which have about 65 volts across them at this moment. Thus the combination of Q_7 and Q_8 is momentarily required to dissipate 650 watts!

The total energy dissipated in the transistors is that due to the first half of an exponential change in current from −10 amps to +10 amps, in other words that due to the change from −10 amperes to zero. The voltage during this interval is a constant 65 volts. Since the time constant L/R is 7.3 milliseconds, there will be an average current of slightly less than 5 amperes for 5.1 milliseconds producing a total energy of 1.6 watt-seconds. When the damping and capacitative components of the speaker impedance are taken into account, the energy fed back to the transistors is reduced somewhat, but 1.6 watt-seconds represents a good value for design purposes. Variations in the current gains of transistors Q_7 and Q_8, and tolerances in the divider R_{27}, R_{28}, and R_{29} may cause a somewhat unequal distribution of this power between Q_7 and Q_8. Either of these transistors might be required to dissipate as much as 430 watts peak with a total energy of 1.1 watt-seconds. This tremendous amount of power requires the use of the largest available junctions with appropriately large thermal capacity so that they can absorb this energy without burning out.

Low-thermal-capacity transistors such as the new high-frequency diffused germanium types will burn out instantly under such conditions. The diffused-base germanium transistors made by several manufacturers were tried first before resorting to low-cutoff-frequency audio types. It was found that the diffused-base transistors would go into thermal runaway or secondary breakdown at steady-state dissipation levels well below their dissipation ratings when the collector-to-emitter voltage was over 30 volts. This indicated that these transistors were suitable only for relatively low power amplifiers and could not be used for anything like 100 watts per channel.

To assure the ability of every transistor to handle the 430-watt surges of power possible in this amplifier, a safe-operating-area test should be conducted. The test setup is shown in *Fig.* 6. In this test a capacitor-discharge sweeps the collector current exponentially from 10 amperes to zero while maintaining a constant collector-to-base voltage of 42 volts. The energy discharged into the transistor is 1.6 watt-seconds, or about 1.5 times the maximum that can occur when used in the amplifier. A transistor passes the test if its curve of base current versus collector current, as observed on the oscilloscope, is continuously negative, indicating the externally supplied turn-on base current always has control. Transistors failing the test frequently go into secondary breakdown and are destroyed.

Operation with a 4-ohm load requires transistors with a d.c.-current gain of 35 at 10 amperes. Low-gain transistors have the effect of causing clipping at lower power output levels. With the transistors used, full output voltage can be delivered to a 3-ohm load, a value which can occur at some frequencies using a speaker system rated at 4 ohms.

Feedback System

Since the amount of stable negative feedback that can be placed around the output stage at high frequencies increases with the gain bandwidth of the loop, r.f. transistors are used in all the early stages. Transistor Q_1 is a germanium pnp common-emitter stage d.c. coupled to the base of Q_2. Diode CR_1 in the base circuit of Q_1 helps maintain symmetrical clipping during severe overloads by equalizing the positive and negative currents that flow through the emitter bypass capacitor, C_{1A}. Transistor Q_2 is a common-emitter stage using a small silicon npn planar unit having a gain bandwidth of over 50 megacycles. This stage is d.c. coupled to an emitter follower, Q_3, which uses the same type transistor. The driver transistor, Q_4, another common-emitter stage, uses a 15-watt, 15-megacycle gain-bandwidth silicon unit.

Feedback from the main speaker output terminal goes all the way back to the emitter of Q_1. Without feedback, an input signal of only 50 μv at input J_2 will produce full output. With feedback the voltage gain is reduced to 100, or 40 db, requiring an input voltage of 0.2 volts rms for a 20-volt output.

Stabilization of the feedback at low frequencies was no problem since the circuit is d.c. coupled. The emitter-bypass capacitor, C_{1A}, allows 100 per cent feedback at d.c. from the output to the emitter of Q_1. Thus at d.c. the amplifier behaves as a five-stage emitter follower which has unity voltage gain and very high d.c. stability. The initial d.c. offset is only 0.3 volts out of a peak output of 28 volts and it does not change significantly with signal. Variations in d.c. offset with signal, which limit the power output under transient conditions, have been one of the chief causes of muddy quality in some transistor amplifiers designed in the past.

Stabilizing the feedback at high frequencies proved to be extremely difficult. The basic philosophy was to achieve the maximum possible feedback at frequencies up to 20,000 cps in order to attenuate adequately the second harmonic of a 10-000-cps signal. Distortion components above audibility are unimportant as long as no audio-frequency intermodulation components are associated with them. In order to provide all

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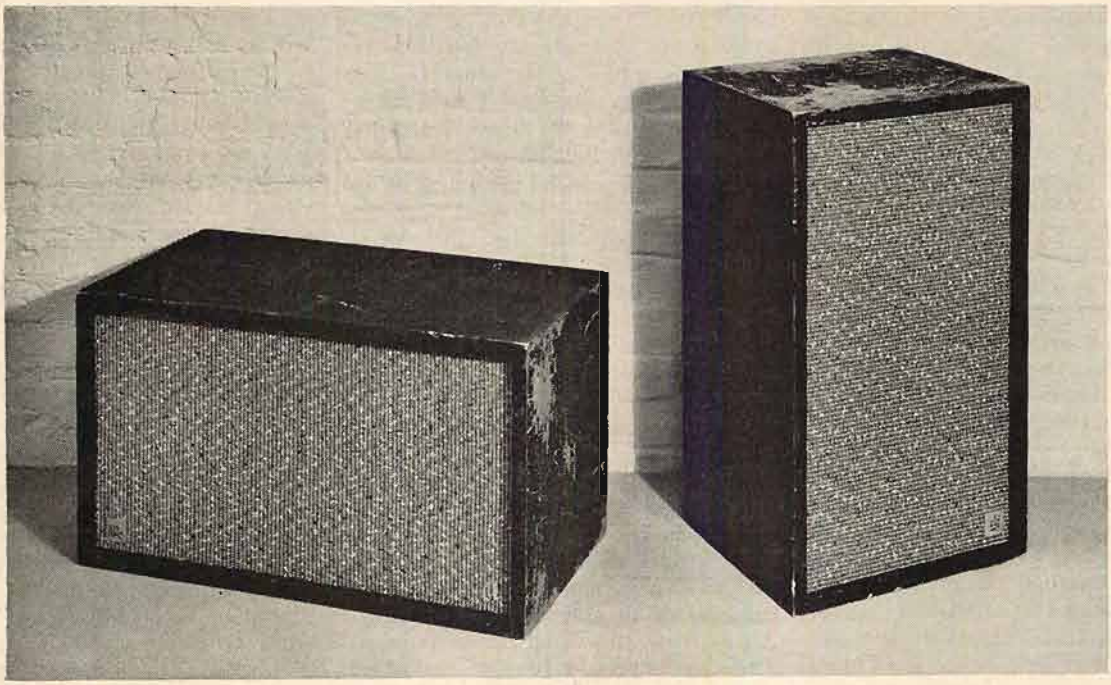

David Jones, the recording engineer who owns them, brought them in to AR for a preventive maintenance checkup. We made a few minor repairs, replaced the grille cloths, and took a picture of them.

AR loudspeakers are often used in professional applications because of their natural musical quality, but they are primarily designed for use in the home. AR-2a's are $109 to $128, depending on finish; other models are priced from $89 to $225. A five-year guarantee covers the full cost of any repairs, including reimbursement of freight charges.

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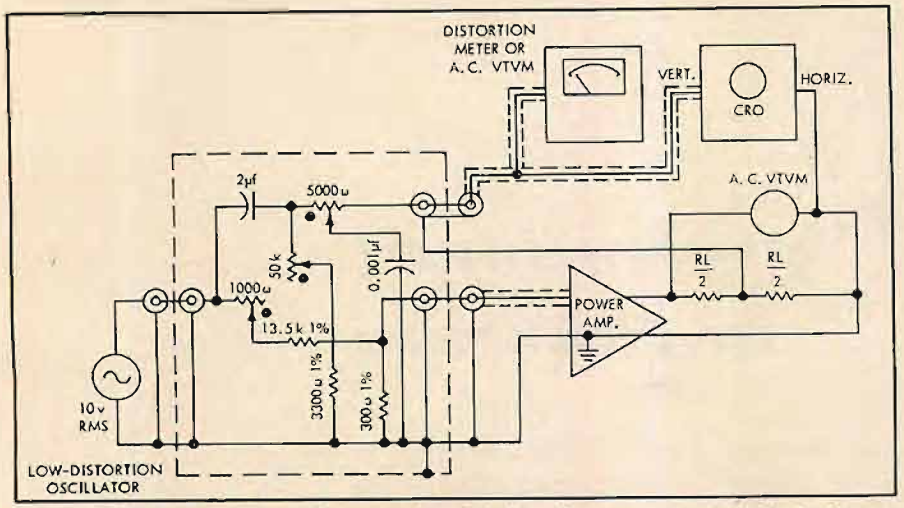


Fig. 8. Circuit for measuring distortion levels below the range of available instrumentation in a non-inverting amplifier with a voltage gain of 40 db.

this feedback with the limitation of audio transistors in the final stage it was advantageous to design a conditionally stable feedback loop. This means the phase shift around the loop can exceed 180 deg. in the vicinity of 70,000 cps while it is reduced to about 120 deg. in the region where the feedback becomes unity at 1.5 megacycles. The high phase shift at 70,000 cps occurs when the load is disconnected and the amplifier is driven to the edge of overload. When a load is connected the phase shift is reduced.

To achieve the desired open-loop response curve, and at the same time handle wide variations in the load impedance including a pure resistive load, a pure capacitive load and an open circuit, it was necessary to minimize the variations in frequency and phase response caused by changing the load. This was accomplished first by isolating capacitive loads from the output by means of a network R_{s1}, L_s, and R_{s2} and providing a separate electrostatic speaker output from terminal 1 to ground terminal 2. Thus when a capacitive load is used the minimum load impedance the amplifier sees above 150,000 cps is 10 ohms due to R_{s2}, in parallel with any resistance that happens to be connected between main speaker terminal 3 and ground.

The effect of variations in the load capacitance at the electrostatic speaker terminals was minimized by connecting a dummy load of 0.33 μf across this output at all times. With this isolation network variations in load impedance above 150,000 cps are held to about 3 to 1 and no additional phase shift is caused by adding a capacitive load at the electrostatic speaker terminals. In fact connecting a capacitive load actually reduces the phase lag above the resonant frequency of the isolation network and helps the stability.

Stabilization of the 66 to 96 db of feedback that occurs respectively during positive and negative outputs basically required increasing the phase shift and rate of rolloff between 20,000 cps and 100,000 cps and decreasing both between 100,000 cps and 3 mc. Phase lead between 100,000 cps and 3 mc is provided by C_{11} which shunts the feedback resistors, R_{19} and R_{20}. Capacitor C_{10} was added to form a bridged-T network so as to provide flat closed-loop frequency response out to 100,000 cps.

The high frequencies are rolled off internally by means of local high-frequency feedback from the emitter of Q_4 through capacitor C_8 to the emitter of Q_1. The feedback voltage is developed across an r.f. choke, L_1, in series with the emitter of Q_4. Capacitors C_{14} and C_{16} in the output stage also aid the stability of the main feedback loop. At high frequencies they maintain a constant collector-to-base voltage across their respective transistors making the transistors behave like zener diodes. In the case of Q_6, C_{14} eliminates the phase shift which would otherwise occur at extremely high frequencies between the collector of Q_5 and the collector of Q_6. All of these stabilizing networks in addition to the previously mentioned effects of L_2 and L_4, produce an amplifier that is free from oscillations and ringing.

Performance

The developmental model was built with a set of high-gain power transistors in the left channel and a set of low-gain units in the right channel in order to compare the effect of transistor variations on the distortion and power output. With a 4-ohm load the low-gain units had about 3 times as much low-frequency distortion because they could just barely be driven into saturation (less than 1 volt collector-to-emitter drop), whereas the high-gain units could be driven into saturation even with a 3-ohm load. Using an 8-ohm or higher load impedance, the low-gain transistors easily delivered the full available voltage and their distortion was similar to the distortion produced by the high gain units. Table 1 is a summary of the distortion measured with each channel operating alone. (see page 42).

The final amplifier uses selected high-gain 2N1982 transistors to achieve the low-distortion level of the left channel.

The reason the distortion figures above are higher than the low-frequency theoretical maximum of 0.0053 per cent peak-to-peak, arrived at earlier for a 4-ohm load, is that the calculation did not take into account the reduction in feedback that occurs at high collector currents as the collector voltage approaches saturation. Also there is some second harmonic distortion due to Q_1 because the base and emitter are both swinging 0.2 volts rms and the collector current does not quite remain constant.

The measurements above were made at output levels in the low-distortion region below clipping. When the maximum power output at various frequencies and load resistances is considered in terms of the usual per cent total harmonic distortion, the output is higher as shown in *Fig. 7*. Since the power supplies are quite stiff, and the amplifier can deliver over 0.9 of the available

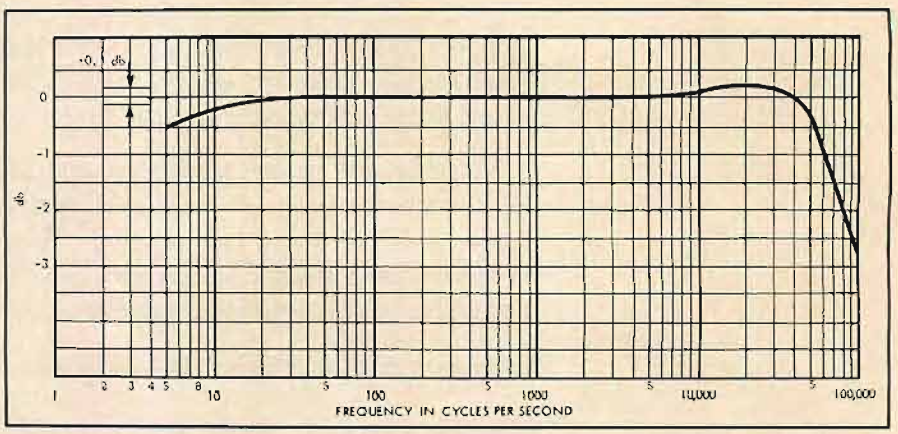
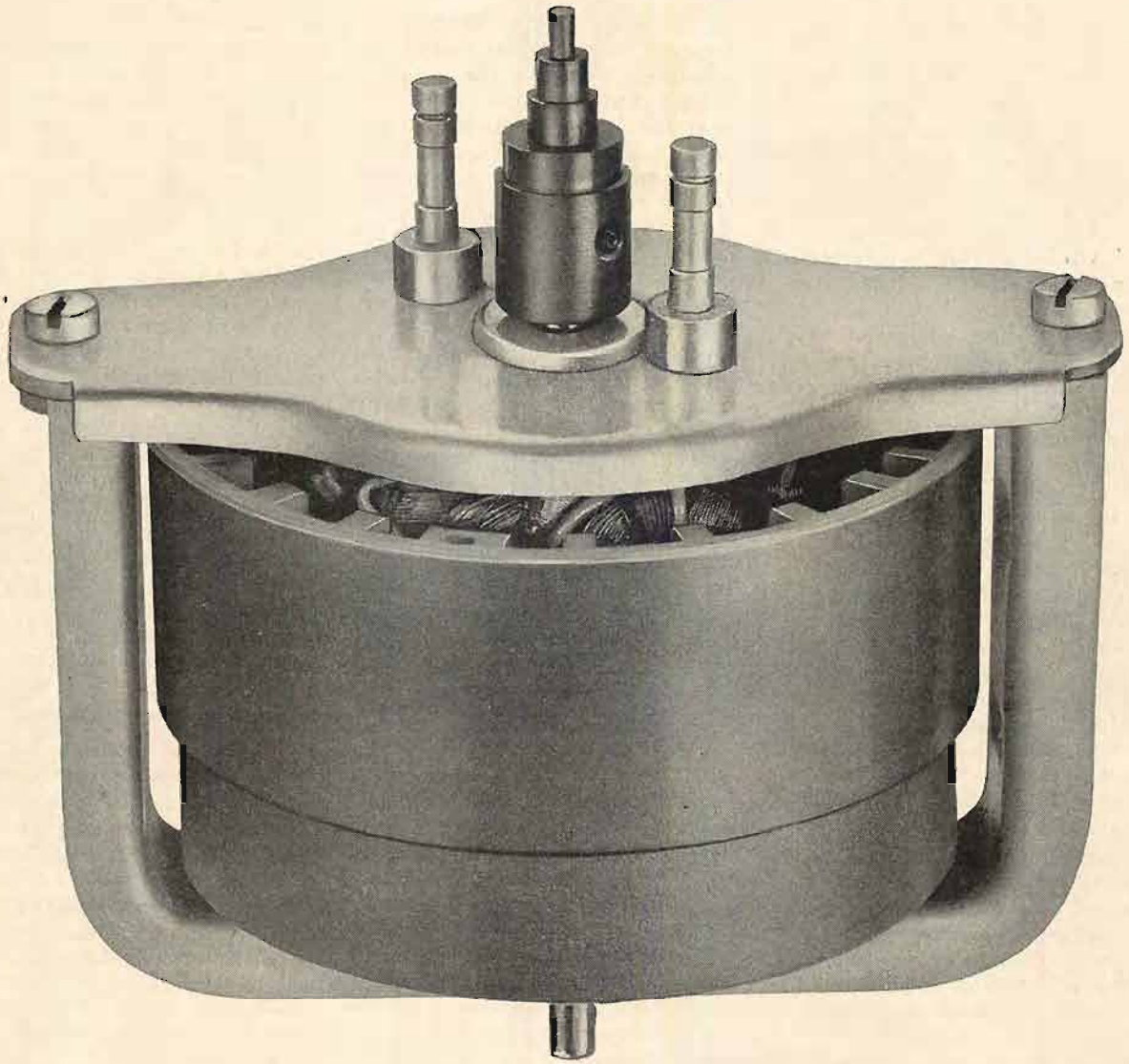


Fig. 9. Frequency response of left channel with an imput of 0.1 volt and a load of 4 ohms.



an accurate timepiece

A clock or watch is undoubtedly more convenient for telling time. Yet, it is actually possible to keep accurate track of time with a hysteresis motor-driven Miracord turntable.

The speed of a hysteresis-synchronous motor is precisely regulated and timed by the frequency of the line current. This speed is constant even with variations in line voltage and load.

Consequently, a hysteresis motor-driven turntable will rotate at the precise record speed, and maintain that speed regardless of voltage fluctuation, or the number of records on the platter.

The Miracord 10H uses the famous Papst hysteresis motor with the outside rotor. It's the same motor employed by the finest professional turntables and tape transports. The external rotor is a dynamically balanced mass. As it spins, it acts as a flywheel, further smoothing and evening out the motion of the turntable.

You can see this flywheel effect with the turntable platter removed. After starting the motor by lifting the arm from its rest, you let it run for about 10 seconds. You then shut the power off, by replacing the arm. The rotor will continue to spin by the sheer momentum of its own mass for at least 20 to 30 seconds. Most motors will stop in about 3 seconds.

MIRACORD

The Miracord is the only record playing instrument with hysteresis motor, dynamically balanced turntable and mass-balanced transcription arm which you can play manually, or as automatically as you please. The Miracord is also available with 4-pole induction motor — the Model 10, priced at $79.95. The Miracord 10H with hysteresis motor is $99.50. Prices include arm, but are less cartridge and base.

Make it a point to see the Miracord at your high fidelity dealer soon. For details, write to:

BENJAMIN ELECTRONIC SOUND, INC. 80 SWALM STREET, WESTBURY, NEW YORK. SOLE U. S. DISTRIBUTOR FOR ELECTROACUSTIC® RECORD PLAYING COMPONENTS

supply voltage to the load, the power output capability of the amplifier is nearly that of a constant-voltage generator. Its power output increases as the load impedance decreases. At 100 cps the maximum output from either channel measured with a 115-volt 60-cps line is 91 watts into 4 ohms, 58 watts into 8 ohms, and 31 watts into 16 ohms.

A 10 per cent drop in the power supply voltages is the main reason why the power delivered to a 4-ohm load is only 3 times that delivered to a 16-ohm load instead of 4 times. When both channels operate simultaneously with 4-ohm loads there is a further drop of 10 per cent in the supply voltages which limits the output to 81 watts per channel or 162 watts (continuous sinewave) total. *Figure 7* includes a curve of output versus frequency for the left channel when both channels are operating.

It will be noted that the power output falls off drastically above 15,000 cps particularly with a 4-ohm load. This is due to the previously explained limitation in the switching time of the audio transistors used in the output stage. They simply cannot be made to swing any faster without wasting a lot more power to increase the drive current. Since the no-signal power input is already 70 watts per channel, equally divided between the transistors and their base resistors, that is the limit.

The reduction in power output above 15,000 cps in no way detracts from the performance with musical signals. Certain types of program material, such as scraping noises, have substantial energy content above 15,000 cps. However, practically all the material available today, on either tapes or records, has a maximum output at 20,000 cps which is down at least 14 db from the mid-range level. This reduced energy content at high frequencies results from the natural limitations of the musical instruments, the microphone, and studio acoustics. Also, the pre-emphasis used in recording limits the levels which can be inscribed on the record grooves or the tape. Thus it is sufficient if an 80-watt amplifier can deliver 3 watts at 20,000 cps. Examples of program material requiring more power output at 20,000 cps can be found, but are very rare. In any case the material can be reproduced without distortion at reduced levels. Where the power is really needed is at the extremely low end of the spectrum where the speaker system is inefficient, and this inefficiency is frequently compensated for by "turning up" the bass control. Music of the organ and the bass drum require very high power output in the region of 30 to 100 cps when bass boost is used.

Oscilloscope measurements with monophonic musical input signals fed to both channels show that the clipping level occurs in the vicinity of 162 watts total power output with 4-ohm loads. There is no clipping of the high frequencies at low levels due to the high-frequency power limitation. The music power output is no higher than the sine wave power output largely because the power-supply voltage drops about as much with musical signals as with sine wave signals. However, by the IHFM industry standard of measurement using unvarying supply voltages the amplifier produces over 200 watts of music power. Unless the power supply filter capacitor is much larger than is economically allowable in most amplifiers, the voltage will drop quickly whenever the program material has heavy bass content. Therefore, excepting the unlikelihood that the program material has practically no bass, the musical output is limited by

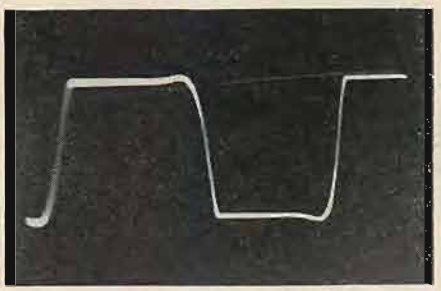


Fig. 10. Squarewave output at 10,000 cps.

the sinusoidal power handling capability rather than the peak power.

The distortion in this amplifier is lower than the capabilities of commercially available distortion analyzers, therefore, it was necessary to devise a special test circuit to extend the range of the conventional measuring equipment. The test circuit shown in *Fig. 8* was designed especially for this amplifier and uses a signal cancellation technique. The vacuum tube voltmeter or distortion analyzer shown is connected to measure the distortion and noise components remaining after subtracting one-half the amplifier output voltage from fifty times its input voltage. With an amplifier having a voltage gain of 100 the fundamental and any harmonics from the audio oscillator are completely cancelled out provided the signals which are subtracted from one another are subjected to the same gain and phase shift. Distortion and noise generated in the amplifier are not cancelled out, but read on the meter. The circuit includes adjustments for gain, low-frequency phase, and high-frequency phase.

Either an a.c. millivoltmeter or a distortion analyzer can be used for the distortion indicator. The accuracy of the cancellation is much less critical when a filter-type distortion meter is used. Measurements using this technique can be made as low as 0.001 per cent.

Measuring the other characteristics of the amplifier required no special equipment other than a switch and an attenuator to allow the use of the same a.c. vtvm to measure both the input and output voltages when checking the frequency response. The frequency response at the main speaker output, shown in *Fig. 9* for the left channel, is flat within plus or minus 0.1 db from 15 cps to 45,000 cps and down 3 db above 100,000 cps. The internal impedance, which reaches a maximum of 0.04 ohms from 10 cps to 20,000 cps, is so low that there is no measurable change in frequency response up to 20,000 cps whether the load is connected or not. The clean square-wave output accompanying this frequency response is shown in *Fig. 10* for 50 cps and 10,000 cps at 2 volts peak-to-peak output.

In spite of the high sensitivity of 0.2 volts rms input for 20 volts output the noise and hum are down 93 db corresponding to 4.5 microvolts referred to a shorted input. With both inputs open the increased source impedance for Q_1 raises the noise to – 83 db in the poorer channel. Channel separation is 72 db at 2000 cps where crosstalk is most objectionable and is at least 57 db from 15 cps to 20,000 cps in both channels.

Care of Transistor Amplifiers

With the hi-fi industry just entering the era of transistorization a certain amount of education is required in the use of transistor amplifiers. While physically more rugged than vacuum tube equipment, they cannot be subjected to the same electrical overloads that vacuum tube equipment can survive. Dealers will have to check the switching systems in their display rooms to be sure the output terminals of a transistor amplifier are never short circuited. A millisecond short circuit is all it takes to destroy a complete set of power transistors in one channel.

Short-circuit protection, while feasible, does not appear to be economical yet since it requires considerable added circuitry. It is not a simple matter of adding a fuse in series with the output since what is needed is a dissipation limiter rather than a current limiter. At high output voltages the amplifier can safely deliver high currents, but at low output voltages it can deliver much less current without exceeding the dissipation limit of the power transistors. Furthermore at low frequencies it is the instantaneous dissipation that should be limited, while at high frequencies it is the average dissipation that should be limited.

Sustained high-frequency signals must be avoided too. Just as sustained high-frequency signals can overheat the screen grids in a vacuum tube amplifier, they also can overheat the junctions in

(*Continued on page 86*)

A Headphone Control Center For Monaural, Diotic, and Binaural Listening

ROBERT J. LARSON* and
JOHN M. EARGLE*

A headphone control center incorporating the CBS-Bauer crossfeed network which effectively converts stereophonic information into binaural information appropriate for headphone listening.

CONCURRENT WITH THE RISE in popularity of so-called stereo headphones, there has been a trend in the recording industry toward more and more separation between channels. Reminiscent as this is of the "ping-pong" era of stereophonic records, it still is being pointed to as a move forward in the art. Certainly many of the techniques employed in this type of recording are advanced and sophisticated, but patently the reason for such "super" stereo is to give some notion of perspective when these records are played on phonographs with stereo speakers a small distance apart so that conventional stereo is hardly discernible from mono.

Our purpose is *not* to evaluate recording techniques but rather to examine means for making the more extreme of these techniques compatible with headphone listening.

A circuit developed by Benjamin Bauer of CBS Laboratories for converting stereo information into binaural information has previously been discussed in detail,[1] and only its barest exposition will be presented here. What we will discuss in detail is how the "Bauer Circuit,"[2] as it is generally known, was incorporated into a control center for headphone listening and how the control center was designed, how it functions, and the effect of a variety of recorded material.

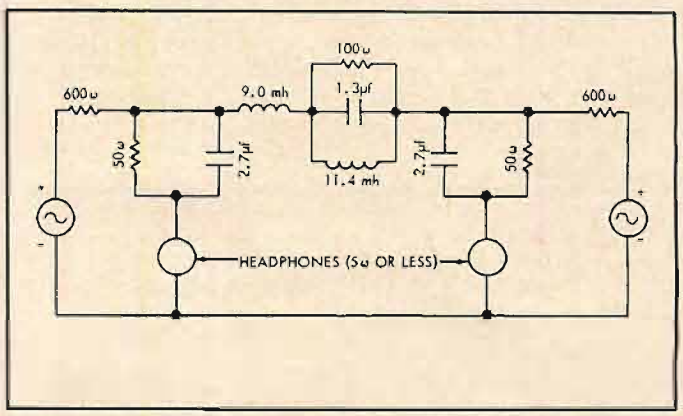


Fig. 2. Original Bauer cross-feed network.

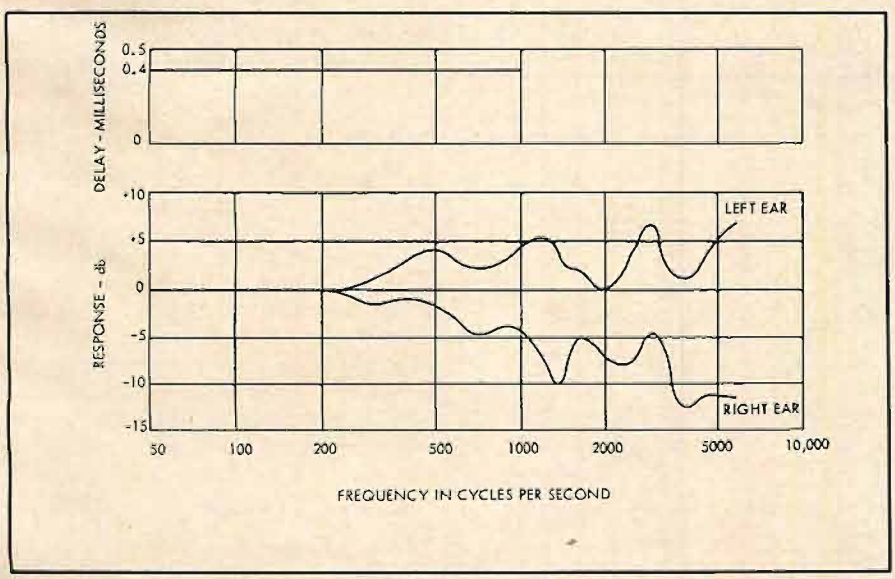


Fig. 1. Relative response at ears of listener for sound source 45-deg. to left of listeners plane of symmetry, normalized to zero-deg. Incidence. (After Wiener.)

The Problem and Solution

The problem is clear: stereophonic recordings made with microphones spaced adequately for the reproduction of perspective over loudspeakers do not give a proper perspective when reproduced over headphones. While the effect of such listening may not be unpleasant, it in no way approximates natural binaural listening. An obvious solution would be simply to introduce crosstalk between the channels to whatever extent is necessary to destroy some of the gross separation which is encountered.[3] A more sophisticated solution is that offered by Bauer, and that is the introduction of crossfeed between the two phones which approaches the phase and magnitude dif-

* *Jensen Manufacturing Co., 6601 S. Laramie Ave., Chicago, Ill.*

[1] Benjamin B. Bauer, "Stereophonic earphones and binaural loudspeakers," *J.A.E.S.*, vol. 9, no. 2, pp. 148–151; April, 1961.

[2] Licensed by Jensen Mfg. Co. from CBS Laboratories Division of Columbia Broadcasting System.

[3] One prominent record reviewer who is an avid headphone enthusiast suggests that 90 per cent crossfeed between phones is not an excessive amount.

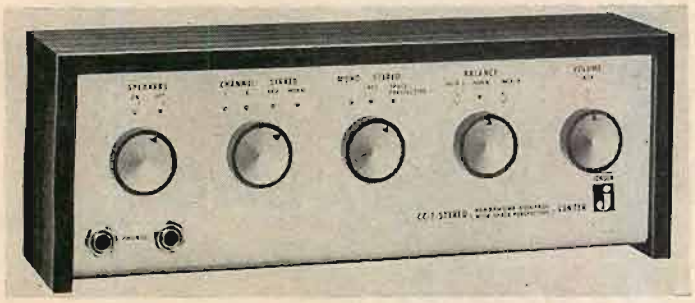


Fig. 3. Jensen "Space Perspective headphone control center, Model CC-1.

ferences between the ears resulting from the diffraction of sound around the head during normal listening. His attempt then is to provide the ears with binaural clues so that localization with headphones will approximate the natural localization process.

A simple example will make the technique clear: Assume that a stereo recording has a signal in channel A which does not appear in channel B at all. When this recording is played over stereo loudspeakers the virtual source will be at speaker A, and the localization process will be normal in every respect. Now, if this recording is played for a listener wearing stereo headphones, only one ear will hear the event, and the resulting localization will be unnatural.

Bauer's solution to the problem is to introduce crossfeed between the channels in such a way that the resultant phasors for an event in, say, the left channel will be equivalent to the phasors of a sound source located 45 deg. to the left of the listener's plane of symmetry. With the Bauer circuit the listener will actually sense the direction of exclusive events in either channel as either 45 deg. to the right or to the left; without the circuit he is merely confused.

Bauer's calculated crossfeed is based on head diffraction of Wiener[4], shown in *Fig.* 1. The graphs show the level differences and time delay of sounds received at each ear for a source 45 deg. to the left of the listener. The circuit used by Bauer to approximate this diffraction is given in *Fig.* 2.

Because of circuit symmetry the crossfeed action is the same for both channels, and all sounds in the recording regardless of their mutual exclusion in the recording process, will appear with the Bauer circuit as they would with stereo speakers located 45 deg. to either side of the listener's plane of symmetry.

If a third microphone has been fed equally into both channels (a fairly common technique in stereo recording), then its virtual source will be on axis, the same with the Bauer circuit as without since by symmetry there is no crossfeed when equal voltages are fed by the sources.

Another case which should be mentioned is the use of microphones whose pickup patterns overlap. Where there is significant signal mutuality between channels resulting from overlapping pickup patterns, the resultant magnitude differences and time delays make a precise phasor analysis difficult. But listening tests bear out what is suspected—that the virtual sources for these events always tend toward the center of the ±45 deg. allowable angle.

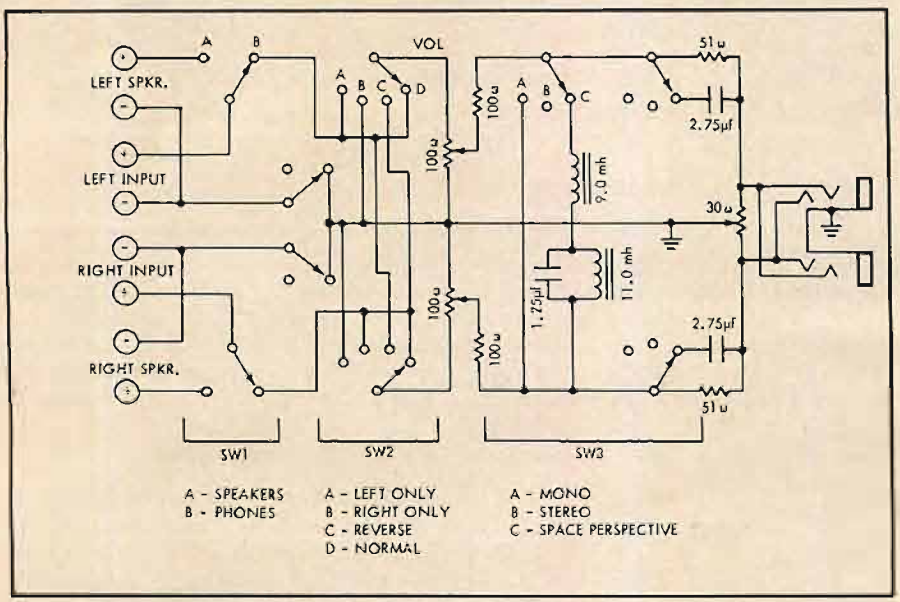


Fig. 4 Schematic of Jensen CC-1.

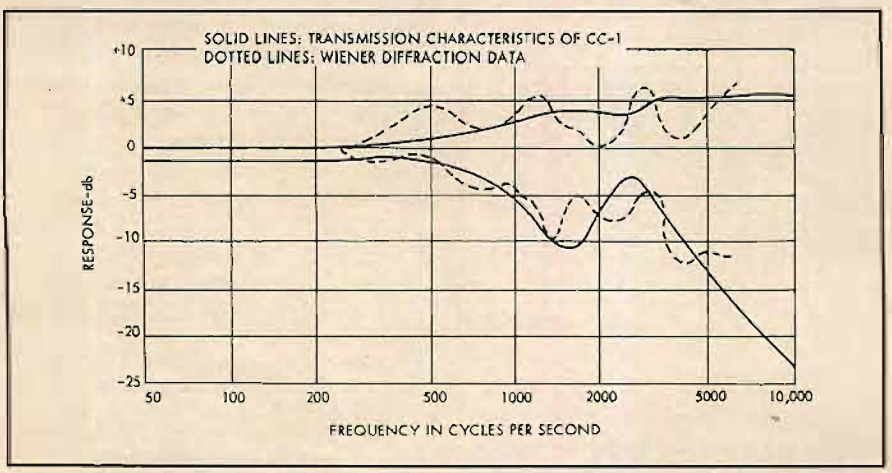


Fig. 5. Wiener diffraction data compared with transmission characteristics of CC-1.

Application of the Bauer Circuit

The Bauer circuit principle has been incorporated into a control center for stereo headphone listening (by Jensen under the name Space Perspective[5] and Model number CC-1). The control center is normally introduced into a high fidelity system following the power amplifiers. One of its five controls feeds the incoming signals to either loudspeakers or phones. The others affect only the phones, providing left-only, right-only, stereo, and stereo-reverse operation, with or without Space Perspective, and permit adjustment of balance and over-all listening level.

The commercial control center is shown in *Fig.* 3 and its schematic in *Fig.* 4. It can be located in a chair-side position by the use of the proper length of cable. The multiplicity of controls allows complete flexibility in listening to all kinds of recorded material and in demonstrating the unit's salient feature, space perspective. For example, either channel can be heard easily with or without crossfeed so that its effect can be clearly observed.

(Continued on page 89)

[4] Francis M. Wiener, "On the diffraction of a progressive sound wave by the human head," *J. A. S. A.*, 19, pp. 143–146; 1947.

[5] TM. Jensen Mfg. Co.

THIS MAN is *not* disturbing his wife while he listens to a stereo concert . . . and he's sitting out in the audience where he wants to be . . . *not* in the middle of the orchestra (where he'd be with ordinary headphone stereo). Right by his hand he can control volume; adjust left-right balance to suit the music source and the best hearing conditions for him; switch from mono to stereo, or stereo with SPACE-PERSPECTIVE*; individually select and/or reverse channels; switch speaker system. 'Phone jacks for two. All this in Jensen's new CC-1 Headphone Control Center with SPACE-PERSPECTIVE . . . an attractive, compact, versatile unit you can place anywhere . . . even hang on the wall.

What makes the *extra* difference is SPACE-PERSPECTIVE . . the amazing headphone development which approximates more closely the sensation of listening to a stereo speaker system in a room. In ordinary headphone listening, left channel sound is confined to the left ear, and right channel sound to the right ear. In stereo speaker listening, sound from the left speaker reaches the left ear *and also* the right ear by means of the natural diffraction of sound waves around the head; and right speaker sound will reach the left ear in the same manner, thus resulting in what we all recognize as natural stereo sound in realistic perspective. SPACE-PERSPECTIVE adds this diffraction, which is missing in ordinary headphone listening, by electrically cross-feeding sound from one channel to the other to simulate the passage of sound waves around the head. You are now "in front of the speakers" via headphones . not in the middle where the sounds are isolated to each ear.

The CC-1 will operate with some other stereo headphones . . . but for best results the Jensen HS-1 'phones are recommended . . . the new professional stereo headphones which offer the most advanced features for top acoustical performance and comfort. The CC-1 Control Center sells for $39.95 . . . HS-1 Stereo Headphones for $24.95 . . . and a CFN-1 SPACE-PERSPECTIVE network only, with input jack, for $19.50. Write for Brochure MH. Jensen Manufacturing Company, Division of The Muter Company, 6601 S. Laramie Ave., Chicago 38, Illinois.

*T.M. Licensed by CBS Laboratories Division, Columbia Broadcasting System, Inc.

LIGHT LISTENING

(*from page 8*)

Three with its performance of *Sleigh Ride* that some sonic activity becomes noticeable on the outlying ends of the listening region. The rest of the record is satisfactory in stereo spread with *Jazz Pizzicato* placing the violins all the way to the left border. Anderson's *Syncopated Clock* has its numerous horological sound effects well scattered for maximum effect and the spoofing of some of the more pompous symphonic fare in *Classical Juke Box* takes place within a large enough orchestral layout. If this release had been given something like the conventional Pops miking, it would have been the final word on the subject of Leroy Anderson. The Boston Pops has always been the home base for his music from the time he first attracted national attention as one of its arrangers and orchestrators. As matters stand now, we have performances that should take care of these tunes indefinitely but I cannot avoid the conclusion that the stereo is by no means the best that RCA can give us.

Touchdown, U.S.A.

Vanguard Tape VTC 1647

In many cases today the tape version of an outstanding recording (and some not so outstanding) appears several weeks after the disc version has hit the market. For some unknown reason, United Stereo Tapes never got around to issuing this exceptionally fine collection of football marches played by the University of Michigan Band which Vanguard Records brought out on disc one year ago. Since the demand for football songs doesn't seem to be a ravenous one out of season, UST decided to hold off the tape until this current autumn sent us back to the nation's stadia. Record collectors are well aware by now that the University of Michigan takes its band activities very seriously. 350 players in all are to be found in the three divisions of the enormous enterprise referred to as the "University of Michigan Bands." One division is the Marching Band, busy at all home football games and travelling with the team when it invades enemy territory. Another group is the Varsity Band which takes care of basketball games and other functions on campus. The band heard here is the University of Michigan Symphony Band. This is the top aggregation at the oldest of the "Big Ten" universities. It was the first major university band to give extensive nation-wide concert tours. In the spring of 1961, the band gave 88 concerts during a fifteen week tour of Eastern Europe and the Middle East sponsored by the U.S. Dept. of State as part of the International Cultural Exchange Program. It was hardly surprising, therefore, that the band's record of a year ago offered something quite special in the treatment of seventeen football marches which included representation of each university in the "Big Ten." The present reel version is sure to delight any tape fan carrying around a pulse still capable of being accelerated. Already announced for release this fall are two more recordings by this outfit on the Vanguard label—"The University of Michigan Band on Tour" and "Sousa." They'll be worth watching for.

Anything Goes

Epic FLS 15100

Nearly thirty years after its first appearance on Broadway, Cole Porter's famous musical is now a New York off-Broadway attraction. In bringing "Anything Goes" to records, Epic gives us our first opportunity to hear this brash favorite of the Thirties in performance by a cast that has actually faced an audience. The young players of the 1962 production can hardly be expected to erase the memories that some of us still retain of the original star-studded cast that was headed by Ethel Merman, Victor Moore, and William Gaxton. This album's cast faces less competition on records than it does back in the annals of the theatre. For many years, we've had to be content with the partial glimpse of the show that had been revealed to us on records in Mary Martin's widely admired mono album—Columbia M4751. In that release, Miss Martin covered a surprisingly large portion of the score in performances delivered with the assistance of an orchestra and chorus under the direction of Lehman Engel. It is perhaps worthy of passing remark that this new Epic production covers only three more songs from the score.

Eileen Rodgers, last seen on Broadway in "Fiorello" and "Tenderloin," is the star of the latest revival. Her singing style, although not as poised as Mary Martin's, does come closer to the burnished sound that Ethel Merman once brought to the familiar lyrics of *You're the Top, Blow, Gabriel, Blow,* and *I Get a Kick Out of You.* Mickey Deems, the comedy director for the current TV hit, "Car 54, Where Are You?" appears in the role made famous by Victor Moore. As Public Enemy Number 13, Deems has his major solo moment in *Be Like the Bluebird.* The producers of this revival evidently felt the need for an added quota of Cole Porter tunes to bolster their production. They have interpolated a fairly large total of six other tunes that appear in Porter shows that preceded and followed the initial Broadway appearance of "Anything Goes." Since the Epic release closely follows the stage production that has been running in Greenwich Village, it is something of a shock to encounter on board the "S.S. America" such other Porter diehards as *It's Delovely* from the 1936 show "Red, Hot and Blue," and *Friendship* from the 1939 opus "Dubarry Was a Lady." The sound of the small orchestra under the direction of Julian Stein is typical of the smaller outfits generally found in theatres below Manhattan's 14th Street. Once you get used to it, you'll scarcely miss the flossier pit bands that are taken for granted on the Main Stem.

Ethel Merman

Reprise R-6032

Della Reese: Della on Stage

RCA Victor LSP 2568

It's a pleasant coincidence to encounter a new Ethel Merman album during the same month that her old show, "Anything Goes," is revived on records. Listening to Miss Merman's recollection of the great songs of her career, including three tunes from that Cole Porter classic, it is somewhat staggering to realize that 32 years have gone by since the first Merman show made her name a byword in the entertainment world. No attempt is made in this album to follow a precise chronology of her musicals despite the fact that the opening tune is *I Got Rhythm* from the production that introduced the Merman style to musical comedy audiences—George and Ira Gershwin's "Girl Crazy." During the rest of that fantastic Thirties decade, Ethel Merman appeared in a total of seven Broadway musicals. A top star in those days evidently had no problem finding a new show. As soon as one production showed signs of faltering, another one was waiting to make use of her talents. In addition to Porter, Miss Merman worked for many leading song teams of the day . . . Henderson and Brown, Richard Whiting and Buddy DeSylva, and Arthur Schwartz and Dorothy Fields. The only item in this collection not usually associated with the singer is the sentimental ballad *But Not For Me* from the score of "Girl Crazy." Miss Merman obviously welcomed the opportunity to choose some of her own repertory today after all these years of being assigned a fairly specialized type of song. Billy May, long associated with a rhythm of hard-driving bounce, was a logical enough choice to arrange and conduct the selections heard in Ethel Merman's first appearance with a swinging orchestra.

Della Reese, in her latest RCA album, reverses the procedure followed in the Merman release. Instead of moving from the footlights to a recording studio, Miss Reese moves a specially invited audience into the large studio at Manhattan's Webster Hall where she proceeds to beat them into a happy pulp with her hammering delivery of a collection of standards, spirituals and blues. With the exception of *Someday,* her special hit on single records, none of the material heard here has ever been recorded before by Della Reese. A bonus for her more ardent fans is the running stream of encouraging patter she provides between selections.

Dick Liebert: Great Love Themes

Reprise 9-6037

During all the years Dick Liebert has been busy at the console of the Radio City Music Hall organ, he has invariably reached his largest audience after the last show of the day was over. His recording sessions generally begin after midnight as soon as the vast auditorium has been abandoned by the day's audience. During the all-night session that gave Reprise this record, a crew of sixteen technicians worked with Liebert to get on tape the subtle shadings of a program devoted exclusively to music designed for late evening listening. This is one of the few organ records around that doesn't include a novelty or two for change of pace. If you have no objection to one mood sustained throughout an entire record, this could be your dish. Some organ fans, on the other hand, may appreciate a word of warning about the undeviating nature of a program that never moves far away from the *Moon Love* and *Lamp Is Low* sort of thing. Liebert gets around the problem to some extent in his choice of keyboard voices. Many of the tunes spotlight the organ's equivalent of string instruments. A cello is imitated in *Till the End of Time,* a viola during *Full Moon and Empty Arms* and a violin in *Tonight We Love.* A Mason and Hamlin piano, wired to the organ's keyboard at a reputed cost of $25,000, repays some of that investment in the course of *Song of Love* based on Schubert's "Unfinished Symphony." Technical proficiency in the processing of the disc could best be described as almost tops.

Martyn Green: The Gilbert and Sullivan Songbook

MGM Tape STC 3980

There are instances when the tape version of a release is superior to the disc and this happens to be one of them. When this collection of Gilbert and Sullivan songs first made its appearance on discs toward the close of 1961, it made only a moderate stir in record circles. It's hard to predict how many new rooters this album will attract in tape form but I'll venture the opinion that most listeners familiar only with Martyn Green's MGM record will get an added kick when they hear his virtuoso performance on tape. The clean processing accorded this reel, combined with sensible balance in equalization, gives tape an unusual opportunity to demonstrate what it can do in bringing out the subtlety of inflection a real singing actor is capable of in the later stages of a long career. It may surprise even those G and S fans who used to look forward to each of his famous 78-rpm albums that Martyn Green has been speaking and singing the lyrics of Sir William Gilbert for thirty-eight years. No one is better qualified to instruct our generation in the finer points of recreating an era filled with characters who managed pomp in any circumstance. The British recording crew treats Green with obvious affection. Since he is pretty much the whole show, the engineers were able to work much closer in each song than they would have in a recording session employing a full cast in a complete production. When Green launches into

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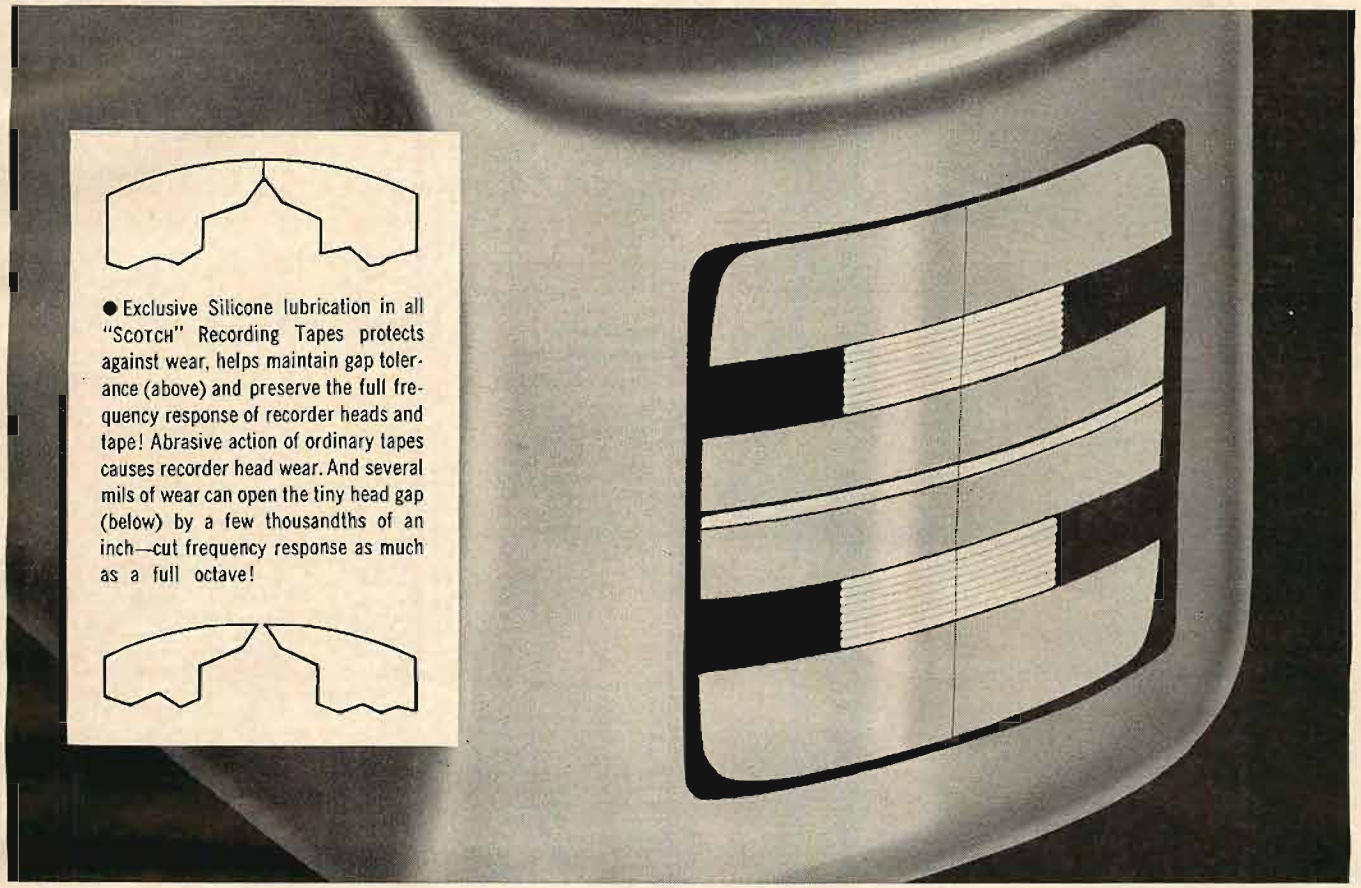

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some of his choice specialties from productions such as "Pirates of Penzance," "Princess Ida," or "Trial by Jury," this tape seeks out each tiny quaver in the portrayal of character. Here's one recording of G and S operettas that requires no libretto to assist the listener in following the lyrics. Since no single performer could be expected to convey the atmosphere of the eight productions represented here, June Bronhill and Andrew Gold take care of some of the roles whose paths happen to cross that of the characters portrayed by Martyn Green. Ornadel leads the orchestra in arrangements by Robert Creis that restore much of the freshness this music once had before it became encrusted with years of half-hearted performance by high school orchestras. While in no way a complete substitute for the full-length G and S productions available to tape fans on reels issued by London Records, this tape is bound to be one of the most frequently played items in any Gilbert and Sullivan library.

George Chakiris

Capitol ST 1750

James Shigeta: We Speak the Same Language

Choreo AS-7

Two young motion picture luminaries make their solo debuts on records this month. In doing so, they underline once more how dependent the record companies are on the initiative of the movies when it comes to spotting and developing new talent. Chakiris comes to records after a whirlwind climb in show business that began to gain its real momentum after a twenty-month run on the London stage when he was selected to play the role of Bernardo in the recent film version of Leonard Bernstein's "West Side Story." Along the way, Chakiris hasn't had too much opportunity to smooth out every wrinkle in his singing style. His breath control is apt to get a bit out of hand in more formal music such as Victor Herbert's *I'm Falling in Love with Someone* which calls for considerable poise on the part of the performer. Quite understandably, he has his best success in the two excerpts from "West Side Story" . . . *Tonight* and *Maria*. Another Broadway production, the top-ranking "How to Succeed in Business Without Really Trying," provides a good clue to Chakiris' future handling of show material in general. In *I Believe in You*, by no means the easiest song Robert Morse hammers home in that hit score, George Chakiris puts on display the warm showmanship of a rising star. He'll bear watching.

The Choreo label distributed by MGM Records introduces a promising new talent in the person of Hawaiian-born James Shigeta. His career so far points up the value of going Horace Greeley one better and moving west from his native land—all the way to Japan. After a stint at New York University—where he discovered that music was more important to him than creative writing—Shigeta took his first step toward a professional career when he placed first in a Ted Mack Amateur Hour. The Korean War soon had him in a Marine uniform. When he abandoned his Staff Sergeant stripes two and one half years later, Shigeta started singing again and accepted the lead in a musical revue to be produced in Japan. In that somewhat improbable spawning ground for a film career, he found an entrance to Hollywood. Jim Shigeta became the toast of Japan on the basis of his record of *Love Letters in the Sand* which sold more than two million copies. After that it was a short step to Japanese television and stage shows with the aid of a tutor hired to help him unravel the mysteries of an Oriental language. When word of his unusual achievement reached the States, he was engaged to appear with Shirley MacLaine on the Chevy Show. Then followed American screen appearances in "The Crimson Kimono," "Walk Like a Dragon," "Bridge to the Sun," and his first American film singing role in "Flower Drum Song." With a list of credits that long it's no wonder that Shigeta turns in a recording that is heads and shoulders above the usual debut release.

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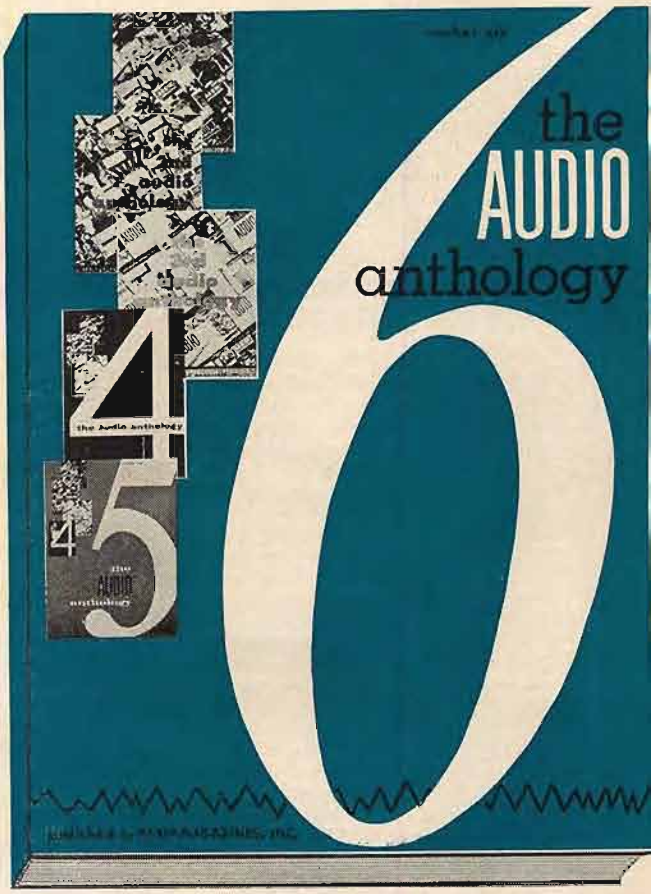

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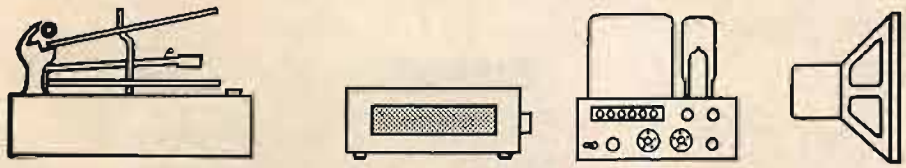

HEATHKIT STEREO TAPE RECORDER, MODEL AD-22

The Heathkit Model AD-22 tape recorder is a 2-track machine designed to record and play 4-track mono and stereo, with record bias and audio output being supplied from the built-in preamp. The AD-22 is supplied in kit form (or preassembled), and is a kit in the old sense of the word—the only parts that are preassembled are the capstan bearing assembly and the main wiring harness. Of course we are all aware of the trend to package and partially assemble kit units, to the extent that some normally complex kits can be assembled in a mere handful of hours. This latter category is really quite ideal for the audiofan who wishes to save a little money and also get a much closer look at the insides of his audio system. On the other hand, the experienced audiofan who wishes to save more will gravitate towards the less elegant package such as this Heathkit unit.

For example we found, on opening the box, that all the small parts were dumped into two moderate-size brown-paper bags. Of course the experienced builder immediately sorts out the parts in some neat array—in fact this procedure is suggested in the manual. On the other hand, it is not difficult to imagine the reaction of the less experienced builder; the hopeless feeling when confronted with a jumbled mass of parts which are not familiar to him. For the latter reason we would suggest that the less experienced builder would be wise to be prepared emotionally and have sufficient available time before tackling this kit.

Insofar as time is concerned it took us just a hair over 16 hours to get the AD-22 put together and operating correctly. It would have taken us somewhat less but we found the mechanical *readjustments* rather time consuming. We will go into that aspect later.

On the whole, we found the AD-22 to be a good performer, basically satisfying the need for a moderately priced tape deck. In addition, the AD-22 is a very uncomplicated and relatively rugged machine which should provide a good level of performance for a long time.

Mechanical Circuit

The driving power for the mechanical system is supplied by a single-speed induction motor which is coupled to the capstan by means of a round rubber belt. (Actually the motor drives a rather substantial flywheel which in turn drives the capstan.)

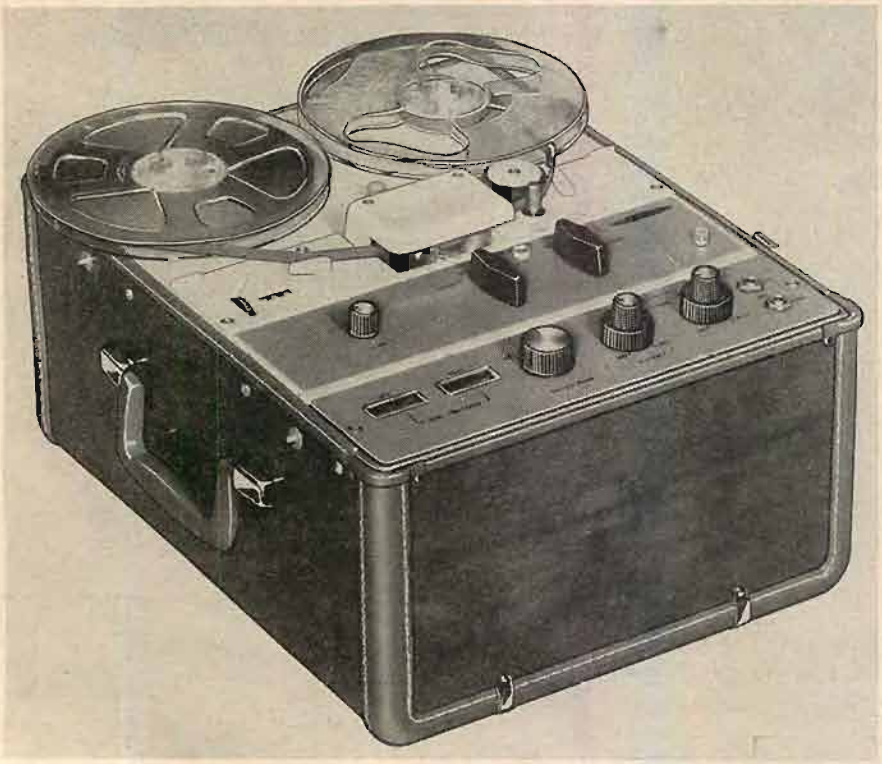

Fig. 1. Heathkit stereo tape recorder, Model AD-22.

The AD-22 is a 2-speed machine and speed selection is achieved by raising or lowering the shaft just to the rear of the head cover—in the up position the speed is 7½ ips and down it is 3¾ ips. The capstan speed is determined by the size ratio between the motor pulley and the capstan flywheel: the motor pulley is two-stepped, the smaller step being for 3¾ ips and the larger for 7½ ips. This system of moving the belt from a larger to a smaller diameter (7½-to-3¾ ips) requires a belt which does not stretch, a stringent requirement. On the other hand it has the advantage of being unusually simple. Also, the speed that would suffer if the belt stretched is 3¾ ips which is not a serious loss in many cases. The method whereby the belt is shifted is also rather simple: the shaft which projects above the deck moves a forked finger that straddles the belt, and the belt moves down or up to follow if the motor is rotating.

In the play or record positions, the tape is clamped to the capstan by the capstan idler thus moving the tape toward the takeup reel. At the same time the takeup reel is driven forward by a belt which runs between it and a pulley mounted below the capstan idler. Thus the motion of the capstan is transmitted to the capstan idler and from there to the takeup reel. Head pressure is achieved by means of a spring-loaded compliance arm between the capstan and the takeup reel and also by a holdback arm whose felt face presses the tape against the tape guide located between the supply reel and the head assembly. There are no pressure pads to grind the tape across the head. Also there are no tape lifters to take the tape away from the head during fast forward or rewind.

Fast forward is accomplished by mechanically shifting the takeup brake drum so that it presses against a rubber surface on the motor pulley. Rewind is accomplished by pressing the supply brake drum against a rubber-faced idler which in turn presses against a smooth surface on the motor pulley.

The forward oblique rewind control may be turned from one position to the other without pausing for the neutral position so that the tape may be "jockeyed" easily to locate a particular passage. The play control however is locked in neutral when the forward oblique rewind control is being operated. This precaution is necessary to prevent the tape from being broken by switching too fast from rewind to play.

In essence then, the mechanical circuit consists of a single-speed induction motor driving the capstan system by means of a belt in order to reduce flutter, while the fast speeds are direct or idler driven to accomplish their mission as quickly as possible. The concept and execution are simple.

Electrical Circuit

The electrical circuit for the playback preamplifier is extremely simple since it is very limited in function; all it has to do is amplify the signal from the playback head, produce the proper NAB playback equalization, and send this signal out to the rest of audio system in proper style. To accomplish these simple purposes, the preamp utilizes three stages of amplification (actually three tube sections V_{1A}, V_{1B}, and V_{2A}) and a cathode follower output stage, V_{2B}. (We will not make mention of tube types since the only type used in the preamp is the 6EU7, a twin triode.) NAB equalization is applied at V_{1A} with the internal resistance of the tube and its plate-load resistor being part of the equalization circuit. It should be noted that special attention is exhibited in the low-level stages in that low-noise resistors are used in the cathode

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When we termed our loudspeaker "dangerous," we expected confirmation by experts. But we never expected everyone to agree. Always there is one dissenter. Who will it be?

It is not Audio Magazine. Quite the reverse. In their September issue, Audio said: "The EMI Model DLS-529 is a true 'bookshelf' speaker in size... and far from bookshelf in sound." As we said, the DLS-529 is dangerous because it demands reappraisal of previously-accepted standard of excellence. And please don't ask us to redesign it to make it sound like an ordinary bookshelf loudspeaker (even though it costs only $159.00*).

Too, we called our loudspeaker dangerous because its transient response reveals flaws in any equipment used with it. Audio Magazine calls the transient response "fine" and says, "(it) handles the frequency spectrum from 40 cps to 15,000 cps with realism and good precision, responding excellently to the attacks of some especially heavy piano passages." Heavy piano passages are a trial for everyone—from recording engineer to speaker designer. And the transient response must be exceedingly fine to "respond excellently" to fierce piano attack.

Audio also cites the DLS-529 for its bass, saying that the "bass reproduction is of the tight variety." Of course it is. But let Audio tell why we've designed it this way. "It avoids," the journal reports, "the overblown fullness which was characteristic of some speaker systems not many years ago."

A word to the stereo-minded about high frequency dispersion. This function is the way sound "fans out" from the drivers. If it's narrow, the stereo effect is poor. Audio Magazine noticed that the DLS-529's high frequency dispersion is "unusually smooth and rather wide." Audio also said, "As might be expected, a pair of (these units) provides really excellent stereo coverage."

And there you have it from the experts—unsolicited, unqualified, undeniable confirmation anew of the dangers of the dangerous loudspeaker.

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and plate circuits of the first two stages in each channel. In addition, in these stages, d.c. heater bias and hum-bucking potentiometers are used to minimize hum.

The record circuit is, in a sense, the reverse of the playback circuit with several necessary embellishments. First of all, the record circuit accepts signals from both a microphone and/or a high-output source such as a tuner. This makes it necessary to have two sets of gain controls as well as entry point at different stages of amplification. Next it has a VU-type meter for monitoring the input signal in each channel before it reaches the record head. Also record bias is necessary to enable the signal to be recorded on the tape with minimum distortion; this requires a bias oscillator. An erase head is provided so that the tape carries no signal by the time it reaches the record head. Finally, the recording curve (on the tape) is the inverse of the playback curve; if the two curves were "added up" the resultant curve would be a straight horizontal line. In addition, record equalization is different for the two speeds at which this machine can record, and thus additional circuitry is necessary.

We will not give a stage-by-stage description of the record circuit because it is rather straightforward and without any especially distinguishing characteristics. We should mention, however, that the bias oscillator tube is a 12AU7 and the oscillation frequency is 75,000 cps.

The power supply utilizes a full-wave voltage doubler followed by a four-section filter network for the B-plus voltage.

Construction

Previously we noted that a certain amount of experience might be helpful in constructing the AD-22. We were referring to the money-saving packaging concept which Heath pioneered. In addition to parts handling experience, a certain amount of mechanical *savoir faire* would be extremely helpful too. Let us hasten to say that this is not a criticism of the kit but rather an awareness of the inevitable mechanical adjustments and the difficulty in performing some of them on a completed unit. It's not just a matter of patience, that's not the type of experience we were referring to, but more a matter of being able to visualize how parts interrelate.

For example, we experienced some difficulty getting the rewind functioning properly. First we consulted the manual in that special section devoted to difficult problems. Unfortunately all the advice and analysis offered failed to locate the difficulty. Then we just propped the machine up so that the recalcitrant area was clearly in view and proceeded to operate the rewind control. Then the cause of the difficulty became clear: the arm which is supposed to move the rewind brake drum in contact with the idler was not moving far enough. It was then a matter of locating the point where the arm had become snagged. This turned out to be not as easy as we expected; the arm had gotten off its track in a rather hard-to-see way. Anyhow, the point of all this is that mechanical adjustments can be more complex than appears on the surface and being able to visualize operation is helpful.

In spite of the previous discussion, the AD-22 is really rather simple to build, both mechanically and electrically. The mechanical assembly was not in any way complicated by "tight corners" or difficult-to-understand directions. To the contrary we find the instructions concise and unambiguous.

Electrically, the AD-22 went together with extreme ease. Contributing largely to this is the printed circuit board which mounts most of the preamplifier circuitry. Another major time and temper saver is the prefabricated harness for the power supply and oscillator chassis; the wires are all neatly laced in position with breakouts at the proper locations to make wiring simple. A rather neat innovation in the manual is the combination of pictorial and procedure in assembling the components to the circuit board; the step-by-step procedure surrounds the pictorial of the board with arrows leading from the assembly step to the component location on the board.

The use of illustrations in the manual is almost lavish when compared with the type and number found in manuals a few years ago. On the other side of the ledger, we found some of them inconveniently placed.

As mentioned previously, it took us 16 hours to assemble the AD-22 with a certain amount of the time consumed by readjustments. We feel that is not likely that the mechanical adjustments will be completely correct until the entire unit is assembled (we are not referring to the difficulty we described before). In reality the possibility of checking mechanical operation is not suggested until after the electrical assembly has been completed and installed. We would suggest that the motor plug be installed and plugged into a power source, the knobs installed and the unit checked prior to starting the electrical assembly. For one thing, the mechanical "picture" will be fresh in mind, and second it will be easier to get at the mechanism.

Performance

The most significant characteristics for a tape recorder and playback machine are accurate speed, low distortion, high signal-to-noise ratio, wide frequency response, and good separation between channels. In addition, an important characteristic is the way the machine handles tape.

In all these areas the Heathkit AD-22 performed well, easily meeting the published specifications. (We would like to point out that we have never tested a piece of Heath equipment which didn't meet all its published specifications easily —and the specifications are invariably well defined and valid.) In the area of speed accuracy we found it to be within 1 per cent at 7½ ips, and at that speed wow and flutter was 0.18 per cent. The harmonic distortion was specified with a 400-cps signal using NAB procedure, and with these conditions the distortion was 0.84 per cent. At the same recording level used in the distortion test, signal-to-noise ratio was 47 db and channel separation was 40 db. Frequency response at 7½ ips was within 3 db from 40 to 15,000 cps as specified although over most of the range it was within 1 db. The playback equalization was within NAB limits.

There are no published specifications for tape handling capability, but from our experience we would classify the AD-22 as a machine which handles tape well. That is, it had positive control of the tape under all running conditions, and it handled the tape gently. It should be pointed out again that this machine does not use pressure pads at the head and thus should have less head wear than machines that do.

In sum, we would rate the Heathkit very well for its performance characteristics in its category, suitable for the kit builder with some experience. It could also be appropriate for the less experienced builder with good mechanical ability. In either case, at its price it is an excellent buy.

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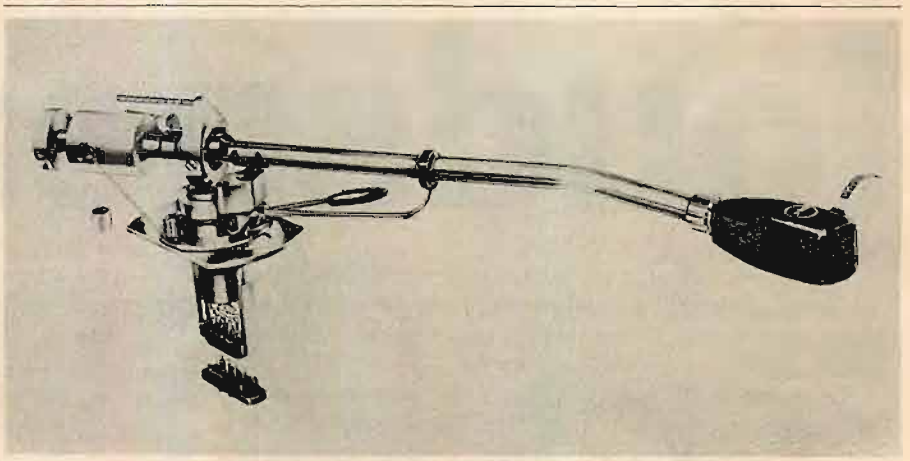

Fig. 2. Shure-SME tonearm, Model 3009 Series 2.

SHURE-SME TONEARM, MODEL 3009 SERIES 2

For the past year or so, the name SME has cropped up whenever fine tonearms were the subject of conversation. This English firm has now become associated with Shure Brothers, a name known and respected in this country mainly as a manufacturer of top-quality cartridges. (In reality the Shure people also make a very fine arm in their own right, which we have reported in the past.) Thus we see two excellent reputations joined and, as well shall describe more fully, a happy marriage it is.

First a few descriptive words about the arm. The Model 3009 Series 2 is essentially the same 9-in. SME arm we have heard about except that it now sports a rather simple "bias adjuster" which compensates for what we call "skating" force—the tendency of the arm to move towards the center of the record and thus exert more force on the wall of the groove closest to the center. The cause of this "skating" force is the friction between stylus and record in combination with the offset of the arm, which produces a turning moment about the vertical pivot towards the center of the record. The bias adjuster applies an opposing force and it is adjustable to compensate for the stylus force.

The Shure-SME arm is one of the few we know of which compensates for this inward force (we can think of only three offhand). Some people have wondered as to the importance of this adjustment with arms that can track with stylus forces of 1 gram or even less. In fact, it is our understanding that the SME people were in the doubting Thomas category until they

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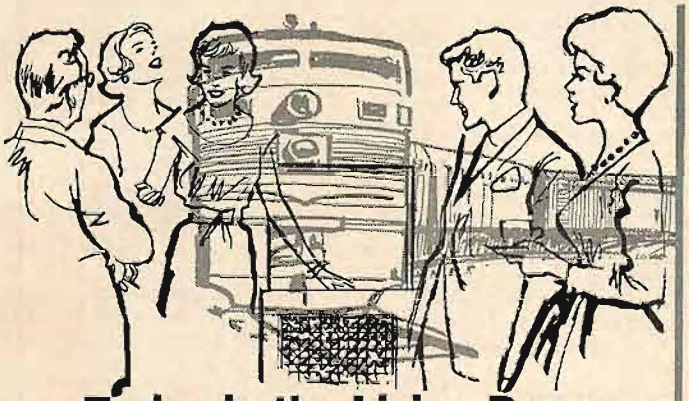

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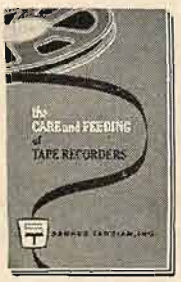

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studied the problem in their labs. The point is, if you are going to the trouble of producing an extremely fine tonearm, as these people evidently have, it is important to eliminate every conceivable form of distortion you know about—and that goes double for stereo.

The Shure-SME Model 3009 uses knife-edge bearings to achieve the effect, and close to the precision, of a laboratory balance. The very low friction of this type of bearing is an important factor in the ability of this arm to track with a stylus force as low as a ½ gram with a properly compliant cartridge. Of course these knife-edge bearings are used only in the vertical pivots, but the horizontal pivot bearings are extremely low in friction too.

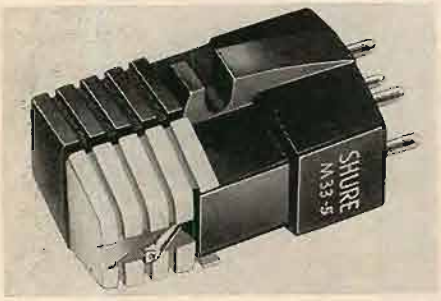

Fig. 3. Shure stereo cartridge, Model M33-5.

An interesting and very useful feature of the Model 3009 is the built-in "dashpot" for gently lowering the arm to the record. (For those who are not familiar with technical English, a dashpot is a hydraulic cylinder which acts as a very gentle brake. With this device it is possible to lower the stylus much more gently than the usual audiofan can manage. And raise it too.

Aside from low bearing friction, a high-quality arm should have no resonance points, or if it does they should be well outside the audible range and damped. We found that the Shure-SME arm showed a peak at about 12 cps. Although this resonance is somewhat higher than we expected of this arm, it was well damped by the fibrous filler inside the arm; certainly it is attenuated sufficiently to be ineffective in the audible range.

One of the problems with this arm is the rather large hole required for installation which creates a good deal of difficulty if the turntable base plate happens to be fairly heavy-gauge metal as ours is. On the other hand, the advantage gained by having the extra space for optimum positioning of the arm more than offsets the inconvenience. Using the protractor provided, the arm is set for minimum error (0-deg.) in the inner grooves and increasing to a maximum error (1½-deg.) at the outer grooves. The advantage of this arrangement has been noted in various places including the pages of AUDIO. The range of adjustment on the baseplate is 1 inch.

The plug-in shells of the 3009 will accept any standard cartridge and the plug-in scheme is similar to the one used on the Ortofon arm so that we would imagine that the shells are interchangeable. Probably the ESL shell would fit too. The leads from the shell terminate in a four-pin socket which mates with a four-pin plug-and-harness terminated on the amplifier end with phono plugs. The entire socket and plug are shielded by a large metal can.

The stylus force is adjusted by means of a small weight riding on a calibrated bar parallel to, and just forward of, the counterweight. The calibration weight comes in two sections; with both sections on, the calibration marks indicate ½-gram steps, the range being from ½ to 5 grams; with one section removed, each step indicates ¼-gram steps and the range is from ¼ to 2½ grams. We were unable to check the ¼-gram setting, but from ½-gram up we found the settings accurate.

The Shure-SME 3009 permitted us to track well with the Shure M33–5 cartridge at 1½ grams althongh the manufacturer recommends 2 grams. Also we were able to track well with another high-compliance cartridge at ¼-gram less than we had been able to achieve in another high-quality arm.

In summing up the over-all excellence of this arm we must mention the all-stainless steel construction which makes the arm look as well as it performs. The Shure-SME arm is not inexpensive. In fact it is one of the most expensive arms of its type on the market; another example of the fact that quality products exact their due (price). L-21

SHURE STEREO CARTRIDGE, MODEL M33–5

Recently we received a notice to the effect that Shure Brothers had been awarded a patent for the moving-magnet cartridge which they released in 1957. That cartridge, the now famous M1, is the antecedent of the cartridge we are looking at today, the M33–5, and most likely a whole host of moving-magnet cartridges. Certainly that first stereo cartridge from Shure was as historic, in its way, as the stereo record. The M33–5, although not quite as historic, is indeed a "state of the art" device; it contains all of the desirable advances that the designers have uncovered since the M1 was introduced. These advances include very high vertical and lateral compliance (20×10^{-6} cm/dyne), low stylus mass, excellent shielding against hum being induced from ambient sources, and considerably higher output. Of course it is too much to expect this cartridge to be as superb as the M1, but it certainly is in the front rank both in performance and sound.

Performance

It is quite obvious from *Fig.* 4 that the M33–5 has an excellent frequency response (please note that the test record used, CBS STR-100, uses a constant amplitude characteristic below 500 cps while the RIAA characteristic does not; therefore the curve below 500 cps should properly appear as a delightfully smooth line which tilts down instead of up). Separation is also good, being slightly over 9 db at 13,000 cps, and over 20 db throughout most of the range. Perhaps the most important characteristic of the M33 is the smooth ontput it produces. To our way of thinking, smooth output whether the curve is horizontal or not, is of extremely great importance for good sound quality. We noted that the output of the M33–5 is high, and it is: 8 mv per channel at a velocity of 5.5 cm/sec. For the test we used the Shure-SME arm with the stylus force set at 1½ grams. A 47,000-ohm load was used. The maximum recommended stylus force is 3 grams.

It is useful to know that the very same cartridge is available with a 0.7-mil stylus (M33-7) rather than the 0.5-mil stylus used on the M33-5. The stylus assemblies are interchangeable so that one can convert from the M33-5 to the -7 quite easily. The advantage here is that one can use the -5 for playing stereo records and the -7 for mono LP's, thus employing the correct stylus for each task with a single change.

Listening to the Shure M33-5 proved to be the best treat of all, as we might have predicted from the smooth response curve. We found it to be a good music reproducer and perhaps the least hum-sensitive cartridge we have encountered in some time. The Shure M33-5 should please a large number of audiofans. L-22

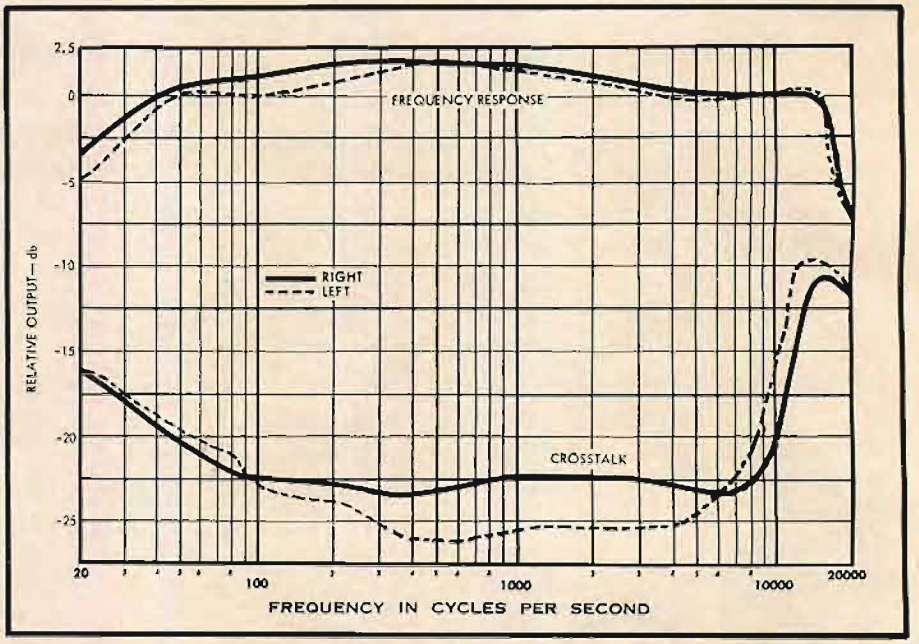

Fig. 4. Frequency response of Shure M33-5 cartridge using CBS Labs STR-100 test record.

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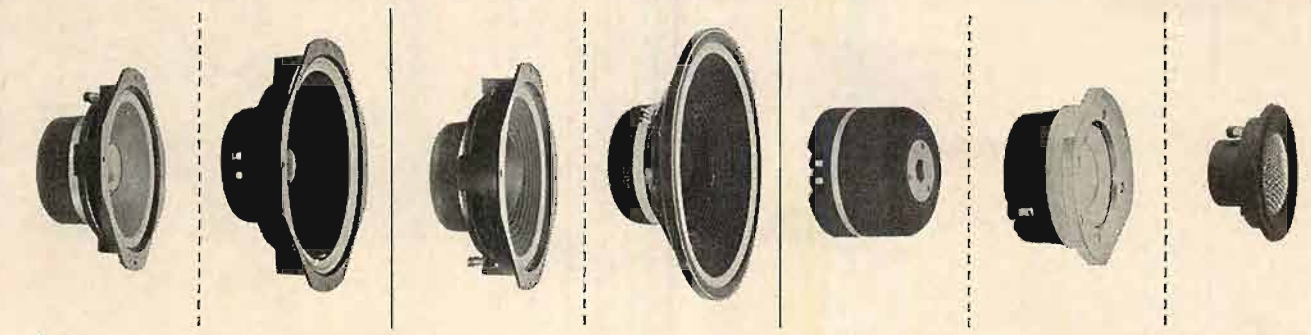

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ABOUT MUSIC

Harold Lawrence

Players Between Notes—A Behind-The-Stands Glimpse

It is 10 a.m. The orchestral players are in position. Jackets are draped over the backs of chairs, instrument cases rest open on the floor, and clouds of cigar and cigarette smoke float upward toward the stage lights. The timpanist, his ear close to the drum head, gently taps the skin and twists the tuning knobs. The oboist, (*Fig.* 1) a reed pinched between his lips, sharpens another, then sounds his characteristic barnyard cackle. The tuba player (*Fig.* 2) looks over a tricky passage in one of the scores to be rehearsed. The French horn player (*Fig.* 3) squeezes a liquid valve-cleaner into his instrument with an eye dropper. The strings, finger-limbering, produce a tonal swirl whose individual components might include anything from a Bach Concerto to *L'Histoire du Soldat*.

All this noise suddenly becomes louder the moment the conductor is seen entering the hall, a phenomenon caused by last-minute preparations. The *crescendo* is followed by a *subito piano* as the musical director mounts the podium, exchanges greetings with the players, puts on his spectacles, opens the score, raps his baton, and the rehearsal begins.

Presumably everyone should now get down to business. But what about the wind players who enter only past the halfway point of the movement, or the percussionist whose three cymbal clashes occur at bars 390–400? These and similarly unemployed musicians may, of course, count bars or wait for cues, although they usually find other things to do. For the rows of music stands fanning out from the podium often conceal activities which bear no connection to the music in rehearsal, but which need not affect the quality of the performance.

Reading is the most popular extra-musical employment. It is a simple matter for the non-player to lay a book or newspaper on his stand, out of the conductor's visual range. Paperbacks are a great boon to orchestral musicians since they are compact and, unlike hard cover books, have not been known to topple over stands. Newspapers are less easily disguised. The sheer bulk of large-city editions makes them unsuitable for mounting on music stands, although tabloids can be thinned out and folded to a manageable size. *The New York Times'* embonpoint, however, poses special problems, but these can be overcome by extracting pages of most interest.

The big readers are naturally to be found in the wind, brass, and percussion sections because of the intermittent nature of their parts. Experienced string players, however, take advantage of even short "rest periods," especially when performing a work in the standard repertoire.

Fig. 1. Oboist with reed.

Fig. 2. Tuba player reviews the score.

Conductors are certainly aware that a considerable amount of reading is done on the job. Their attitude is realistic; they shut their eyes to it, hoping that the players will have the good sense to be discrete. However, when confronted by a "flagrant" reader, they have no alternative but to kick up a fuss. Several years ago, a composer of light music who occasionally indulged in conducting, was directing a rehearsal in New York City. His stick technique was primitive, but the repertoire was of the familiar "pops" variety which caused no anxiety among the musicians. The maestro did little more than beat time, except in the case of one piece, which he conducted with what was for him a dramatic flourish. The work featured a cymbal clash at bar 237. For this he was ready with one of the few cues of his career, and his baton whipped the air. The percussionist, who had recently invested heavily in the stock market, was anxiously studying the reports in the newspaper spread out over his table, and had missed the cue. The conductor immediately called a halt and inquired: "Say, what about the cymbals at bar 237?" In *prestissimo* tempo, the player folded the newspaper, dropped it to the floor, and, with perfect sangfroid, replied: "You want it louder, maestro?"

A sign on a Washington, D. C., newsstand warns the passersby that "Excessive reading will not be tolerated." The quick-thinking percussionist may have convinced our dilettante conductor that he had indeed played his part, but here was a clear case of excessive reading.

The orchestral player's reading matter extends from newspapers and magazines to Proust, languages, electronics, and crossword puzzles. The clarinetist, for example, whose lips are moving as he seemingly examines his music part, may be actually trying out a simple sentence in Russian.

Generally speaking, the first desk player does not indulge in on-the-job reading. His extra-curricular activity revolves around his responsibility as section leader, and his own artistic career. The horn leader, for instance, might keep his players in their chairs during short breaks in order to rehearse a tricky passage involving intonation or rhythmic problems. The concertmaster, for whom a new concerto has just been commissioned, may be busily working out fingering and bowing at every chance.

Fig. 3. Horn player lubricates valves.

The explosive growth of amateur photography has added a new wrinkle to the rehearsal scene. We now find cameras dangling from the necks of orchestral musicians who are self-appointed photo-journalists of their orchestra. Unlike reading, special permission for this activity has to be obtained from the conductor and the management. Some of the finest candid pictures of conductors and soloists have actually been shot from the orchestra seats.

There is no doubt that the amount and character of behind-the-stands conduct varies according to the stature and effectiveness of the man on the podium, all of which relates to the problem of discipline, a topic few conductors wish to explore in public. AE

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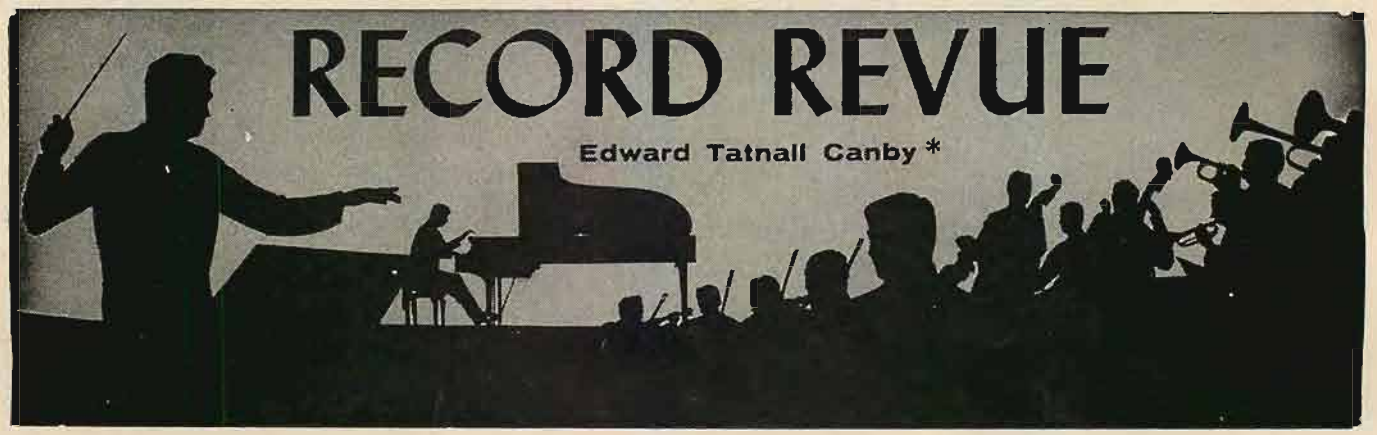

RECORD REVUE

Edward Tatnall Canby *

BAROQUE AND BACK

A Recital by the Academy of Saint Martin-In-The-Field directed by Neville Marriner. (Concerti Grossi by Corelli, Torelli, Locatelli, Albicastro, Handel.)
L'Oiseau-Lyre SOL 60054 stereo

Here's another of those pleasant British groups dedicated to old music that are a specialty on this nominally French label, associated with London Records (British Decca). These concerti are played with the proper "authentic" small ensemble, plus solo group and continuo accompaniment, in a semi-intimate style, a sound that is now utterly familiar to millions of record listeners (and radio listeners) the world over—though it still eludes the world's major symphony orchestras, which will never understand it anyhow. (Not until the symphony concert turns into a Cocktail Hour Musicale or a Night Club Coffee Seance—it would take that sort of revolution.)

The playing itself is pleasantly musical, sensitive and gentle in a British way, a bit old-fashioned in sound. Still some of that plop-plop-plop plodding articulation that used to be the official way of playing all Baroque music—not much, luckily. Enough to give the music a somewhat heavy cast, of the sort we used to think mandatory in Baroque music.

Heavy, but musical. A pleasant record.

Buxtehude: Organ Music (complete). Walter Kraft.
Vox Boxes 27, 28, 29 mono
(9 LP's)

Phew! Vox's boxes aim to be comprehensive. I did *not* play all 18 sides of this super-set. I'd like to, but please, give me a year or so. The music is well worth it.

I'm not clear as to whether Vox is reissuing these; in any case, it appears that they must have been recorded over a goodly stretch of time beginning in mono days and hence aren't technically suitable for new release in the usual fashion. So much the better—for the Vox Boxes are generally bargains at their price.

The recording is excellent, if not spectacular. I question to some extent the mike placement, which seems to me a bit too close; but this is a minor problem, leading merely to a certain lack of rapport between the echo or liveness and the sound itself. Common effect. What is more important is Walter Kraft's playing, which is technically skillful but musically methodical and unimaginative, lacking in humor and sprightliness, notably in the Buxtehude fugues with their peasant-like tunes. Buxtehude can be better than this. But a goodly part of him is here, nevertheless. I'd recommend these boxes as an excellent base, at a good price, from which one may proceed to collect and compare other performances of the music.

* * *

The complete Buxtehude organ works seem to have fascinated a surprising number of recording companies, though to my knowledge Vox's is the only "*complete*" set that has been completed. Westminster started a series, one disc at a time, in a sort of ultra-violet stereo sound. The Archive Series has the beginnings of a complete Buxtehude and will no doubt go on to the end sooner or later. The Haydn Society launched a Danish series, of which I got Volume 1 before the company stopped sending them out. (That was almost four years ago.) Even Washington, a label usually circumspect in the number of its releases, launched a complete Buxtehude, with the famous Finn Viderø. I have Vol. II, anyhow, as of 1960.

The nicest Buxtehude to date, in my estimation, is that from the tiny Overtone company of New Haven, Conn. That's because Luther Noss is a splendid Buxtehude organist, the organ is very fine, and the recording is very hi-fi, though mono. How about 8 more LP's of the same, Overtone? That'd do it.

Try These for Baroque

Vivaldi: Four Violin Concerti. Nathan Milstein; Chamber Ensemble.
Angel S 36001 stereo

Corelli: Christmas Concerto. Tartini: Cello Concerto in D. Vivaldi: Sinfonia in G. Hungarian Chamber Orchestra, Tatrai.
Monitor MCS 2056 stereo

From many thousands of miles apart, on two labels of unlikely juxtaposition, come two splendidly styled "Baroque" recordings, each impeccably played, each reflecting the very best sort of "authentic" performance of the music. It is significant, I guess, that the music is from Italy, a country which at the time of these composers dominated the musical world from Russia to America.

It is astonishing the way that Nathan Milstein has tempered his violin tone and polished his technique to project the extraordinary sound of this performance—almost without vibrato, pure, disembodied, incredibly accurate, beautifully phrased, perfectly blending with the ensemble harmonies. It is "authentic" in that this is the *only* way the music could have been intended—on sheer internal evidence. The sense falls apart under the Romantic treatment of the standard violin technique. An amazing record and every music lover should have it on hand as living evidence that the usual fat, stuffy symphonic Vivaldi is *wrong* and always was. Who said Baroque music was thick? Not here.

By some miraculous intuition, the distant Hungarian ensemble on Monitor's disc has found the same sort of tone quality for its similar music. The orchestra is somewhat larger, the performance a bit more conventional, but the sound is there even so. Another fine record for the man who wants to know what Baroque music *really* sounds like.

Variations on Popular Songs by Sweelinck. E. Power Biggs, organist.
Columbia MS 6337 stereo
(mono: ML 5737)

"Eee-power" (like air power), as most organ fanciers tend to call him, got a brand new organ for his home base in Cambridge, Massachusetts, back in 1958 and since then has been performing on it for Columbia, instead of on the world's old organs all over the place as featured in earlier Columbia albums. The change, I'd say, has not been altogether healthy. There was an enthusiasm, both verbal and musical, in Mr. Biggs' world-wide organ-sampling, a sense of stimulation afforded by the heady succession of marvelous instruments, that is lacking today in the home production. In fact, Mr. Biggs has reverted to a type of routine performance familiar for many years, out of this same building on an earlier organ, via radio and on his RCA Victor records before he shifted to Columbia.

The Sweelinck Variations are lovely. Each is based on a popular tune, some of them British, melodies that are as straightforward today as then. Each offers marvelous counterpoint and elaboration and plenty of opportunity for color-contrast, within the simple Elizabethan-period harmonies.

Mr. Biggs' trouble is not at all in registration nor in technical facility. He rips along famously, and colorfully, too. But even so, his music is mechanical, lacking in flexibility and phrasing. Mr. Biggs makes use, against all his own best theories, of a mannerism that must date from his student days among the big, soggy Romantic-period organs of British and American churches—he plays a needless and annoying staccato, separating each tone from the next. On the Romantic organs it was either this or nothing; you *had* to separate the sounds if they were to be heard. On the new (and old) Baroque-type organs, as Biggs would be the first to say, there is no such necessity at all. Why bother, then? Especially when the mannerism contributes so unpleasantly to a lack of phrasing and shaping of melodic line.

XV Century Netherlands Masters. Isaac: Music for the Court of Lorenzo the Magnificent; Obrecht: Missa Fortuna Desperata. New York Pro Musica Motet Choir and Wind Ensemble, Greenberg.
Decca DL 79413 stereo

The New York Pro Musica, with the help of some whopping foundation grants and a lot of paying audiences, turns out old music by the carload. Impossible to keep up with all their discs. This one, though, has special interest in that it introduces some of the Pro Musica's newly trained old-instrument players and their strange instruments—shawms, cornetti, Sackbuts. Also the larger choir of men and boys that now supplements the solo singers.

No question that this organization has wrenched the whole business of "authentic" music out of its complacency. The Pro Musica has a new sensation every year, born out of solid musicology, too. Their vocal works, for instance, are here accompanied by the new weird instruments exactly as indicated in old

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paintings, engravings, carvings and what-not, as well as in written accounts. No substitutes. Right from the horses' mouths. The resulting sounds are startling and probably ought to be. We mostly hear what we are used to, these days, authentic or no, not what we would have actually heard, say, in the XV century. Far from it.

Two things seem to me not very authentic in the Pro Musica production style. One is the voice quality. The Pro Musica simply has a blind spot here, for they use perfectly ordinary vocal tones of an Italian-opera or church-choir sort, quite indiscriminately, even in their high-toned countertenors. Good voices—but strictly of today. If we are to have shawms and krummhorns, and shawm players, why not train up or seek out some "authentic" voices *too*? By internal evidence in the music, by analogy, we could easily find a proper tone quality. It would, I suspect, sound like a batch of vocal crows cawing. That's what the krummhorns and shawms sound like. I like them.

Secondly, the Pro Musica's music is lovely in the slow sections, but tends to race like a batch of noisy sports cars in the fast parts, dashing the music into bits and pieces on the curves. Neither lovely nor musical, I say. Why such a tension, why so violent? Must be the atom bomb and people's New York nerves.

SOUND IN STEREO

Authentic Sound Effects, Vol. 1. Elektra EKTP 7251 stereo tape

Here is Volume (Reel) One of a series of sound effects tapes in stereo and it brings up some interesting questions.

Sound effects *discs*—not tape, not stereo, not even LP—go back to the early days of broadcasting. Their use was specific enough. Ninety per cent of it was for radio drama and for radio commercials; the rest was for "live" sound effects, in stage plays both pro and amateur. The discs weren't ordinarily found on the general home market and few of them ever got onto a home phonograph.

Then came hi-fi—and sound for sound's sake. Something new had been added and it wasn't only low distortion and wide tonal range. Suddenly, people in homes wanted sound effects *to listen to*. Crazy. But they've been getting them now for a long while. Bird songs, auto races, steam railroads, the Queen Mary, and so on.

Now mind you, "hi-fi" sound effects for listening aren't at all like the old recordings. They are louder and noisier, of course, but mostly they are much longer. LP allows it, and the customers demand it—they want enough of each sound to get the feel of it, painful or joyous as the case may be. None of those five-second dabs, please! Definitely, the hi-fi man's sound record is altogether a different affair. It's for continuous listening.

After all, the old 10-inch 78-rpm discs couldn't very well feature an unbroken half hour of steam railroading, like today. Commercial sound effects were physically limited to short passages, as brief backgrounds, to suggest a setting in minimum sound-terms. Auto drives up, stops. Beep beep. Baby cries—once. Bell rings. Door opens, closes. Thunder, one clap. Water pours from faucet, ten seconds. No sooner started than stopped, and by this means the old records managed to cover a great deal of sound-ground. You could thus find almost any effect you wanted—provided it was short.

So now we have Elektra's new tapes, hi-fi, four-track, in stereo, and the company says they are "ideal for theatre groups, home-movie enthusiasts, radio and TV stations, slide shows, industrial presentations, parties, sound buffs, and many others." Not very grammatical (many other *whats*) but you get the idea. What you'll find here is strictly the old-line type of sound effect. Dozens, mostly very short, just like the 78-rpm discs, in spite of hi-fi and stereo. They are as useful as they always were, of course. But few sound buffs are going to be amused. Too short. Too many long pauses between effects (to facilitate locating). Definitely not the sort of tape you just listen to. Don't expect to add these to your "sound demonstration" library; they are strictly practical.

If so, then a couple of cogent questions. First—why on tape?

Well, tape offers hi-fi and top stereo quality. People own tape recorders, too. On the other hand, tape is very clumsy when it comes to locating a particular spot in a hurry. That is of the essence in sound-effect recording. Otherwise, you're likely to hit the wrong spot at a crucial point in your dramatic presentation. Instead of that horrendous auto crash with the broken glass, maybe you'll get a loud cat's meee-yow, or even worse, a car *not* crashing—just driving up peaceably and stopping. That could wreck a whole year's worth of soap opera!

So if you use tape and you'll want to cue in a hurry, better check your equipment with script in hand before you go all-out. You can't just lower a stylus onto Band Five. Maybe what you'll want is an electronic spotter like that currently being offered by the Crown tape recorder people. Scrape off a bit of oxide before each item and the machine counts the scrapes, stopping precisely at any place you want. Just push the right button. Costs money, but it's infallible, they say.

Finally—why stereo? Well, stereo is a good idea for everything these days. Can't do any harm and might be darned useful. You'll have to be extra-careful, though. Auto roars by, right to left. Script calls for left-to-right. OK, just switch channels—but don't forget to switch back for the next item. Telephone rings. In the wrong speaker. Same remedy—and don't forget it, or you'll be having telephones in the darndest places by mistake. Or babies gurgling on top of red-hot stoves, doorbells ringing in the kitchen sink, dogs barking on the mantelpiece. You never know where things are going to be heard in this new spatial stereo.

Maybe the easiest way is to switch your tape recorder to safe-and-sound mono, like in the old days. Life is complicated enough as it is. Elektra won't mind.

MOZART AND FORWARD

Mozart: Symphonies No. 33, K. 319; No. 36, K. 425 ("Linz"). English Chamber Orchestra, Colin Davis.

L'Oiseau-Lyre SOL 60049 stereo

It is a fine thing to be able to hear these relatively small-scale Mozart symphonies played as they were intended to be played, by a "small" orchestra, informally, at fairly close quarters. For many years the large symphony orchestras have performed then, even with "reduced" forces, in a "big" style that is unsuited to their musical meaning. Too portentous, too grand, too concert-like. They just don't go over well at a symphony concert, right alongside Tchaikowsky and Rachmaninoff, not to mention Beethoven and Brahms.

The earlier work here, No. 33, is particularly nice, played ingratiatingly, simply, with fine phrasing and in a relaxed fashion in spite of a high standard of accuracy. No rushing tempi, no virtuoso stuff, and at the same time no Germanic stodginess (such as we often find in non-Germanic orchestras!).

I long owned Sir Thomas Beecham's 78 version of the "Linz" symphony, complete with large orchestra and absurdly slow tempi. I used to think it a pretty dull work. Here, things move much faster—a bit of a jolt for me at first, until I got used to it. But all in all the "Linz" comes out here in its own best terms. Useful.

Haydn: The Seven Last Words of Christ (Oratorio Version). Soloists, Vienna Academy Chorus, State Opera Orch., Scherchen.

Westminster WST 17006 stereo

This solemn and sweet succession of seven slow movements was introduced on records years ago in a much simpler form, the version for string quartet. The original was for orchestra alone, serving as a set of musical interludes in a solemn service of short sermons on each of the seven texts. Later, Haydn converted it to the present form by adding solo and choral parts, plus one extra instrumental section.

The main difficulty—easily by-passed on LP—is that the whole is slow, except the brief "earthquake" music at the end. In a church service this could be no problem. In concert, the music drags. On records—you take it a piece at a time. In that fashion, it is lovely, and this is a typically mellow, rich Austrian performance, well laid out under Scherchen's direction. He does strange things to other music, but in Haydn he seems always to get the best of the sense and dignity in the music.

Rossini: Overtures. London Symphony, Pierino Gamba.

London CS 6204 stereo

If memory, always slightly fuzzy when caught unawares, serves me right here, Pierino Gamba was a boy-conductor a bit of awhile ago, the knee-pants sort who has to stand up on a box to be seen. Well, you'd never know it from this record, for two good reasons. First, London says nary a word about its conductor. Just a lot of stuff about Rossini. Second, the music is impeccably and authoritatively played, about as nicely as it ever can be. Full of bounce, humor, rhythm, good phrasing and balance, perfect detail-work. Five overtures here, the usual ones.

Of course (you'll muse) a first-rate orchestra could play these pieces without a conductor of any sort, they are so familiar. True. But, I suggest, not *with* a bad conductor. In such precision-playing as Rossini requires, any conductor less than excellent becomes a monkey wrench in his own performance. Without him—fine. With him, more than a likely chaos and confusion.

So Mr. Gamba must be good.

Brahms: Symphony No. 1. Philharmonic Orch., Giulini.

Angel S 35835 stereo

I picked this one out with some trepidation —Italian ideas of Brahms are often rather

startling. Brahms was about as un-Italian as they come, up in North Germany.

Well, the Philharmonia, at least, is perfectly able to play a fine Brahms First. It does, here. It has no important eccentricities, sticks nicely to comfortable tempi and accepts Brahms' musical fabric in its own terms without strain. After a good long listen, I find only one mild complaint: it isn't really a very inspired performance. Lovely sound, even so.

Curtain Up! Sousa Favorites. Eastman Wind Ens., Fennell.
Curtain Up! Orchestral March Favorites. Assorted Orchs., conductors.
Mercury SR 90291-92 stereo
(also others)

One of the blessings of tape, sometimes not entirely a blessing, is the way one can cut the same taped musical pie in any number of directions, revamping for new sales. I can only mention these two in Mercury's new series, presumably open-ended, of excerpts from the Mercury catalogue reissued in new groupings under new headings.

The Sousa material as performed at Eastman is absolutely first-rate, no matter how you slice it. You'll begin to see in these recordings what a superb composer this Sousa was, in his own area. Best marches ever written. Perhaps even better in their way than, say, the Strauss waltzes.

The orchestral marches are so varied I can't take space to describe them—numerous composers, several performing groups too, out of Mercury's artistic stable. Better look the whole series over to see whether these packages suit your needs.

Bernstein Conducts Copland—El Salon Mexico; Appalachian Spring; Dance from "Music for the Theatre." New York Philharmonic, Bernstein.
Columbia MS 6355 stereo
(mono: ML 5755)

Perfect. What else? Bernstein has been one of Copland's most devoted and perceptive followers in his own music, going further in the same direction that Copland himself pioneered, the use of a popular American-style idiom for American music. Their minds in this respect run on a heartenlingly similar track, though their careers have been different.

In Europe and often hereabouts too, Copland's scores get a *too-classical treatment*. The jazzy, folksy elements are uncomfortable for plenty of "classical" conductors and not a few performing musicians as well. These characteristic Copland sounds, therefore, tend to be played down, weakened, apologized-for; or they are given the Brahms-and-Wagner treatment, buried under an elegantly classical exterior. Not so in the Bernstein version! Enough said.

Milhaud: La Création du Monde; Suite Provençale. Boston Symphony, Munch.
RCA Victor LDS 2625 stereo

About time somebody did another "Création"—this short jazz-influenced score was one of the very first of its type, well before Gershwin and Copland, back in 1923. It shocked the musical world then, of course, but it doesn't now. In fact, this is a rather tame recording of music that once seemed outrageous. Maybe it's inevitable.

I have a priceless old blue-shellac 78 Columbia recording of the same music, performed back in the early thirties when the stuff was still pretty far-out. It sounds that way, and it should. In contrast, the suave Charles Munch and his suave Bostonians play the early jazz as though it were so much Edward MacDowell. It should be closer, drier, too, more in a theatre style, ideally speaking. Not much the Boston Synphony can do about that, I guess.

The later "Suite Provençale", of 1936, was derived from some Seville theatre music Milhaud wrote, based on themes from an "early" Provençal composer, André Campra. Accordingly, all commentators, including RCA Victor's, expatiate about the sunny Provençal country as portrayed in the music, quite overlooking a much more obvious effect in the actual sound—a "Bach-like" Baroque, in

modern terms, out of the turn of the Eighteenth century. Milhaud's typical "polytonality" is merely a heap of genial dissonance, two chords at once, added on top of the very Bach-like rhythms and harmonies of the basic music. Reminds me a bit of Stravinsky's "Pulcinella" music, based on the Eighteenth century Pergolesi.

This is a Soria Series release and so, for a dollar more, you get the usual gorgeous bookful of reproductions in color and monochrome, plus essays and comment. Skira did the printing.

Music of Edgar Varèse, Vol. 2: Arcana; Deserts; Offrandes. Dona Precht, soprano; Columbia Symphony, Craft.
Columbia MS 6362 stereo
(mono: ML 5762)

Columbia continues here the over-all documentation of the old man who has, at last, been recognized as the Beethoven of the avante-garde composers, the grandaddy of the *Musique Concrete* and computer school of composition. Here you have his huge "Arcana," for 120 orchestral musicians, first produced by Stokowski and the Philadelphia Orchestra back in 1927; you have Deserts, Varese's first big tape piece, alternating two-channel factory-noise tape sound with a live small orchestra for a good half hour, tape-assembled in 1954 on French equipment. Big music, any way you listen. Then there are, to fill out, the two strange solo songs called "Offrandes" (Offerings), with small orchestra, dating from 1922.

It's an exciting record—and I'm glad to see that the technical deficiencies of the original "Deserts" sound on tape have been fixed up, notably the severe tape hiss that marred the early "live" performances on stereo Ampexes. Extraordinary how the factory noises and the instrumental "live" music tie in together, sound alike! "Arcana" was a big thing at the Philharmonic last year and this is an offshoot-performance. You never heard anything like it, and never will.

Varèse, you see, is one of the few "radical" composers in tape and assorted sound-effects, who is a top musician, trained, skillful, familiar with all the "greats" of the last half century. He is one of them. Stravinsky writes (or dictates) the extended comment on Varèse that appears on the record jacket. You can take Varèse as an authentic big man, and you can hear it, I think, in the music. It's noisy and astonishingly "different"—but it sounds with an authority, a sophistication, that runs rings about the others in the field.

I continue to be sorry that all of Varèse's music is entrusted to Robert Craft's somewhat chilly direction. Varèse is such a hearty, healthy Frenchman! But better this, and Columbia's willing cooperation in an expensive venture, than no Varese at all. That's the way it used to be, more or less.

P. S. Until Columbia got hold of him, Varèse spelled his name with a d. Edgnrd. I guess Columbia persuaded him to change, if only to placate the proofreaders who kept on taking that offending d out of their copy. It *couldn't* be right. (But it was.) *AE*

JAZZ and all that

CHARLES A. ROBERTSON

STEREO

Odetta: Sometimes I Feel Like Cryin' RCA Victor Stereo LSP2573
Odetta: Odetta And The Blues Riverside Stereo RLP9417

All the confusion of moving from one record company to another turns out to be just what Odetta needed to put over one of her pet projects. While regarded primarily as a folk singer, she varied programs from the time of her first appearance on records with the inclusion of one or more early blues classics. To give this part of her repertoire an authentic touch, she broadens her usual style and adopts the deeper, pulsating tones of the late Bessie Smith. So close is the resemblance to the Empress of the Blues during the prime years that Odetta's name figured prominently in talk about a filmed history of her reign. The concurrent release of two albums entirely devoted to the blues certainly looks like the start of a plot to nail down the principal role. Odetta's credentials are in the best shape of any presented so far, but the decision makers in Hollywood may run true to form and file them away under the section set aside for candidates to play the life of Billy Holiday.

No longer under contract to Vanguard, the singer is now signed exclusively with RCA Victor, but fortunately the shift was made in a hop, skip, and jump. Keeping a promise to sing with a small band on a Riverside date introduced her to Dick Wellstood, who serves as pianist and arranger on both albums. Work on her first Victor release had already begun last April when the Riverside sessions were held, with Wellstood in charge of a sextet consisting of Buck Clayton, trumpet, Vic Dickenson, trombone, Herb Hall, clarinet, Ahmed Abdul-Malik, bass, and drummer Shep Shepherd. So well did everyone get along that the singer scrapped plans to use a more modern group at Victor and insisted on having Wellstood direct the accompanying force.

Wellstood works regularly in the crew Wild Bill Davison leads at Nick's in Greenwich Village, and his ability as a solo pianist is known to the patrons of Eddie Condon's East Side spot. Represented as a leader on a Prestige LP, another will be forthcoming from Riverside because of his excellent supporting role behind Odetta. Not especially active as an accompanist before, he provides the sort of backing that both guides the singer along and allows a great deal of freedom. The arranging chores were reduced to a bare minimum by research into Riverside's archives of early blues, followed by sessions of joint listening to the titles selected. From that point on, according to Wellstood, it was simply a matter of "picking the right guys and letting them do what they wanted to do."

One comment passed around at both dates was a complimentary "she sings just like Bessie Smith only better," and it went unchallenged by musicians who heard the original in person. The knack of singing better than the early Queens of the Blues is no great accomplishment, as few, if any, ever took voice lessons. Instead, they learned before an audience each night and put harsh experience to work in a style difficult to emulate. Odetta studied the classics and toyed with the idea of trying the concert stage before deciding on a career in folk music. While giving a good account of herself in previous bouts with the *blues*, some stiffness and the detached air of the trained singer impaired her efforts. Going into action with genuine jazz players makes an enormous difference, and only the barest vestige of formal constraint remains. The next time Eileen Farrell decides to indulge in a blues album, she had better invite the Messrs. Wellstood, Clayton, and Dickenson along.

Because the extra voice of Sonny Terry's harmonica adds more of a country flavor, the Victor release probably holds greater appeal for Odetta's large and faithful folk audience. Also on hand as substitutes are Buster Bailey, whose clarinet graced several Bessie Smith recordings, and drummer Panama Francis. Not only are Bessie's majestic tones recreated in both cases, but the wild abandon of a second Smith girl, Mamie, lives again, along with the individual styles of Mama Yancey, Ma Rainey, and Ida Cox. Jazz fanciers who are unconvinced it can be done should start with the Riverside set, and not a few will echo Wellstood's remark, "I hadn't really had a chance to hear her sing any of these things before. I didn't think anybody could live up to the originals, but *wow*. . . ."

Folk enthusiasts dismayed at the inroads of big business into their domain can take some consolation from the amount of youth talent drawn into the fold by the prospects of solid booking. If Odetta had started out in a different day and age, she might have reached to concert stage or turned all her attention to the blues.

Johnny Gregory: TV Thriller Themes Philips Stereo PHS600-027
Geraldo: Cruise Along—Dance Along RCA Camden Stereo CAS720

Although international television is now a reality, it will be a long time before the Telstar brings British private-eyes and society dance bands to home screens in this country on a regular basis. For those unable to await the great day patiently, this shipment from overseas offers an hour or so of dancing pleasure to while away the time. Johnny Gregory's idea of crime detection is to pit a full-sized swing band against twenty strings, twelve voices, and a trio of Latin percussionists in a stereo spectacular. Hot pursuit by the band sleuths keeps the strings from lagging and never allows the vocalists to overstay their welcome. Six themes are completing a round trip, including such fearless adventurers as *Perry Mason, Johnny Staccato,* and *M Squad.* Viewers on these shores are already familiar with one or two of the visiting contingent, especially Taranteno Rojas' *Sucu-Sucu,* the currently popular theme from "Top Secret." Most formidable of the strangers to arrive are Johnny Dankworth's *The Avengers,* and the sinister *Echo Four-Two.* The evidence not only indicates that Gregory and countrymen have crime under control, but most stereo problems are also well in hand, as demonstrated by the eerie muted trumpet on *Ghost Squad.*

Geraldo now holds the title of musical director of the Cunard fleet, a position which by any criterion assures the genuinesness of this shipboard serenade. The orchestral style is much the same as when he headed one of London's top society bands, and the various medleys include a double helping of that purely British institution the quick step. Tucked away among interludes devoted to mambo, foxtrot, cha cha cha and old fashioned waltz is one of the sauvest and most melodic versions of the Twist yet contrived. After all, any Englishman should be able to twist in a raging sea with a glass of champagne in one hand. The album is thoroughly first-class, but a ticket to step on board sells at tourist rates. Only five years ago, the bass range of the opening blast of a steamship whistle would have been somewhat of an audio event.

Stan Getz and Charlie Byrd: Jazz Samba Verve VSTC276 (4-track UST tape)

After failing to make much headway when introduced in this country a year or so ago, a new Brazilian dance music known as *bossa nova* jumped to national prominence when just about every *radio* station suddenly started to feature a compelling theme from this album. Bearing the strange title *Desafinado,* it was written by Antonio Carlos Jobim, a collaborator on the film score to "Black Orpheus." The velvety tenor-sax sounds of Stan Getz and the subtle guitar rhythms of Charlie Byrd began to emerge from all parts of the broadcast world, even places where a jazz record was last heard from back in the swing era. Except on a few enlightened FM stations playing the LP, the version used is a shortened 45 rpm extract from the album. All of which tends to increase the value of the four-track stereo tape as demonstration material. Even the most uncritical will be able to discern immediately the great difference between what their ears are accustomed to and hearing the stereo tape played on good equipment. The contrast should prove to be very effective at audio shows, dealer showrooms, and any place else where tape components are shown off.

Because of the sextet's instrumentation and the stereo positions of the *soloists,* this particular tape is highly responsive to control settings, enabling home listeners to display the flexibility of their setups to visiting audiofans. Not only can the relative volume of the two featured soloists be altered at will, but the balance between the principals and the rhythm section can be adjusted to suit various tastes. Rather than locating a single setting that sounds right, the problem is one of seeing how many pleasing variations can be worked out. The controls can also be used to touch up the tonal texture of each soloist independent of the other, and a check of how much tampering the tenor sax will withstand and not become harsh or thin should settle the question of why Getz continues to win polls. It should also be proof enough of the theory that the engineer who equalizes the master tape or cuts the final master must know how everyone sounded in the studio. An ideal condition matches the natural sound of the live musicians when the controls are set flat, and this tape comes as close to perfection as any.

In fact, one of the most enjoyable experiences of the past few years has been to witness the steady improvement in the quality of Verve's product. Once notorious for slipshod sound, the label has pulled abreast of the field, and this tape belongs right in the top rank. The session took place last February in Pierce Hall at All Souls Unitarian Church, Washington, D. C., with Ed Green at the control console. The auditorium adds appreciably to the over-all effect, and ample space is allotted to the augmented rhythm team of Keter Betts, bass, drummers Buddy Deppenschmidt and Bill Reichenbach, with younger brother Gene Byrd alternating on bass and guitar. Every owner of four-track playback equipment should make an effort to get hold of this tape, either by outright purchase or through hints pointed at the holiday season.

Lalo Schifrin: Bossa Nova Audio Fidelity Stereo AFSD5981

As several composers of *bossa nova* also are working guitarists and some groups employ no less than two guitar players, it would seem that the instrument is essential to proper performance of the latest import from Brazil. By the same token, the very newness of the music may preclude any set rules as yet about the mode of rhythmic propulsion. If so, Lalo Schifrin has fashioned arrangements that demolish both contentions almost *as soon as* the program gets underway.

First, the Argentine pianist decides to augment his regular companions from Dizzy Gillespie's quintet with only two percussionists, dispensing with the guitar. Second, everyone in the rhythm section takes turns at inserting guitarlike effects whenever an opening appears, so the guitar, in spirit at least, must be a necessary adjunct. The way in

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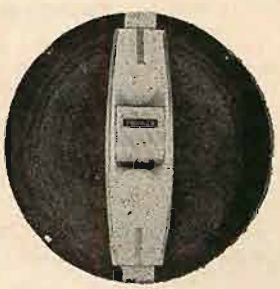
Sensitivity:	102 db/watt
Crossover Frequency:	3,000 cps
Total Flux: Woofer;	62,500 maxwell
Tweeter;	14,000 maxwell
Flux Density Woofer;	10,000 gauss
Tweeter;	9,000 gauss



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which the players transfer the assignment from one to the other, tossing the ball around in stereo like a pennant-winning baseball team covering the bases, and the ingenious methods of carrying it out contribute greatly to the enjoyment of the recording. Extra accents may come sizzling from the cymbals of Rudy Collins, or bounce off the strings of Chris White's bass. Brazilian drummer Jose Paulo responds on the panderlo, a native tambourine capable of tinkling softly or rising to swift crescendos. Jack Del Rio, another expert from the Argentine and member of Xavier Cugat's orchestra, manipulates the cabaca, a gourd with a loose covering of beads.

Schifrin's piano style is another good reason for his doing without a guitarist, as it ranges far and wide. Known for an allegiance to modern jazz since arriving in this country, the pianist operates under no such restrictions when surveying Latin music. His explorations probably go back further in history than the famed "Spanish tinge" of Jelly Roll Morton, and some of his findings may antedate jazz by a century or more. A composite of various cultures and periods, his playing is highly personal and flows best when unimpeded.

Co-worker Leo Wright never gets in the way and strikes a happy medium between the saxophone styles of the other leading jazz exponents of *bossa nova*, Stan Getz and Sonny Rollins. Occasional solos on flute also give him the extra advantage of exploiting the lyrical qualitities of the exotic melodies to the utmost. At a time when a lot of misinformation is being printed about the origins of *bossa nova*, Jono Tazajara's notes shed authentic light on the subject. The recording is equally luminous, and it will shine brilliantly at audio shows this season.

Lou Rawls: Sings Stormy Monday
Capitol Stereo ST1714
H. B. Barnum: Everybody Loves H. B.
RCA Victor Stereo LSP2553

Some inventive soul should think up a name for the new crop of singers, especially those who trained in gospel groups, as they seldom fit any single category. They flit from urban to country blues, from rock and roll to the twist, from jazz to pops, or mix several styles together at once. Many try to emulate Ray Charles, others strive to be as sophisticated as Jon Hendricks, but they all continue to draw inspiration from gospel sounds and rhythms. Among the latest to arrive are Lou Rawls and H. B. Barnum, two lusty-voiced passengers who descended from the gospel train in Los Angeles and began to branch out in various directions.

Rawls crossed paths with Les McCann, Ltd., and the encounter was mutually rewarding enough for them to get together again on the blues for the singer's debut album. Most titles selected are known from one particular version generally considered to be the best ever recorded. Instead of taking these performances as models, Rawls picks different tempos, looks for distinctive phrasing, and wraps everything up in an individual styling. Nothing will ever displace Billy Holiday's own *God Bless The Child*, or Leroy Carr's original recording of *In The Evening When The Sun Goes Down*. Formerly a featured soloist with the Pilgrim Travelers, Rawls possesses a formidable set of vocal chords and knows how to bend a note in any direction. What he needs to do next is go his own complete way with original material, written either by himself or during some future collaboration with the McCann firm of Leroy Vinnegar, bass, and drummer Ron Jefferson.

H. B. Barnum ranges over more territory than a dozen other singers without spreading his talent too thin. As varied and extensive as this program is, it bypasses his composing activities, gospel singing, and the ability to conduct and play many instruments. Barnum merely acts as arranger and pianist, and interprets such widely-separated works as *Good Rockin' Tonight*, and Thelonious Monk's *'Round Midnight*. Peggy Lee's prior claim is no deterrent to his bursting forth on *I'm Going Fishin'*, becoming one of the few males to bring the tune to net successfully. Even with wild scatting on *Wham Re Bop Boom Bam*, honky-tonk abandon on *Old Piano Plays The Blues*, and the quiet reserve of *Gigi*, one album is wholly inadequate to contain all of Barnum.

Sonny Rollins: What's New?
RCA Victor Stereo LSP2572

The obvious answer to the question posed by the album title is the Brazilian *bossa nova* featured throughout, but hearty disagreement is apt to be felt by more than one Rollins follower. To them the real innovation is undoubtedly the pairing of their hero's tenor sax with a choral group, even though it appears only on one number. They may forgive the intrusion because it takes place during a Jimmy Jones arrangement of *Brownskin Girl*, one of several tunes that Rollins originally conceived as calypsos. They need only point to the close relationship between the two versions to prove that Rollins anticipated a trend and was well on the way to Rio several years ago. As far at least as the Virgin Islands, where most of his calypso ideas were born.

The muscular Rollins approach often causes *bossa nova* to recede into the background as jazz takes over almost entirely, posing the question of what really is new. Mixtures of jazz and Latin rhythms are either impressionistic sketches or fresh jazz works on a novel base. As the latter method is the one favored by Rollins and his partner, the guitarist Jim Hall, it seems only proper to call the results samba jazz. Instead of rushing out to cash in on something because of current popularity, Rollins engages in a valid and logical extension of his previous work. He even remembers to include a forgotten movie theme, *The Night Has a Thousand Eyes*, and tests his resourcefulness as improvisor by inviting a duel with Candido on conga drums. Hall, who played *bossa nova* in native surroundings while touring South America with Ella Fitzgerald, holds up his end of the bargain on *If Ever I Would Leave You*, indicating that the next new thing could be a Latin version of the complete "Camelot" score. Extra percussion aids regular quartet members Bob Cranshaw, bass, and Ben Riley, drums, in filling out the full dimensions of the stereo stage. AE

LETTERS

(*from page 6*)

SIR:

It was gratifying to see in the article "A condenser microphone mixer," (October, 1962), that some of the problems of the compatibility between European condenser microphones and American speech input systems are receiving the attention they deserve. There is, however, one area, that of proper impedance matching between the microphone output transformer and the preamplifier input transformer, that needs further clarification.

The amplifier in all professional condenser microphones is in itself basically an impedance-matching device; it converts the extremely high diaphragm-to-grid impedance (approximately 180 megohms) to a balanced low-impedance line suitable for long cable runs. It is by nature a voltage amplifier and is, therefore, incapable of any power input. The impedance that is listed in the European specifications, usually either 200 or 50 ohms, is the source impedance looking back into the microphone output transformer. If the transformer load is improper, it will reflect back into the plate circuit of the tube and shift the operating point to a non-linear portion of the curve. This transformer should never look into an impedance less than 5 times the source value. Since American input transformers do not have 100-ohm strapping, these microphones can never be operated with a 200-ohm source impedance. They should always be strapped for the 50-ohm impedance.

The problem of overload of the console preamplifier and the internal microphone amplifier due to close miking techniques has only one satisfactory solution. This is an integral attenuator in the microphone itself between the capsule and the preamplifier grid. While padding of the microphone line at the console input will prevent overload after this point, only the above mentioned type of attenuator will protect the microphone itself.

ALBERT B. GRUNDY
International Electroacoustics, Inc.
333 Sixth Avenue
New York 14, New York

The Author Agrees

SIR:

The illustrations regarding input terminations for my mixer design described in the October issue of AUDIO were in error; there should have been only one schematic (rather than two) with the source impedance being 50 ohms rather than 200 ohms. This was my error, and since a correction *must* be made (microphone-amplifier distortion will occur), I also would like to expand on the input requirements for my design: 1. The microphone, with a source impedance of 50 ohms should look into a load of at least 5 times this value, or 250 ohms. 2. The mixer input impedance is 100k ohms. These two conditions indicate, ideally, a transformer with a primary of 250 ohms and a secondary of 100k ohms.

The transformer used (Triad 3417—150 ohms input, secondary loaded with 100k) reflected approximately 200 ohms to the mike (50-ohm source) and, therefore, tests were conducted to ascertain any ill effects from loading the mike some 20 per cent more than recommended. None was observed.

For those who might be concerned about the frequency response of the transformer when fed from a source lower than the nominal input (50 ohms into 200 ohms) the response is flat from 20 to 20,000 cps

within +0.75 db, −0 db. The curve shows a gradual rise reaching a maximum at approximately 18kc (+0.75 db) and is +0.3 db at 20,000 cps. Lowering the source input to approximately 20 ohms causes a rise of +1.2 db.

A better choice of input transformer recommended for those who might like to construct this unit (I had some 3417 transformers on hand) is the Triad HS-3. When terminated at the 250-ohm tap (with 100k loaded secondary), it reflects approximately 215 ohms to the mike and exhibits an improved frequency response for a source impedance of 50 ohms. It is flat from 20 to 20,000 cps within +0.3 db, −0 db, the peak in response of 0.3 db occurring at approximately 15.5 kc. Lowering the source impedance to approximately 20 ohms causes a total rise in response of 0.5 db.

WILLIAM G. DILLEY
577 East Avery Street
San Bernardino, Calif.

4-in. = 4-ft.

SIR:

A couple of printer's errors seem to have crept into my paper, "Extending the usefulness of the Schober autotuner," which was published in the October issue of AUDIO. One is merely amusing and will probably be spotted as such by most of your readers; the other is somewhat misleading.

Thus in the second sentence of the paper my "setting the temperament" came out as "setting the temperature." Later, in the third sentence of the final paragraph, the paper should read "Organ pipes shorter than about 4 feet in length," not 4 inches.

WINTHROP S. PIKE
165 Hickory Court
Princeton, N. J. Æ

TAPE GUIDE

(*from page 28*)

Demagnetization of Heads

Q. I have heard that record and erase heads can be demagnetized by turning off the tape recorder or tape preamp power while in the record position, due to the collapsing of the bias and erase current fields. Is this an effective method of demagnetization?

A. Demagnetization of a head is accomplished by means of an alternating magnetic field of fair strength that gradually and steadily diminishes to zero. If these conditions are met when the tape recorder is turned off, demagnetization will take place, although I don't know whether this will be as effective as the result of using an external head demagnetizer specifically designed for the purpose. If I had to bet on one technique versus the other, I would bet on the head demagnetizer.

Depending on the design of the tape recorder, it is possible that when the unit is shut off the decline in the magnetic field of the heads is too sharp to produce effective demagnetization. Furthermore, the field may be too weak for good results. Abrupt cessation of current through a head is apt to *magnetize* the head. Hence in some of the better tape machines a resistive-capacitive network is employed to prevent a surge of current through the heads when the power is turned off or on, or when the unit is switched between the record and playback modes.

To be on the safe side, I recommend use of a head demagnetizer. This item is quite inexpensive nowadays, being available for $3 or less in some places. Besides, it enables you to demagnetize the playback head, if this is separate from the record head, which you could not do by the expedient of turning off the power. Heads should be demagnetized after about 8 hours of use.

More on Demagnetization

Q. It is recommended in the instruction manual of my tape recorder, as one of the demagnetization steps, to remove a.c. power from the recorder before demagnetizing the heads and other metal parts that contact the tape. In my case, the a.c. power cord receptacle is in a rather awkward location for convenient plugging and unplugging. Therefore I wonder if I might forgo this step.

A. I see no point in removing the a.c. cord from the house receptacle. I believe that the instructions simply intend you to make sure that the tape recorder is shut off when you demagnetize the heads. If oscillator current is flowing through the record and erase heads, this may result in imperfect demagnetization.

Demagnetizing Separate Heads

Q. When demagnetizing separate heads, is it necessary to move the demagnetizer several feet away after demagnetizing each head, or is it just as effective to proceed directly from one head to the next until the last head is reached and then move the demagnetizer several feet away?

A. I think it is somewhat safer to withdraw the demagnetizer slowly from each head than to go from one head to the other and withdraw slowly from the last. Inasmuch as the former procedure involves only a few moments of extra time, why not play it safe? Æ

TRANSISTORIZED PREAMP

(*from page 37*)

First and second stage transistors. From the number of low-noise transistor types available the RCA type 2N175 was chosen for stages one and two, mainly because of its 3-pin base that fits a standard 3-pin socket. Suitable operation conditions provided, the noise figure of the 2N175 is about 6 db and thus well below the permissible values of F_{Imax} and F_{IImax}.

Output stage transistors. Any desired large-signal, audio-frequency transistor having a maximum collector dissipation of well above 75 mw may be used for stage three. Again for reasons of the convenient 3-pin socket the RCA type 2N109 has been selected for the author's unit.

Resistors

All the calculations in the previous paragraphs have been based upon the assumption that the resistors involved are ideal and generate the thermal noise which is due to their ohmic resistance only. In reality, however, the noise voltage generated in a resistor normally is several times the calculated value, depending mainly upon the physical structure of the resistor.

In order to obtain the required signal-to-noise ratio, it is necessary to use low-noise resistors in critical places where additional noise would invalidate the calculations. Metal-film resistors have been employed successfully in the author's unit, their noise factor being significantly lower than that of molded composition and deposited carbon types.

(*To be continued*)

AUDIO ETC

(*from page 14*)

controlling bias or charge, to tell it when to go, go, go, straight into the nearest amplifier.

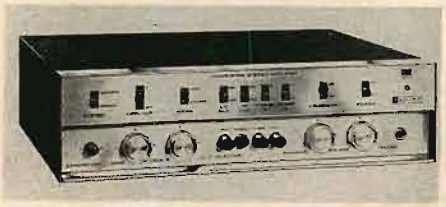
A wild Canby guess—maybe all an electron beam needs is to "see" a healthy pair of variable anodes, deep down in the stereo groove. Hmmm. Let's see now . . . With these new semi-conducting, no-static record materials something might be done.

Would a modulated groove wall by any chance absorb electrons variably? That might do it. A handy dual circuit, from stylus-cathode to record-groove "plate." Two beams, of course, and a common return via the record, each circuit directly varied by the varying electron-sensitivity of one stereo groove wall. It's a marvelous idea—if it'll work. Almost as good as science fiction.

Definitely, this is not a Trend for 1963.

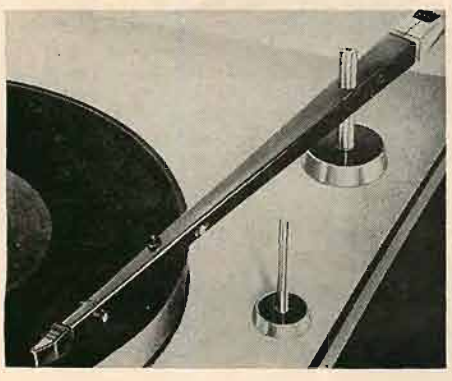
NEW PRODUCTS

• **100-Watt Transistor Stereo Amplifier.** A transistorized stereophonic amplifier with a 100-watt power rating at the 4-ohm speaker connection, the Allied Radio Knight KN-450A features a cool-running 18-transistor circuit with two silicon rectifiers and no output transformers. Heat generation is held to minimum. The circuit features a military-type terminal broad wiring arrangement. The 15 controls include: Four pushbuttons to select tuner, phono, tape, or auxiliary sound sources; a tape monitor switch; a separation control; on-off switches are provided for both high and low cut; and two switches are provided for channel phasing. Fuses are eliminated by a positive circuit-breaker design. Five stereo inputs are provided, plus two a.c. convenience outlets. A special stereo headphone jack for personal and individual listening is also standard with the unit. Frequency response is plus or minus 0.5 db, 20 to 30,000 cps at rated power; harmonic distortion is 0.5 per cent at rated

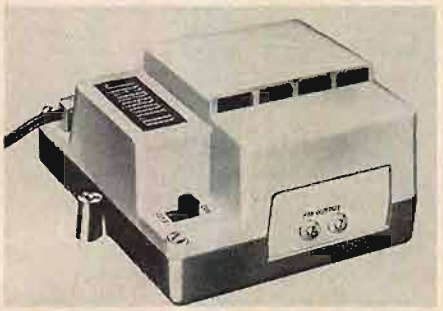


power; hum is – 90 db at tuner input and –60 db at mag. phono input. Offered with a dark brown textured metal case with polished brass control panel, the KN-450 is intended for 110–125 volt, 60-cps a.c. operation. It measures 3¾ by 13⅞ by 12¾ inches, including case, and is priced at $189.95. An optional oiled walnut cabinet is offered for $14.95. Allied Radio Corp., 100 North Western Ave., Chicago 80, Illinois. **L-1**

• **Integrated Tone Arm and Cartridge.** A new, improved version of the Model M212/216 Stereo Dynetic integrated tone arm and cartridge, the Model M222, is being offered by Shure Brothers. The new unit comes equipped with the new Shure N22D tubular stylus with 0.5-mil diamond and is capable of tracking at ¾ to 1½ grams, in part due to a stylus compliance of 22 x 10^{-6} cm/dyne. The M222 is furnished with improved plug and newly designed matching cable assembly for quick solderless installation. The N22D stylus is available separately for existing Model M212/216 integrated tone arms. Packaged with each N22D is a snap-on counterweight to reduce the tracking force of M212/216 tone arms to ¾ to 1½ grams. The N22D may also be used to replace the Shure N21D stylus in Shure cartridges where ¾ to 1½ gram tracking is desired. Net price of the M222, including stylus, is $89.50. Net price of the N22D stylus separately is $24.75. Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, Illinois. **L-2**



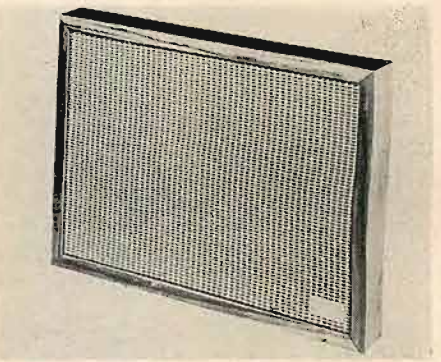
• **FM-Stereo Range Extender.** Designed to double the primary reception range of FM tuners, the Jerrold FM Range Extender, Model FMX, makes it possible to overcome the reception range limitation of FM-stereo broadcasting. With a minimum gain of 20 db over the entire FM band, the new one-tube antenna amplifier helps reduce background noise and "drifting" of signal. The FM Range Extender has been engineered for simple indoor installation any-



where in the home between the antenna and the FM tuner or radio. It may be mounted in an attic, closet, or on any convenient wall or flat surface where a 117-volt 60-cps outlet is available. The amplifier is extremely compact, weighing slightly over two pounds. It incorporates the latest 6DJ8 frame grid tube, insuring stable, high-level performance. Designed for all-day continuous operation, the FM Range Extender is provided with a shut-off switch, so that it may be disconnected when not needed for long periods of time. The current utilized by this equipment is comparable to that used by an electric clock. The FM Range Extender is priced at $29.95. Jerrold Electronics Corporation, 15th and Lehigh Ave., Phila. 32, Pa. **L-3**

• **Precision Condenser Microphones.** A new series of precision condenser microphones from B & K features physical ruggedness, high sensitivity, and an extensive selection of accessories. Broad measurement range of 10 cps through 100,000 cps at levels from 15 db to 180 db is offered through the choice of ¼-, ½-, and 1-inch sizes. Two different types are available for each diam-

eter. One type is adjusted to have overdamped resonance in order to give a flat 0-deg. incidence free-field frequency response. The second type is adjusted to have a critically damped resonance to produce the best possible pressure response for closed coupler measurements. Typical applications are accurate measurements for product sound control, precise acoustical calibration, defining acoustical environments, and boundary layer measurements. B & K Instruments, Inc., 3044 West 106th Street, Cleveland 11, Ohio. **L-4**

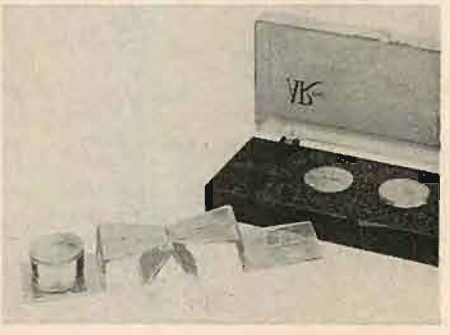


• **Miniature Speaker System.** The University MINI 2-way speaker system is only 2-in. thick, 18-in. wide, 13-in. high, and designed to meet the highest possible acoustic standards. The MINI utilizes an open-enclosure design, so that the baffle board radiates. This relatively large radiating area is intended to reinforce the bass and help produce a smooth mid-range. A separate tweeter adds highs up to 17,000 cps. The MINI is handsomely finished in an oiled walnut cabinet. Price, $44.95. University Loudspeakers, 80 So. Kensico Ave., White Plains, N. Y. **L-5**

• **Stereo Tape Recorder.** The Dual TG 12 SK, at a price of $349.95, features: 4-track stereo-mono record and playback; 3 speeds; pushbutton controls; automatic shut off; and no pressure pads for lowest possible tape wear. Specifications include: Frequency response of 40–20,000 cps ± 3 db at 7½ ips; signal-to-noise ratio of better

than 46 db at 7½ ips; wow and flutter 0.15 per cent at 7½ ips; channel separation better than 60 db from 30 to 25,000 cps. Included in the price are two microphones. The TG 12 SK is a complete playback system with two built-in speakers, one in each lid, and a 10-watt stereo amplifier. United Audio Products, 12–14 West 18th St., New York 11, N. Y. **L-6**

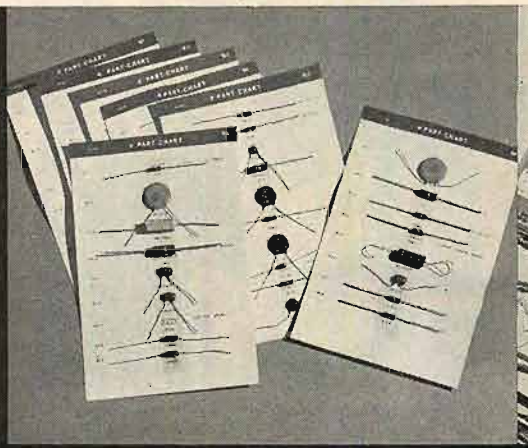
• **Stylus-Force Gauge.** This gauge is essentially an equal-arm balance which is set on a plastic "knife-edge" pivot. In chemistry lab we learned that the equal-arm balance was the most accurate simple



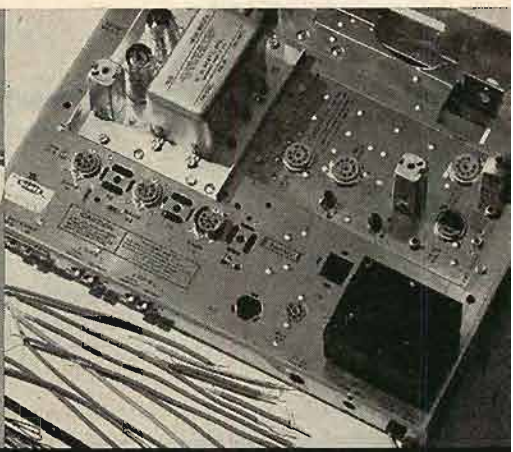
Here's why Audio Magazine says Scott® Kits are

"Simplest to build..." and have "Engineering of the highest calibre" *

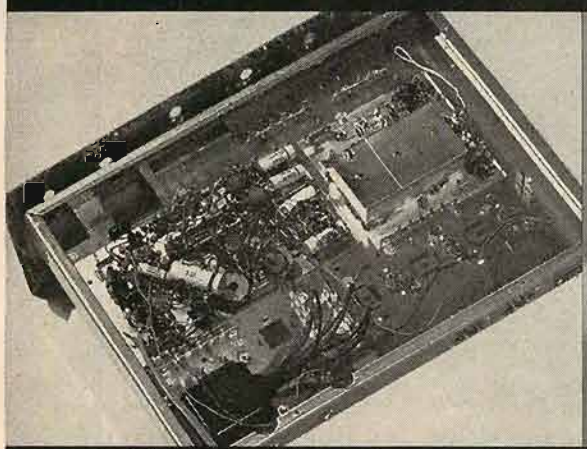
The exclusive Scott full color instruction book shows every part and every wire in natural color and in proper position. To make the instruction book even clearer, each of the full color illustrations shows only a few assembly steps. There are no oversized sheets to confuse you.



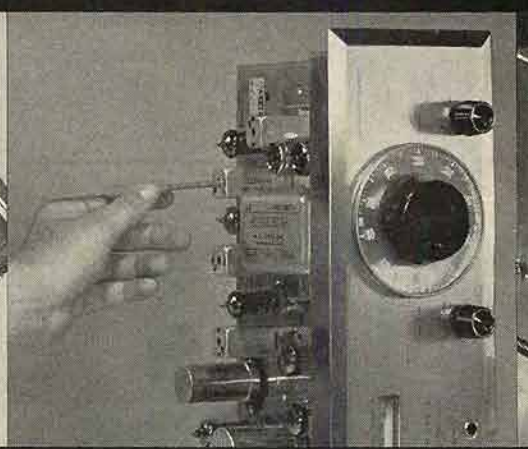
Each full color illustration is accompanied by its own Part Chart . . . another Scott exclusive. The actual parts described in the illustration are placed in the exact sequence in which they are used. You can't possibly make a mistake.



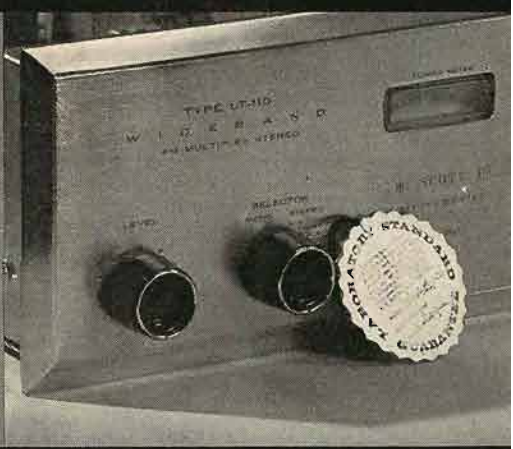
Much of the uninteresting mechanical assembly is completed when you open your Scott Kit-Pak. All the terminal strips and tube sockets are already permanently riveted to the chassis. To insure accuracy all wires are pre-cut and pre-stripped to proper length.



There are certain areas in every professional high fidelity component where wiring is critical and difficult. FM front ends and multiplex sections are an example. In Scott Kits these sections are wired at the factory, and thoroughly tested by Scott experts, assuring you a completed kit meeting stringent factory standards.



Tuners are aligned with the unique Scott Ez-A-Line method using the meter on the tuner itself. This assures perfect alignment without expensive signal generators. Amplifier kits require no laboratory instruments for perfect balancing.



The new Scott Warrantee Performance Plan guarantees that your kit will work perfectly when completed. If you have followed all recommended procedures and your kit fails to work Scott guarantees to put your kit in working order at the factory at minimum cost.

*Audio — February 1961, Pages 54-56

When you finish your kit you'll be delighted by its handsome good looks. And when you turn your Scott Kit system on you'll know for yourself why the expert editors of leading high fidelity magazines like Audio say . . . "only the most sophisticated engineering thinking could design a kit as simple and foolproof as this . . ." *

SCOTT®

H. H. Scott Inc., Dept. 035-11
111 Powdermill Rd., Maynard, Mass.

Please rush me without charge your full color brochure on the complete line of Scott FM stereo tuner, stereo amplifier and speaker kits. A sample 36 page full-color Scott Kit instruction book will be included if you enclose 50¢ in coin or stamps.

Name.....

Address.....

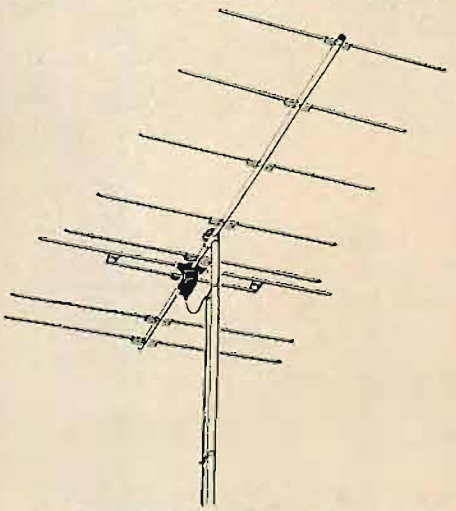
City.....State.....

If any of your friends would like a copy of the new Scott Kit brochure send us their names and addresses.

Export: Morhan Exporting Corp., 458 Broadway, N.Y.C.
Canada: Atlas Radio Corp., 50 Wingold Ave., Toronto

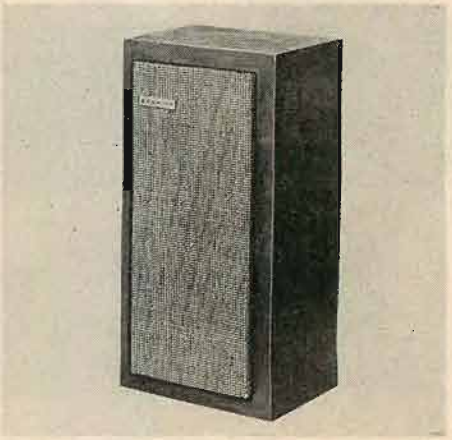
way to measure weight. Of course, this presumes the counterweights are extremely accurate—in this case plastic weights are supplied. In any case it is quite possibly an extremely accurate means of setting stylus force and at a price of only $1.00. Acoustic Research Inc., 24 Thorndike St., Cambridge, Mass. **L-7**

• **FM-Stereo Antenna.** The new Winegard "Stereotron" FM antenna for both stereo and mono is an 8-element unit with a built-in Nuvistor amplifier that can be used in any location. The "Stereotron" amplifier takes up to 200,000 μv of signal, so that it will respond to weak signals from distant stations and strong local signals will not overload it. It has a minimum gain of 26 db over a folded dipole and a flat frequency response of ± ¼ db



from 88 to 108 mc. The "stereotron" is available for use with either 300-ohm twin lead or 75-ohm coaxial cable. The antenna has a permanent gold-anodized finish for corrosion protection. It can be purchased without the Nuvistor amplifier if desired, and the "Stereotron" amplifier can be purchased separately to be used with any FM antenna. The Stereotron antenna only (Model SF-8) lists for $23.65, and the "stereotron" amplifier (Model AP-320) lists for $39.95. Winegard Co., Burlington, Iowa. **L-8**

• **Speaker Kit.** H. H. Scott announces the first of its line of speaker kits. The Scott SK-4 comes complete with cabinet in walnut, mahogany, or unfinished pine or hardwood. Directions are easy to follow. It is patterned after the Scott S-3 speaker. Cabinet is factory-assembled and prefin-



ished. The three-way system has a high-compliance, low-resonance woofer and separate mid-range and high-frequency drivers. A multiple-crossover network has separate controls for the mid-range and tweeter drivers. For further information, write Department P, H. H. Scott Inc., 111 Powdermill Road, Maynard, Mass. **L-9**

NEW LITERATURE

• **Dynamic Beta Power Transistor Tester.** A new, eight-page technical brochure describes the Hickok Model 1885 Dynamic Beta power transistor tester. This two-color brochure is available without charge. Brochure RD1885 describes a versatile transistor tester which measures beta and leakage from data included on a roll chart. Transistor manufacturer's specifications, or the user's requirements can easily be the basis for tranistor testing. The brochure includes technical specifications, simplified schematic diagrams, and circuit descriptions of the beta and leakage tests, the variable duty cycle pulsing system, and the variable power supplies. RD Instruments Division, Hickok Electrical Instrument Company, 10514 Dupont Avenue, Cleveland, 8, Ohio. **L-10**

• **Pushbutton Switch Catalog.** This new 6-page 2-color catalog for the electronics industry introduces the new Switchcraft "Tiny-Frame" pushbutton switch. The "Tiny-Frame" switch, Series 970, is a small, direct-acting pushbutton switch for applications where space is at a premium. It is available in many switching circuits and in locking or non-locking action. The catalog, Engineering Specifications Catalog S-301, also illustrates and describes Switchcraft's "Littel Switches," "Button Switches," "Cord Switches," "T Switches," and many others. This catalog was designed as an industry guide for engineers on special and standard pushbutton switches. It lists engineering data, design features, dimensional drawings and a full page of appliaction ideas. Write to Switchcraft, Inc., 5555 N. Elston Avenue, Chicago 30, Illinois. **L-11**

• **New Book.** "Reproduction of Sound," by Edgar Villchur is published by his company, Acoustic Research, and is 93 pages, paper, and priced at $2.00, postpaid, direct from publisher only. This book is a non-mathematical analysis of the nature of sound and of how reproducing components work. The book may be used as a general survey of principles for the interested layman, or as a pre-engineering survey and introduction for professionals. The first few chapters deal with the fundamental nature of sound and the standards to be applied to a high-fidelity reproducing system. A brief discussion of recording, with emphasis on stereo, is followed by a treatment of each of the reproducing elements in turn: pickup and needles, preamplifiers and amplifiers, speaker systems, and finally the listening room itself. Acoustic Research Inc., 24 Thorndike St., Cambridge 41, Mass.

• **Interchangeability Directory.** A new and enlarged edition of the RCA Interchangeability Directory of foreign versus USA receiving-type electron tubes is now available. The new edition, form No. LCE-197B, indicates the USA direct replacement type or similar type, if available, for more than 800 foreign tube types used principally in AM and FM radios, TV receivers, and audio amplifiers. Radio Corporation of America, Electron Tube Division, Harrison, N. J. **L-12**

• **Condensed Semiconductor Catalog.** Amperex Electronic Corporation's new 15-page catalog includes basic specifications of the new line of universal communications transistors manufactured by the PADT (Post Alloy Diffusion) process. The catalog also contains a complete listing and specifications of a comprehensive line of germanium pnp and npn audio (small and large signal), computer, switching (high and low speed) and VHF transistors for converter, mixer, and oscillator applications. Also listed with specifications are the complete Amperex lines of germanium and silicon diodes, including silicon reference and power rectifier types. Free copies of the condensed Amperex Semiconductor Catalog may be obtained by writing on your company letterhead to Amperex Electronic Corp., Advertising Department, 230 Duffy Avenue, Hicksville, Long Island, New York.

COMING ATTRACTIONS

1

Another Word on Multiple Speakers.
J. W. Ward

The outstanding virtue of multiple-speaker arrays consists of the way they handle the mid-range. A mid-range multiple-speaker array is presented and variables that affect performance discussed.

2

A 1-Megacycle Frequency-Compensated Audio Attenuator.
Weaver Dodge

An audio attenuator can be used to calibrate test equipment, check equalization and amplifier capabilities, and provide a precision low-level signal for measuring input noise and hum. Complete with construction details.

3

Leakage Inductance—A Useful Circuit Component.
Norman Crowhurst

Leakage inductance is available in many audio circuits but is not often utilized fully. Here are several examples of normally ignored applications, and explanation of how they work.

200-WATT AMPLIFIER

(*from page 52*)

a transistor amplifier. The difference is that a transistor can be overheated only once.

Treated properly, installed where there is reasonable ventilation, and never short circuited, this transistor amplifier should prove to have extremely long failure-free life with no need for periodic maintenance or adjustment. Æ

REFERENCES

Burwen, R. S., "Transistor music system using direct coupling," AUDIO, Vol. 43, No. 8; p. 21; August 1959.

Burwen, R. S., "Portable transistor music system," JAES, Vol. 6, No. 1; p. 10; January 1958.

TAPE SYNC

(*from page 26*)

here and menton the scheme that is probably the simplest of all. Merely use a stereo or other multitrack recorder and record the sync signal as one of the tracks, hoping the separation is sufficient to prevent hum on the track containing the program material. The reference sync can be either from a step-down trans-

former, from power supply ripple, or from a generator mounted on the camera. Hardly any disadvantages are present with *this* system except that a stereo machine is required, which could be a little heavier, and the resulting audio signal would be only a half-track recording. This also necessitates an inventory of new machines and makes the thousands of single-track recording machines obsolete. In some cases the economics involved will prevent us from converting to stereo machines just to record single-track sound. One manufacturer in this country markets a machine using the above scheme. The machine was designed to record audio on one track and sync only on the second and does not carry the extra weight of a complete second channel as would be the case of a normal stereo machine.

. . . Another System

We now come to another new system that you might think was devised just to confuse the issue. The writer set up the criteria as follows: It must be usable with any professional or semi-professional tape machine recording at any tape speed with complete compatibility; it must not require any special machining or installation on the tape machine itself; it must be reliable and require no special operating conditions. In other words if the tape machine will run and record on the tape being used no matter what the condition of the tape, and will produce acceptable results, the sync system will be well within its design tolerances. To top it all, it must not add hum or other extraneous signals to the recording that cannot be eliminated *conveniently*. This sounds almost too good to be true. One disadvantage, that may really be an advantage is that the recordist must carry along two small "black boxes," to use this system (see *Fig.* 4). This of course means this scheme can be used with any machine available. If you break down in the hinterlands, pop into any radio station and borrow their machine to finish the job. What happens if the "black box" breaks down? All we can do is design it to be very reliable, utilizing a minimum of special components and to operate under extremes of conditions. The writer's unit has been tested with line voltages ranging from 75 to 130 with both new tubes and with tubes of low emission. The system uses a vacuum tube, as indicated, but could be done with transistors, about 3 or 4 of them. However, inasmuch as we have to plug the box into line voltage, it was decided that low-voltage d.c. was just as hard to come by as medium-voltage d.c. so a vacuum tube was used. The system uses a sub-audible sync tone locked to the 60-cps line frequency. The sync generator is a 30-cps multivibrator locked to 60 cps and the wave shaped to a 30-cps sine wave with less than 1 per cent total harmonic distortion (see *Fig.* 5). It is impressed on the track at a −20 VU level, so it can be monitored on the VU meter, and can be injected into the system anywhere. It works perfectly with the Ampex 600 series machine because it can be plugged into the line input and still have the mic input for audio. On single-input machines an adapter would have to be built, but this should be no problem since the sync generator has a built in 100-k isolation resistor that has handled all problems so far. In some cases an adapter socket can be used—the type that has a one-to-one straight-through wiring with the tube pins brought out to tie points. The second "black box" contains a filter to eliminate the 30 cps from the program material. This could be installed in the machine but that would remove the compatability claim. A sharp high-pass filter or a resonant band-reject filter can be used and in both cases would preserve all the low frequencies necessary for excellent-quality voice recordings. The writer also plans to use a bridged-T configuration in the three-position mixer now being constructed specifically for use with this system and an Ampex model 601 recorder. The necessary filter design to preserve the "external only" criteria presents some formidable problems, mostly financial. While the 30-cps generator is relatively inexpensive, the 30-cps reject circuit can be very costly. To install the filter in the mic line means high-Q coils and large values of capacitors, all of good quality. A balanced mic line also contributes more to the cost. All must be well shielded and if you use mics of radically different impedances, more than one box is needed. These filters are relatively maintenance free, but a transistor or tube type filter could be built, probably at less cost than the passive configurations designed. The author, at this writing, is using a 30-cps resonant reject filter that passes all frequencies from 50 cps up with no attenuation. Theoretically this should work well, but also presupposes that during playback the "acceptance" circuit would pass 30 cps only. In practice this is hard to accomplish, so those circuits also receive enough energy up to approximately 70 cps to affect the sync signal. Manual transfers are possible, however, with the operator ignoring the sync signal display "bounce." A sharp high-pass filter with a nominal 80-cps cutoff would eliminate this problem, but would reduce the desirability of this system for sync music recording. This does not bother the writer because it is firmly believed that music should be done under other than "portable-strapped-on-your-back" conditions. Music should be recorded using studio type equipment only, unless it must be done for an effect or other reasons, but then

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AUDIO, published Monthly at Lancaster, Pa., for October 1, 1962

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher: Charles G. McProud, 204 Front St., Mineola, N. Y.; Editor: David Saslaw, 204 Front St., Mineola, N. Y.; Managing editor: none; Business manager: Henry A. Schober, 204 Front St., Mineola, N. Y.

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3. The known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: none.

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5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue). 35,000

(Signed) HENRY A. SCHOBER, Business Manager.
Sworn to and subscribed before me this 14th day of September, 1962.

(Seal) Edmund H. Strecker, Notary Public.

State of New York. No. 30-3874750. Qualified in Nassau County. Term expires March 30, 1963.

this system will work as well as the other compromises mentioned *before. In* transfer, the sync component must be removed from the program unless the playing equipment will not pass 30 cps. Being an almost pure sine wave makes the chore rather easy either with the normal high-pass filters in all photographic channels or dialog equalization of some sort. In practice it is possible to put the 30-cps signal well below the tape noise and stage noise with no strain and absolutely no change in audible voice quality.

It is hoped that this article will kindle the reader's imagination or dander or both and thus promote more study and search for the "perfect" tape synchronization system. Æ

TRACKING ANGLE

(*from page 24*)

from one record to the next also cause problems of channel separation. It is surprising, but frequently different amounts of crosstalk can be measured with the various records. Sometimes crosstalk is high from the left to the right channel, and low from the right to the left channel, and vice versa.

Figure 7 demonstrates what happens when the pickup is incorrectly positioned. The amount of channel separation will vary with the angle α. If everything is correct in both cutting and playback, two identical curves will be obtained for crosstalk on the left and right channels. However, measurements show that two identical curves are not obtained in all cases. This can be due to geometrical faults in the construction of the pickup, but if these are eliminated it is found that widely differing results are obtained when measuring the various test records.

Figure 7 shows a drawing of the stereo groove. φ is the vertical tracking angle and β is the cutting angle. x is 45 deg., the half angle of the angular distance between the two minimum points for the two curves for crosstalk as a function of the angle variation α.

If we assume that the cutting direction is 45/45 in the cutting plane, there is the following relation between the three angles:

$$\tan x = \frac{\cos \varphi}{\cos \beta}$$

If we know φ and measure x we can thus find β.

Figure 8 gives these curves for various phonograph records. The B & O pickup was used in measuring these.

Since the vertical cutting angle varies from record to record, it is not possible to find any ideal pickup construction until standards can be agreed on.

The fact that the vertical cutting angle is in reality not vertical results in the

determination that the stylus tip should not be vertically oriented. *Figure* 9 shows what happens if the stylus angle is not in agreement with the cutting angle. This is a point which is frequently difficult to impress on people, even professionals. Generally there is the feeling that a pickup stylus should angle forward very slightly in order to avoid damaging the record. In reality this is a great misunderstanding. Due to the recording conditions, the stylus tip should in reality point in the opposite direction, and exactly as much as the cutting angle varies from the vertical line.

After a cold and sober theoretical consideration, the stereophonic phonograph records should in reality be intolerable to listen to. However, practice reveals a different situation. Even though the experienced ear can probably hear the greater distortion, there is no doubt that the stereophonic effect is such a great advantage that considerably more distortion can be tolerated than is the case with mono records. On the basis of listening tests it seems that such high demands for distortion reduction in stereo systems are unnecessary as compared with single-channel systems. This should not draw attention away from the sources of faults that can be removed with the greatest ease by merely establishing standards.

In the IEC-publication 98 and 98-1, which contains recommendation for commercial stereophonic records, the problem about the cutting angle is not mentioned. However this publication is being revised. At the IEC-meeting in Helsinki last year the Danish delegation proposed to standardize this angle at 15 deg.:

(This proposal was made in Europe before the essentially European committee. See the Editorial for further comments about the status in the U. S. Ed.)

The proposal contains the following definition of the nature of the groove:

"The stereophonic groove shall carry two channels of information. The two channels shall be recorded in such a manner that they can be reproduced by movement of a reproducing stylus in two directions at 90 deg. to each other and at 45 deg. to a radial line through the stylus tip and the center of the disc.

"The reproducing stylus motion shall be tangent to or lie in a plane through the stylus tip and the record center, inclined at a nominal angle of 15 deg. clockwise to the normal through the stylus tip as viewed from the center of the disc."

It is hoped that the changing of Publication 98 and 98-1 will be confirmed as soon as possible, and that the different record makers will adopt this standardization as soon as possible. AE

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HEADPHONE CONTROL

(*from page 56*)

It will be noted that some of the circuit values in *Fig.* 4 are different from those in the Bauer prototype. The values in the original circuit were arrived at analytically, and they do not necessarily represent practical values. For example, tolerances on the inductors have been brought into line with those of the rest of the circuit. Also some capacitance values have been changed slightly. An important change is the substitution of 100-ohm resistors for the 600-ohm resistors in series with each source. The purpose of the high resistances was to bring the crossfeed factor below 200 cps as close to unity as possible, but when this was done the insertion loss of the unit increases (more about this later in a discussion of power requirements). The use of 100-ohm resistors results in an insertion loss of 30 db compared with a loss of more than 40 db in the prototype circuit. This is done at the expense of about 1.5 db of crossfeed factor. Listening tests have shown that a difference of this magnitude at low frequencies is not perceptible. But the resulting 10-db decrease in insertion loss, however, is much to be desired.

The balance-control potentiometer plays an additional role. When it is centered each half of it appears in parallel with one of the phones. Since the CC-1 is designed to work with 8-ohm phones the resulting parallel resistance is close to 5 ohms, the desired load. The use of 4-ohm phones is also possible with only a slight decrease in sensitivity.

Operation of the Control Center

Most low-impedance dynamic headphones are remarkably sensitive; a power level of 5 to 10 milliwatts is usually sufficient to drive them to normal peak listening level. If they were operated directly across the output of a power amplifier, hum and tube noise would be quite audible even with the signal present. There would also be the possibility of inadvertent overload of the phones and excessive sound pressure

in the listener's ears when connected in this fashion. Thus it is customary to operate high-quality phones with about 20 db of attenuation in the input to the phones. Resistance in series with each phone is necessary in the Bauer circuit, and this accomplishes the desired attenuation. The prototype circuit has 40 db of attenuation whereas the CC-1 control center has only 30 db. This will give us an idea of what kind of power amplifiers are necessary to drive the system. If 10 milliwatts of power is required for peak output in each phone, then each amplifier channel must be capable of 10 watts output. This should be termed "available" power since it is available to but not actually drawn by the system. Obviously more power would be necessary to drive the prototype. The 100-ohm input impedance of the CC-1 does not represent an ideal load for a low-impedance amplifier output, but in this day of well regulated power amplifiers no problems are likely to be encountered.

The user should first turn down the amplifier volume before switching the unit from phones to speakers since all attenuation is being taken out of the lines. Uncomfortably loud levels may result if this is not done.

The second control from the left on the panel of the CC-1 gives the listener the choice of energizing each phone separately or both simultaneously in either stereo normal or reverse modes. The first two of these positions are to be used in stereo listening, but by using them in conjunction with the middle switch the user can explore the full range of possibilities of the system. It is felt that this flexibility will be of use to experimenters in electroacoustics and to engineers in the recording field.

If a listener wishes to hear a single-channel program, he can do it in a number of ways. He can simply energize one phone (this is the only real meaning of the term "monaural"). Or he can energize both phones with the same signal ("diotic" is the correct term for this). There is listener fatigue associated with the first of these methods since it does not approach any normal listening condition. Finally, the user can place the second switch in either the "Right Only" or "Left Only" position and the middle switch in the "Space Perspective" position. Then the virtual source will be either 45 deg. to the right or left with localization taking place naturally. Listener reactions have certainly favored this way of listening to a single-channel signal.

Subjective Evaluations of Listening With Space Perspective

The Space Perspective system has been used with every type of stereo record-

ing available. As expected, its most dramatic effect is with recordings exhibiting extreme instrumental separation. In a sense listening without it is rather like looking into a stereoscope for which the pictures had been taken with an interocular distance of, say, three feet instead of the normal three inches. Extending our analogy, the effect of Space Perspective on a widely separated recording is like reducing the interocular distance—thus lessening the parallax and drawing the picture into normal perspective. This analogy is only qualitative, for the notion of convergence is not as clearly defined for binaural hearing as it is for binocular vision.

Recordings with an equally-fed center microphone have been mentioned earlier. Where there already exists considerable crossfeed between the channels (that provided by the common microphone), the addition of more crossfeed by means of Space Perspective is rather subtle and in some cases barely noticeable. Recordings made with fairly closely spaced omnidirectional microphones may sound equally well with or without Space Perspective due to the high signal mutuality present in the sources.

An interesting phenomenon observed in using Space Perspective is the apparent elimination of excessive reverberation where there is an abundance of it. The psychoacoustic mechanism is not at all clear, but it is suspected that in these recordings the reverberatory information is different in each channel. Without Space Perspective each ear hears separate reverberatory information; this is not natural and may give rise to a bizarre and unreal sensation of vastness and spaciousness. Adding Space Perspective lessens this difference in reverberatory information thus tending to produce a more natural auditory environment. The ear probably equates a decrease in the sense of vastness with a decrease in reverberation.

Some observers have noted a slight drop in bass when switching to Space Perspective while listening to material with a preponderance of bass in one channel. With the circuit switched in, the two phones are virtually in parallel below 200 cps, and with the rather large series resistances each phone is effectively being driven by a constant-current source. Consequently any change in load impedance will be reflected by a change in voltage across the load. Thus paralleling of the phones at low frequencies reduces slightly the level of any bass present only in one channel. The system is dramatic in its correction of inappropriately recorded material and only slight in its effect on material which already possesses strong signal mutuality between channels. But in every case it preserves the spatial geometry which the recording director had in mind. Æ

Industry Notes • • •

Shure Dynetic Cartridge Patented. The U. S. Patent Office has issued Patent No. 3,055,988 to Shure Brothers for the moving-magnet Dynetic cartridge. The patent also covers the stylus suspension system of some of the Shure Stereo-Dynetic cartridges. Application for the patent was filed on April 8, 1957, upon introduction of the company's original M1 Dynetic cartridge.

New Fairchild Stereo Cartridge. Shown for the first time at the recent New York High Fidelity Show in development form, the new Fairchild "F-7" represents a departure from previous Fairchild designs. Utilizing a transistor amplifier to provide the required gain, the new cartridge concentrates on the main problem of a cartridge, that is to trace the groove properly. Thus, they have designed a very low-mass cartridge which does not incorporate the relatively large generator usually associated with conventional cartridges. The approach is said to offer great promise.

Remote Volume Control Patented. Alexis Badmaieff, holder of 27 patents in the fields of electronics and acoustics and chief engineer of the Acoustics-Transducers at Altec Lansing Corporation, is the inventor of this new concept for remote volume control of sound systems. Called "Revocan," the unit is designed to fulfill remote control needs in churches, arenas, auditoriums, stadiums, theatres, and other areas of mass gatherings. The unit provides means for controlling the gain of an amplifier from a point away from the amplifier's location.

Also, almost simultaneously with the announcement of the above patent, Altec Lansing held its twenty-fifth anniversary management conference. It is one of the largest independent national service organizations and became an independent organization in 1937, when it assumed responsibility for the installation and maintenance of a major portion of the motion picture industry's sound reproducing equipment.

Soundcraft Sales Soar. Although August is traditionally a period of low sales, Soundcraft Corporation announced that it broke all existing sales records for a single month. In addition, it was announced that the company's eight months' sales had set a new record. The entire trend seems to be a continual rise at a very satisfactory rate.

Headphones Win Design Award. Among the top five "awards of excellence" of this year's design competition held in conjunction with WESCON, the Clevite Brush Model ED-300 headphones were cited for "ease of adjustment, performance, and simplicity of construction." The principal criterion of the competition is "product acceptance through industrial design."

Fisher Plans Plant Expansion. At the twenty-fifth anniversary dinner of Fisher Radio Corporation, Avery Fisher announced a massive expansion program. The plans called for the construction of 52,000 square feet of additional manufacturing space to the Milroy, Pennsylvania, facility. Existing space is 62,000 square feet, which brings the projected total to 114,000 square feet. At the same time, Mr. Fisher also reported a planned doubling of the firm's advertising budget for the forthcoming year. The same plans were announced October 16 at a second 25th anniversary dinner hosted by Fisher rep Charles Lienau.

Miracord Distributor Moves to Westbury. Benjamin Electronic Sound Corporation, United States distributor for Miracord, is now located at 80 Swalm Street, in Westbury, L. I., where operations will be housed in an air-conditioned building with more than 10,000 square feet of space. According to Mr. Benjamin, the move was necessary in order to accommodate the expanded sales of their product and in anticipation of new product lines.

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EDITOR'S REVIEW

(from page 18)

(CONTINUED ON PAGE 98)

The above informative legend appeared at the bottom of page 60 in the October issue, thus indicating that the article "Accent on beauty" would continue on page 98. Of course we forgot to mention which issue we had in mind; we obviously didn't mean the October issue. For those readers who might be curious as to how the article ends (Does the headphone plug go into jack A or B? Is it true that the photograph records are stored in the First National Bank next to the mortgage for the equipment?) we concluded the story in this issue on page 4. We were going to wait until the next time we had a page 98 available but decided against it when we got the monthly bill for storage of the type.

to make professional quality stereo tape recordings your recorder must have three heads

All professional tape recorders have three separate heads—one erase, one record, one playback. Record heads and playback heads have different gap widths. A wide gap record head is a must to record all the sound on the tape. A narrow gap playback head is a must to reproduce all the sound from the tape. Professional quality sound on sound recordings can be made only on a recorder with three heads.

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ADVERTISING INDEX

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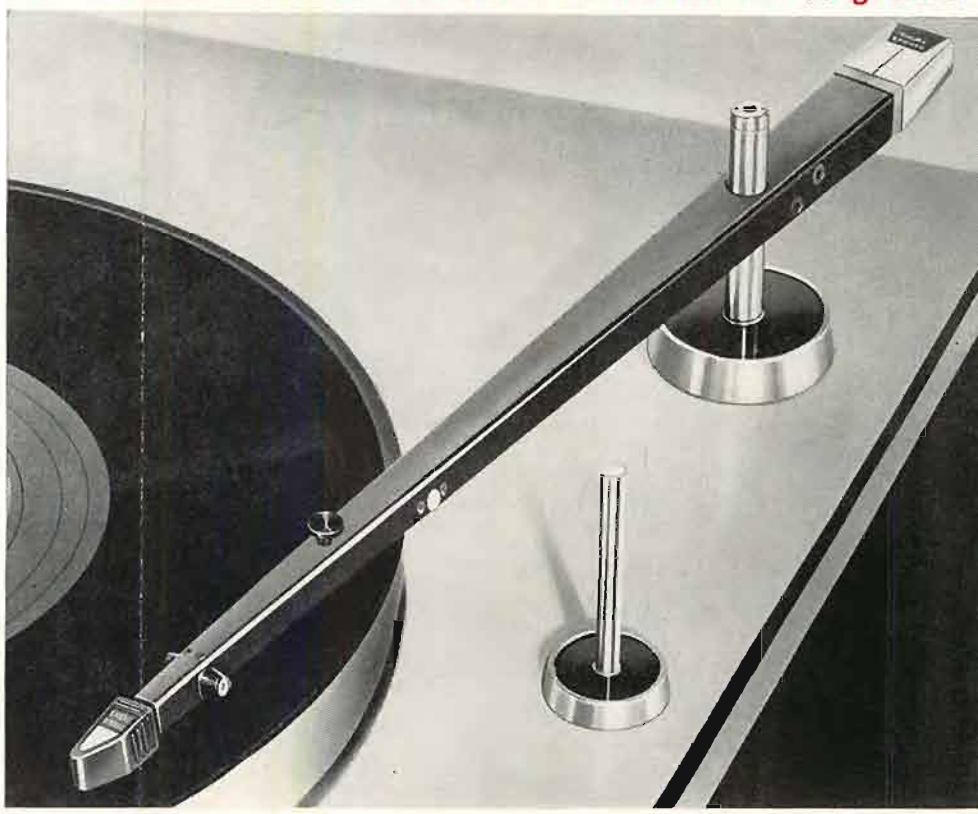

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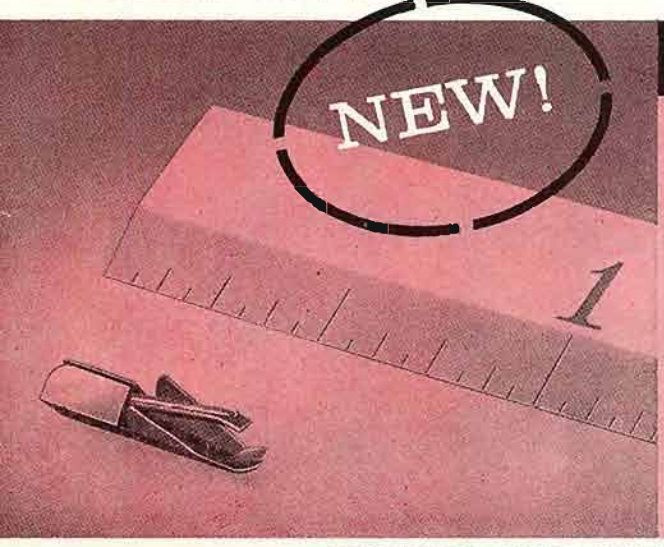
INDUCTANCE	400 millihenrys
D. C. RESISTANCE	600 ohms
STYLUS	.0005" diamond



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LITERATURE: SHURE BROTHERS, INC. 222 Hartrey Ave., Evanston, Illinois, DEPT. A-K

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