AUDIO

DECEMBER, 1959
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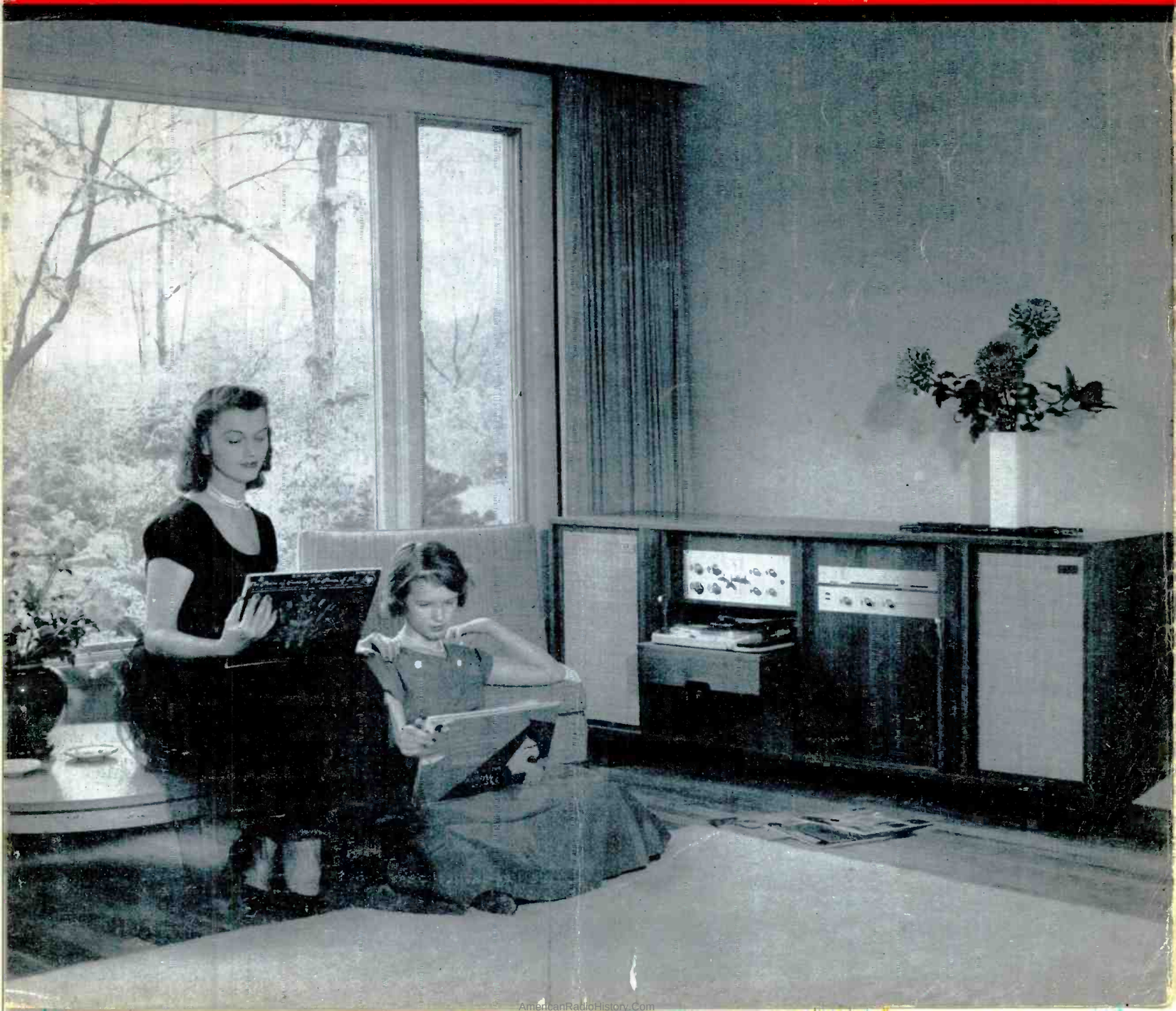

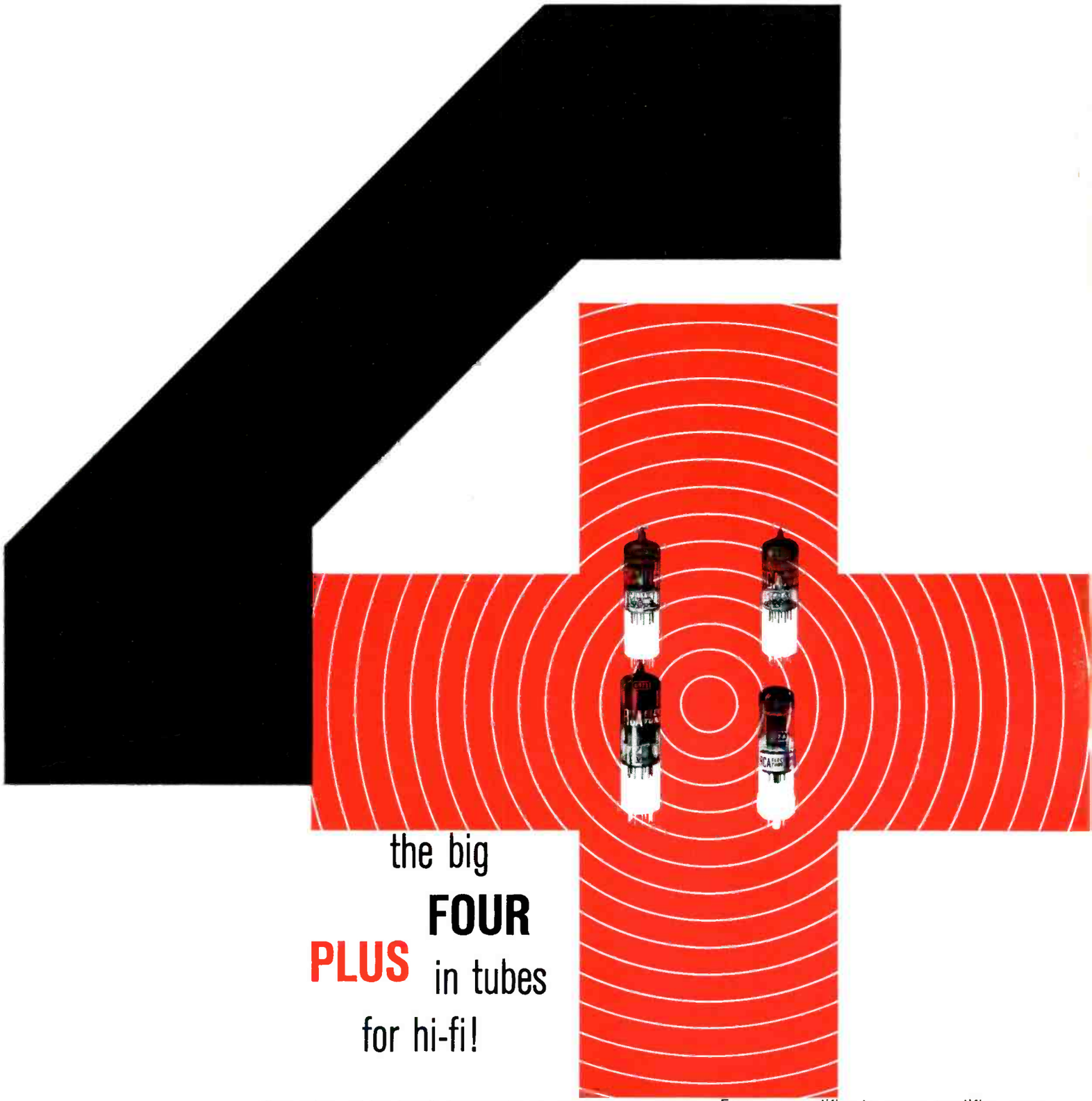

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DECEMBER, 1959 VOL. 43, No. 12

Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

COVER PHOTO—Models Cecile Richardson, senior and junior—wife and daughter, respectively, of AUDIO associate editor Harrie K. Richardson—enjoy some high-quality music reproduction in the new home of hi-fi rep Harold Weiler in Harrison, New York. The equipment shown includes a Grado stereo cartridge, ESL gyro-balance arm, Thorens turntable, Marantz stereo preamp consolette and two 30-watt power amplifiers, together with two KLH Four loudspeakers in an M and K cabinet. Across the room in a matching cabinet is a Movic tape recorder. Problem: Guess what lines Mr. Weiler represents.

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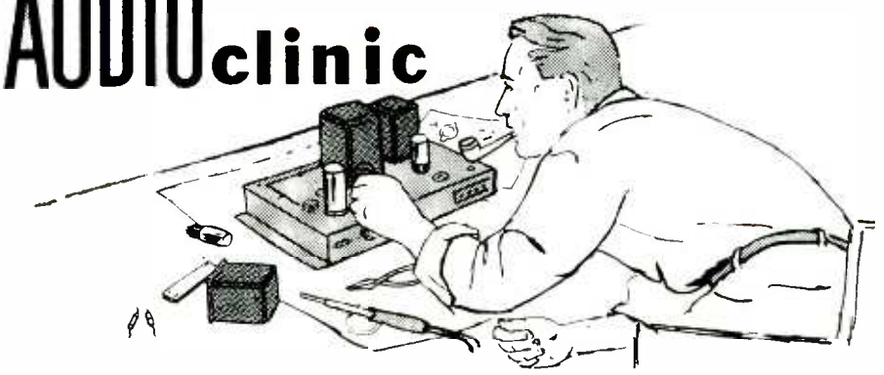

JOSEPH GIOVANELLI*

D.c. Filament Supply

Q. What is the best way of obtaining a d.c. filament supply for preamplifier and power amplifier tubes from my homemade power supply? My power transformer has two 6.3-volt windings, a 5-volt winding, and a center-tapped 800-volt CT winding. Julian Reis, San Francisco, Calif.

A. *Figure* 1 shows one method for obtaining d.c. for your filament supply. You mentioned that you wished to use d.c. on the filaments of your power amplifier as well as on the filaments of your preamplifier. Let me assure you that it is usually not necessary to use d.c. for the power amplifier, especially on the heaters of the output stage. You see, power amplifiers are usually low-gain devices, and therefore, are not especially susceptible to hum. Further, it is costly to apply d.c. to that many filaments, partly because of the rectifier needed to supply sufficient filament current, and partly because of the value of the filter capacitor associated with such a high-current supply.

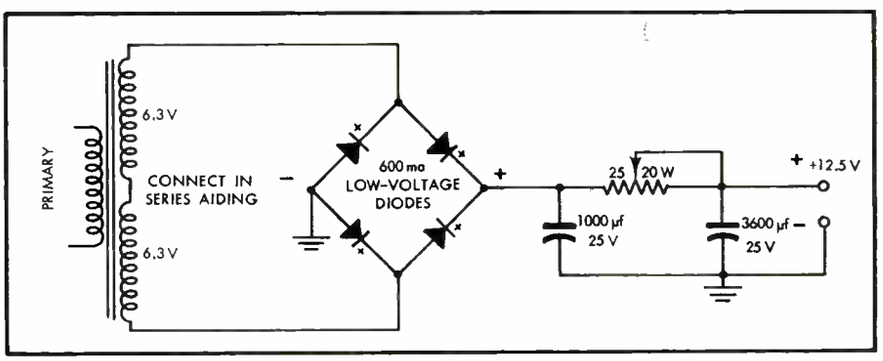

Fig. 1

As *Fig.* 1 shows, connect the leads of your power transformer in series aiding. To be sure that you have them properly connected, measure the voltage across the extreme ends of this network. You should obtain a reading of approximately 12.6 volts. It goes without saying that your preamplifier should be wired for 12-volt operation.

Amplifier Instability

Q. I have the following problems with my recently built Ultra-Linear amplifier.

With the speaker (6-ohm voice coil) connected to the 8-ohm tap and signal applied, measured voltages, from the 16-ohm output to chassis, run 0.1 to occasional peaks of 1.5 v. (orchestra music signal applied), and the needle "wiggles" constantly. Also, the voltage falls constantly as the gain control is turned down.

However, with the speaker connected to the 4-ohm tap, the voltage measures 3.5 v. under the same conditions and varies only at intervals, and then only plus or minus 0.1 volt. Furthermore, when gain control is turned down, voltage falls until about 10 per cent rotation is reached, where it suddenly rises to approximately 5 volts; from there on it falls again. Eric Barnitz, Northport, N. Y.

A. The peculiar voltage readings you experience when the speaker is connected to the 8-ohm tap is produced by instability of the amplifier. The reason that your amplifier is more stable when your 6-ohm speaker is connected to the 8-ohm tap than it is when this same speaker is connected to the 4-ohm tap is simply that under the former condition, the amplifier is loaded down more heavily, thereby reducing the feedback to a point where performance is stable. I recommend that you reduce your feedback by 6 db or that you check to see whether it is optimized by the correct value of shunt capacitance.

A.c. or d.c.?

Q. I notice that I get an a.c. voltage as measured from B plus to ground. This voltage behaves strangely. When I connect the positive lead of my a.c. voltmeter to

* *3420 Newkirk Ave., Brooklyn 3, N. Y.*

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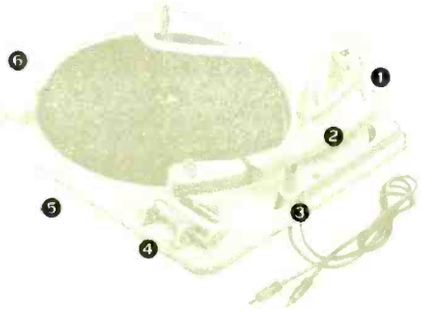

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B plus, and common to ground, no voltage is present. When these two leads are interchanged, I obtain an indication of 750 v. This is peculiar because maximum d.c. voltage is supposed to be 430 v. Please explain this behavior. Eric Barnitz, Northport, N. Y.

A. The meter indicates as it does for two reasons. When the meter is connected in the circuit in one direction, the diode circuit is biased in the nonconductive direction, and hence, the meter receives no voltage. When the meter is connected correctly as far as the diode is concerned, you will get a reading which is 1.414 times that of the actual voltage. This is because the meter would, if nothing were done to it, indicate rms voltages, but the designer of the meter evidently wanted his instrument to indicate peaks. Hence, he adjusted the multipliers so that they would indicate a reading 1.414 times that of the rms value. Since the signal being fed in was really d.c. and not a.c., there was no difference between peak and rms. If this meter were to be used to measure d.c., it would have to be recalibrated. Also, the diode would have to be removed.

Crosstalk and Pops

Q. The inputs and outputs of the preamplifier, power amplifiers, and tape recorders that are used in my stereo system, plus another tape recorder for monophonic dubbing, are all connected with a switchbox for complete flexibility in connecting the various units with one another, to permit either preamplifier to be used in a recording operation while the other is used in a listening operation, to permit dubbing from one tape to another while listening to radio or records, and so on. The two identical preamplifiers through which stereo tapes and records are played are in addition to two dissimilar preamplifier-control-units used for radio, monophonic record playing and monophonic tape recording.

This switching arrangement is very convenient and works admirably in most respects. However, there is a certain amount of crosstalk that can be annoying on occasion. For example, if a radio program is being recorded silently through one of the monophonic control units at the same time that a record or tape is being played through the rest of the system, there is a leakage of sound from the program being recorded which becomes noticeable during quiet portions of the program being listened to. Since this occurs even when the volume control on the control unit used in recording is turned to zero, I assume that the leakage is coming from the tape recorder output of the control unit; but that the audio output also contributes if the volume is turned up.

All of the shielding of connecting cords is grounded to the aluminum control box, and only the "hot" wires are connected to the switches themselves. Is this the reason for the crosstalk? Could it be avoided if double-pole switches were used, and the shielding switched rather than grounded to common?

In some of the switching I found it necessary to use shorting switches (three-

(Continued on page 83)

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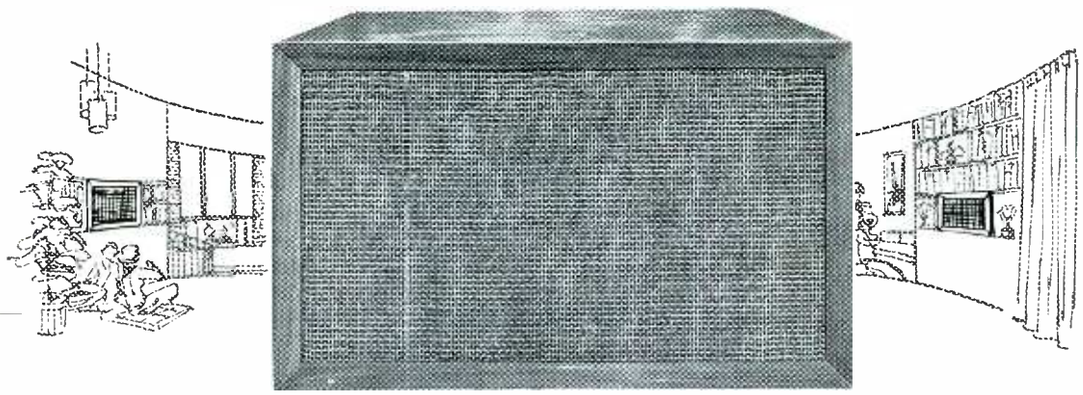

All-New and Incomparable OMEGA I

NEW! KAL Audette

Compact for bookshelf or table, this cabinet of high impedance port construction becomes a consolette simply by attaching matching brass legs. Houses a superb Lorenz 8″ woofer, tweeter and crossover. Frequency response: 35-18,000 cps. Impedance: 8 ohms. Power rating: 18 watts peak. Size: 11″ x 23¾″ x 10″. Gross weight: 16 lbs.

Brown or Blond Leatherette $49.50
Matching Brass Legs 5.95

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NEW! Audette SENIOR

A superior system of advanced audio engineering and decorator beauty. Infinite baffle construction for "big system" performance. Complete with elegantly proportioned 4″ legs. Contains famous Lorenz 8″ woofer and tweeter with high pass crossover. Frequency response: 30-18,000 cps. Impedance: 8 ohms. Power rating: 20 watts peak. Size: 22¼″ x 22¼″ x 10½″. Gross weight: 37 lbs.

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For the connoisseur with an ear for true fidelity—and an eye for true value! The Kingdom Lorenz all-new OMEGA I is a masterpiece of engineering skill and rare decorator beauty—specially designed to be used in pairs for stereo, or singly for brilliant monaural.

Modern slimline cabinet **completely finished on four sides** for use horizontally or vertically—ideal for bookshelf, table top or floor. Constructed of 1⅛″ solid lumber core with selected face veneers of genuine African ribbon mahogany, American black walnut and other choice woods. Joints meticulously crafted for air-tight stability.

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LETTERS

Measurement Standards

SIR:

Establishment of the IHFM Standard Methods of Measurements for Tuners and Amplifiers, as printed in the May, June, and October issues, was surely a big step toward meaningful specifications of hi-fi equipment. However, one glaring omission casts a shadow of worthlessness on the specification of frequency response. The Standards define Frequency Response of Amplifiers solely on the basis of tests with "GAIN, LEVEL, and other controls whose primary function is the adjustment of gain . . . preset to the position of maximum gain," (Sec. 1.10.1) whereas a hi-fi system is rarely operated with all controls wide open. Drastic changes in frequency response are possible when control settings are reduced from maximum, especially in poorly designed equipment, but a rating by these standards provides no clue to response when the controls are set for normal operation. The tuner standards mention this possibility of degraded response but fail to include it in a firm definition of frequency response. (Secs. 6.01, 6.03.07, 7.01 and 7.05.05.)

As an example, the writer's $190 Glorions-Name (no longer made) AM-FM tuner could legitimately claim response of its FM output as "flat ± 1 db to 15 kc" when rated by these standards even though measurements for a perfectly normal setting of the level control showed a 10-db loss at 15 kc.

Specifications, product tests, and magazine reviews which omit essential facts, such as those cited, are unfair not only to the consuming public but also to the manufacturers who carefully design and thoroughly test their products before releasing them for the market.

HAL M. DAVISON,
5119 Connecticut Ave, N.W.,
Washington 8, D. C.

Distortion Reduction

SIR:

I read with interest Mr. Joseph Giovanelli's AUDIOCLINIC column in the October issue. Mr. Giovanelli should be heartily commended by manufacturers and high fidelity enthusiasts for his consistently accurate and informative replies to rather difficult questions.

I can't refrain, however, from taking exception to his reply to Mr. John Kelly's question on IM distortion and detectability. It is my feeling that any reduction of distortion (intermodulation, harmonic, transient, phase shift, etc.) in any link of the recording or playback chain will manifest itself in cleaner and more realistic sound.

Lowering distortion results in less listener fatigue. Proof of this theory can be found in careful listening tests. By direct comparison, using the same tape deck, preamplifier, and speakers, two amplifiers of the same manufacture can sound different if one has 0.8 per cent harmonic distortion and another unit offers only 0.3 per cent distortion. Certain subtleties in the high- and low-frequency response will be immediately apparent to trained ears.

LEON KUBY, Sales Manager,
Citation Kit Division,
Harman-Kardon, Incorporated
520 Main St.,
Westbury, N.Y.

Audio Societies

SIR:

We would like to make contact with audio societies in other localities, and would like to exchange monthly meeting notices with them.

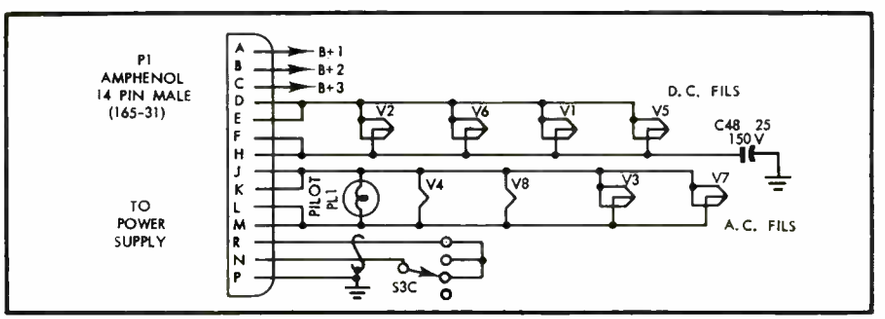
I might add that your subscribers in Washington, D.C., and vicinity might like to know that we meet the last Tuesday of each month at 8:00 p.m. in the Carnegie Institution auditorium, 1530 P Street, N.W., and that we have both a regular and a student membership.

ANTARES PARVULESCU, Secretary
Washington Audio Society,
c/o Washington Academy of Sciences
1530 P Street, N.W.,
Washington 5, D.C.

(We would be pleased to publish a regular and continuing list of all audio societies throughout the world if we could only find out about them. So far, we know of about five, and that is all. ED.)

ERRATA

As it occasionally seems to do, a schematic in the November issue developed a bad case of gremlins. The figure shows the lower left corner of the original drawing corrected to what it should have been. In addition, the plate-load resistor of V_{6B} should have been connected to B+2 and the plate load resistor ov V_{7B} should have been connected to B+1 instead of the reverse. The letters "A" and "B" of the switch section S_{2B} should be interchanged. Aside from these minor errors, the schematic was apparently correct.



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LIKE your classics bright and melodic? Do you enjoy music of the toe-tapping variety? Then "High Spirits" is just for you. This reel of sparkling classics shows you how vibrant and colorful music can be when it's recorded on *Audiotape*.

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AUDIOMAN NO. 3

William M. Mueller, of Parma, Ohio, by vocation a microwave maintenance man for AT&T and by avocation—obviously—an enthusiastic audio hobbyist chosen as third Audioman of the Month.

NOW LIVING WITH HIS FIFTH HOME hi-fi installation, William M. Mueller says his next rig will be bigger and better —his idea of a proper home being "a system with a roof over it." But he still has time for model airplanes, radio and TV DX, photography, and hi-fi building for his friends, and he is an ardent baseball and football fan.

Bill, who is only 35, is quite adept with all sorts of tools, as indicated by his cabinet work, and he takes hi-fi seriously—so much so that his present home, built four years ago, was wired during construction so that he can switch stereo to all rooms of the house as well as the basement and future garage (which he hasn't had time to build, and we can guess why) and yet he is never satisfied. Even one addition has been made since the photograph of the control center was made—sixty colored pilot lights are now mounted in a wooden molding across the top of the console and connected to function as a color organ.

The present system is almost entirely enclosed in the cabinet shown, and consists of a Garrard RC88 changer with a Pickering Fluxvalve for monophonic use; a Garrard TA/Mk. II with a Stereotwin 200 pickup for stereo use; a Bell Model T-203 tape recorder; four Fisher products—a Model 80R tuner, MPX-10 multiplex adapter, and two 80-C preamps; a Bogen STA-1 stereophonic adapter; two 60-watt Dynakit-type amplifiers modified to provide means to measure and balance plate currents; and, at the right end of the control assembly, a home-made switch center, with position indicator pilot lamps to show which room(s) stereo is switched to, and to reverse phase on one channel, as well as to cut in a third speaker for center-channel operation. The control also allows the use of a modified Craftsman Xophonic reverberation unit on the second channel while he is playing monophonic programs on the first. To the right and left of the main cabinet are home-made Karlson-type enclosures with JBL D-130's inside and JBL 075's for the top end. Several other pairs of speakers are located in other rooms all in home-made Karlson-type enclosures and all JBL equipped. The cabinet provides for record and tape storage, and in the lower compartments are the manual record player and the power amplifiers. The Xophonic unit is behind the TV set. Both power amplifiers have regulated supplies, and all units plug together with Jones plugs. The entire system is so constructed as to be serviced from the front, with every component arranged to slide or hinge outward.

In the past few years, Mr. Mueller has helped more than thirty of his friends with the planning and installation of systems, and he has personally worked on seven separate rigs. He'll probably be on his sixth system for his own home before long —just as soon as one of his friends talks him into selling No. 5. And then, as in the old saying, "here we go again." And we say, "More power to him."

Compact, elegant, and completely functional, with a control for everything, all in one place.

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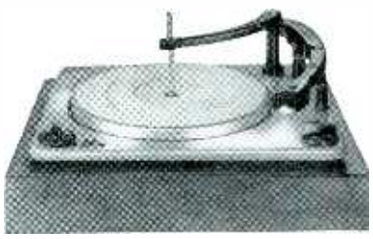
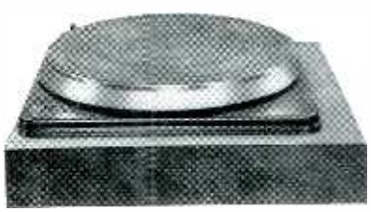


The Coronation II, Model TSC-740—$42.50
*The Conquest II, Model TSC-640—$38.50



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AUDIO ETC.

Edward Tatnall Canby

THREE CHANNELS?

Last month's striking AUDIO cover photo, something called the Forecast Music Sphere, was an inadvertent forecast of the subject-matter of this month's discussion here, an area that will probably keep me and everybody else intermittently busy for a long time to come. I've been worrying behind the scenes for months already without any public showing of distress; I hereby take off with a first stab at the whole interesting question of the Speaker in the Middle, that may, or may not, fill up the famous hole which may, or may not, be there in the first place, and/or which may, or may not, provide satisfactory stereo out of a single bass source.

That's a messy sentence but it expresses the indecision that now reigns all over the place. It's hard to find a proper name for this new trend away from two speakers towards three, since there are a number of overlapping aims involved, both technical and economic. Will it make for a cheaper and simpler stereo—with, say, one woofer instead of two? Or will it make for more expense—with three units instead of two? Do you get better stereo in the same space, or just-as-good stereo in a smaller space, or is the idea to provide, without limit of cost, the absolute ultimate stereo in an even larger spatial set-up? Let the comparisons dangle! Does it cost "more"—or "less"? Phew. I'm really confused myself, having interviewed a number of different promoters of variants on these themes and having studied some literature and a lot of advertising.

I'll end up, this month, with observations on one particular commercial embodiment of the three-speaker principle, but in general my approach, so far, has been to play my cards close, to avoid foreign entanglements, so to speak, to do my own experimenting, such as it is, via home-made approximations of the various principles being promoted. I'm scarcely beginning, even now, though as early as last winter my assistant and I were tinkering in utter ignorance with a center-speaker hook-up that finally produced precisely no sound at all, when we got the two amplifiers in balance. The good old A – B principle!

You can find this neatly described, along with a number of decidedly better ways to go at things, in our October issue, thanks to the boys at Pilot (p. 23, and see the big ad on p. 39). That article is a required technical addendum to this discussion and, may I say, we have just completed here in my home-and-castle a Pilot-type alteration of a non-Pilot amplifier which should provide three *bona fide* channels for three equal speakers, with the middle one A + B, non-cancelling. But I haven't had a chance to try it yet.

Indeed, I'll have to pass quietly by at least fifty nine other fine arrangements, for now, and that includes Paul Klipsch's resplendent three-channel systems, the CBS satellites, Fisher's new baby speakers—satellites too in that they are minus low bass—University dual-voice-coil woofers, Motorola Three-Channel, Aero Third Channel, "magnificent" Magnavoxes and all the rest. I still must absorb, too, a monograph by Klipsch giving ten—count 'em, *ten*—ways to derive an electrical third channel from two stereo tracks. All quite fascinating, intriguing, confoosin' and the question is, where to begin. Where to end

Well, I should say at once that, fascinating or no, I am as yet, *practically* speaking, unconvinced by any of these heady three-way possibilities and "it" is still ending where "it" began, with two fine speakers playing two tracks.

For listening, that is. I'm not persuaded —not yet—that a good stereo set-up needs any sort of enhancement (short of a three-track system straight through), whether to remove holes, widen the listening area, conserve cash or reduce bulk. My stereo system remains basically two-piece and I revert to that arrangement—I have so far—after every excursion into three-way experiment.

Maybe I'm just lucky. *My* stereo is just fine, thank you. But . . . you never can tell, and so while I continue to listen two-way, I continue, on the side, to experiment three-way. For it's always possible that there could be something better; I might be wrong. And in addition, there is an extremely practical matter: if and supposing your stereo for any reason *is* unsatisfactory —and there are plenty of such situations —then isn't it possible that one or another of these ingenious three-point systems could make it better? Or make it cheaper, smaller, more convenient? A big question and nobody has the final answer.

One-Woof

Let's categorize. There are two general approaches to this multiplying of the stereo output. They overlap by about 50 per cent, but you can tell 'em apart, more or less. One line of thought involves a simplifying, space-saving, cost-cutting operation, that seeks to combine the bass end of both stereo channels into one outlet, on the theory that bass is not involved in the stereo effect. This leads to the satellite approach. Keep your highs properly separate, in two speakers, but remove the bass out of them (how far down?) and thereby make them much smaller and simpler. Two little speakers for the stereo, all the bass in one big woofer in the middle, or under the couch or any old place.

Some of the little speakers are semi-microscopic, implying that only the upper middle and the high frequencies are really of any use—also implying that all the rest can be safely put in the neutral middle. Others, more conservative and, I suspect, on sounder theoretical ground, simply shave off the bottom hundred-odd cycles of the full range, leaving everything from perhaps 150–200 cps upwards in the side speakers. Good, because there is a remarkable gain in speaker simplicity here, at a relatively small loss in tonal range. A speaker that responds neatly down to 150 cps and up to the top can be astonishingly compact without serious compromise. As always, it's those last low cycles in the subcellar that make all the trouble for us, and always have since we started asking for them.

So, you see, there are quite fascinating possibilities in this first approach, the One-Woof deal, provided you are really convinced that (a) low bass really, practically, audibly, *does* come out non-directional and non-stereo; *and provided* (b) *that you have discovered an adequate way to combine the bass tones from the two stereo tracks into that one-woof middle.* Ah—what complications here! The mere fact that one company has put out a double-voice-coil woofer, combining the two tracks mechanically, and that another sends the tracks through a matrix and a complete third power "re-amplifier" shows that things aren't as simple as they seem.

Three-Tweet

The other approach I will call, for symmetry, the Three-Tweet. The basic idea here is not to fuss with the bass, but to spread out the top, redistributed into three equal channels. The bass may go along for the ride and probably will. It could even be one-woof, and occasionally is. But the interest, the ear-appeal, is in the three upper-end channels, two "regular" and a third one in the middle. That interest is, of course, heightened by the fact that many a stereo recording, though two-channel in its commercial form, had three channels to begin with an includes direct center-channel information from separate mikes, just waiting—perhaps—to be reassembled into that middle channel.

This Three-Tweet way of thinking is quite democratic, for we find it in the Motorola beach portables (and more of the same), in Pilot stereo consoles and components, and we find it also in the relatively giant Klipsch three-way stereo systems, definitely not in the bargain basement. (I haven't a doubt that these gentry feel themselves quite mutually exclusive and might well deny any similarity between their systems; but for my own categorizing purposes I lump all three as three-tweet threats.) All in all, the general idea of three channels out of two has an exhilleration about it that keeps it very much

(*Continued on page 58*)

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EDITOR'S REVIEW

RECORDING PERSPECTIVE

DURING ONE of the habitual talk-fests commonly engaged in by those interested in the art of sound reproduction, the question came up about the perspective in which a particular recording was made. And with it, came the discussion about how recordings made with different perspectives will sound in various rooms.

Now it is fairly well known in the sound movie business that the sound must appear to be creditable to the scene which accompanies it. For example, an intimate two-shot must have a close-up quality to it, completely free of any "room sound"—which is another name for reverberation. Similarly, an orator on the rostrum in a large hall must sound as though he were actually there—even if the camera moves in for a close-up, there should be some room sound remaining. Sound picture engineers, directors, and producers have become so accustomed to these requirements that it is rare that you hear a sound which is not in keeping with the picture. The one exception is likely to be the case where the camera alternates between long-shots, medium-shots, and close-ups on a singer performing on a stage. Here, in order to keep the singing voice consistent throughout, the sound quality is usually a compromise, and does not change from one camera position to another.

In orchestral recordings, in contrast, there is no picture to guide the listener. However, when one pays close attention to the amount and type of reverberation, he should be able to approximate the microphone positions, particularly with monophonic recordings. Some orchestras are microphoned so that they sound as though they were in a large hall, and the listener seems to be back about 25 rows. A prime example of this type of recording can be heard in practically any number by the Pittsburgh orchestra under Steinberg. The opposite of this gives the impression that the microphones are distributed throughout the orchestra, at no time more than a foot or so from the instruments, and most of the discs from the Westminister Laboratory series are in this group.

In the distant microphoning, the dynamic range is reduced by the "flywheel" effect of the large hall; in the close-up technique, the dynamic range is high. As we see it, therefore, this means that in the home, the distant type of microphoning can be listened to comfortably in a small room, since the reverberation of the performing location is added to that of the listening room, and in this case the reverberation of the hall is sufficient in itself. However, with the close-up technique, listening in a small room gives the impression of being crowded amongst the musicians. On the other hand, if the listening room is larger, one gets the impression of being on the stage with the orchestra, yet not being crowded.

Short of providing some reverberation device in the home, there is very little that can be done about this problem—except to be careful to choose records suited to his particular listening conditions. We have always felt that the close-up quality, such as that of the Westminster Lab series, was interesting, because we do not hold that it is necessary to be transported into the 25th row of some auditorium to hear our music. If the nearness of the performance makes it more interesting to the listener, that is what he should have. But we realize that in most instances we have listened to the Lab records in a rather larger listening room than usual, and that furthermore, we usually have several speakers throughout the house playing simultaneously, giving an increased reverberation, in effect, in the listening area.

Makes an interesting experiment, though. Just try listening to extremes of reverberations in both large and very small rooms. Should provide the subject for a whole evening's experimentation—and enlightenment.

And that is practically our last word for this year, except that

The Editors and Staff of **AUDIO** *wish you a Merry Christmas and a Happy New Year*

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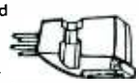

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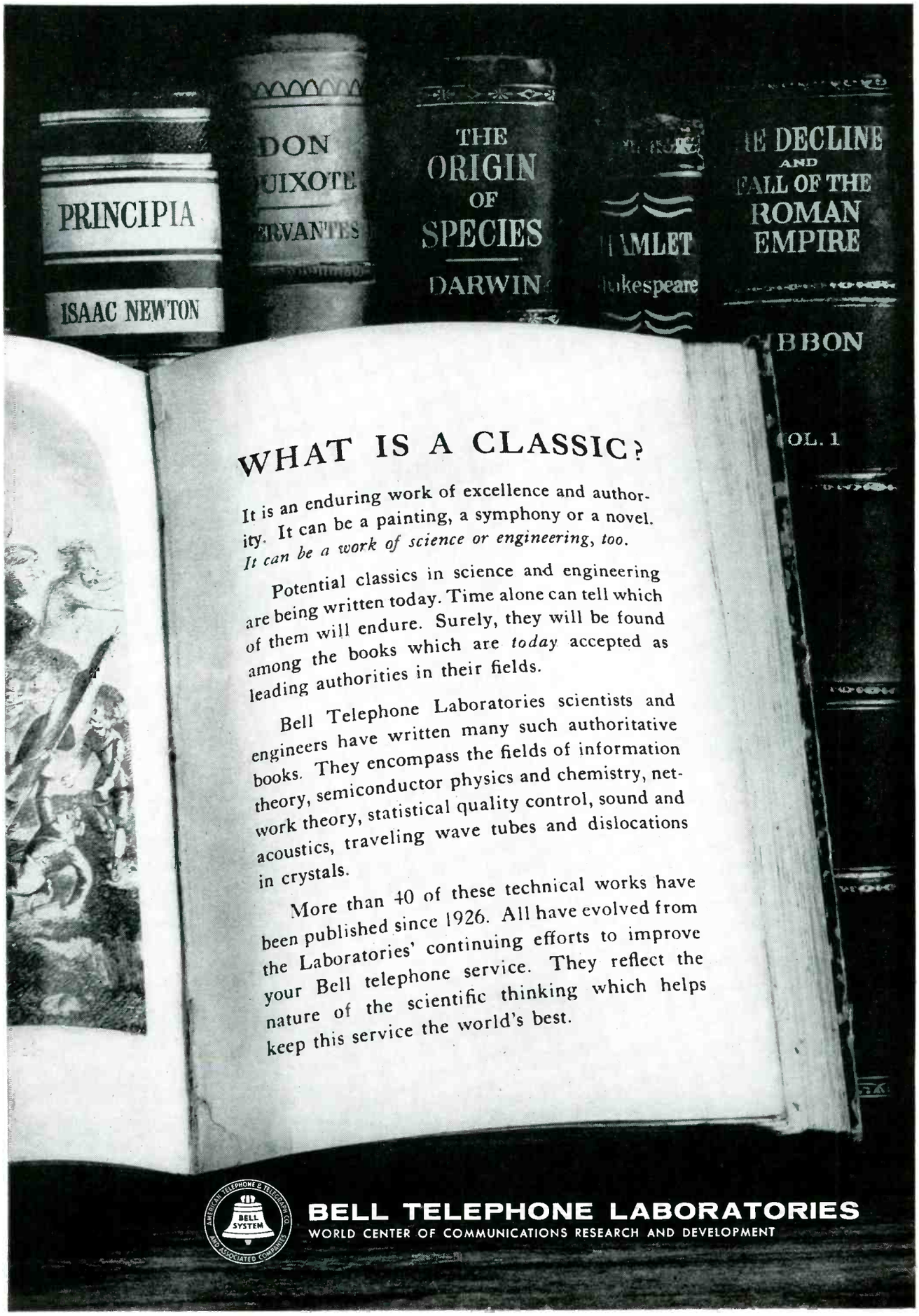

The Low-Loading Self-Biased Amplifier

L. B. DALZELL*

Low loading has been suggested as a means of improving self-biased amplifiers. The author discusses the modification of conventional amplifiers to this mode of operation.

IN A SERIES of articles on amplifiers for high-quality sound reproduction published in *Wireless World* for May and June, 1955, W. A. Ferguson of Mullard of Britain presented some thoughts on what he called "low loading" as a means of improving the performance of a self-biased push-pull output stage.

In the booklet *"Philips Hi Fi Amplifier Circuits,"* published in 1958 in Holland, the same statements on low loading are covered, and are expanded into more concrete form.

The following is quoted from the Philips booklet: "The operating conditions for class AB normally recommended and published by the tube manufacturers are based on measurements with continuous sine-wave drive. The cathode resistor is so chosen that under zero-signal conditions the tubes are operated in class A, whilst at full drive the working point is shifted to class-B setting. The anode-to-anode load resistance

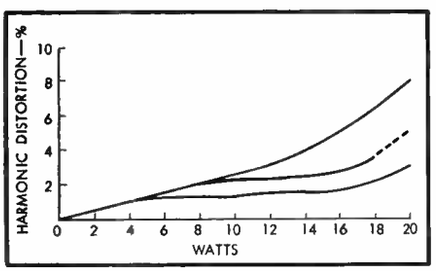

Fig. 1. Distortion of push-pull EL84's. (A), cathode-bias, 8000-ohm load; (B) fixed bias at same bias and load as (A); (C) fixed bias, 6600-ohm load, optimum bias. All measurements made with continuous sine-wave input.

is chosen for optimum performance in class-B setting at full drive. The shifting of the working point is due to the influence of the increased anode and screen-grid currents on the cathode bias. For a typical output stage with two EL84 pentodes on a supply voltage of 310 v. the increase in cathode current, and hence the control-grid bias, is about 40 per cent with a sinusoidal input voltage.

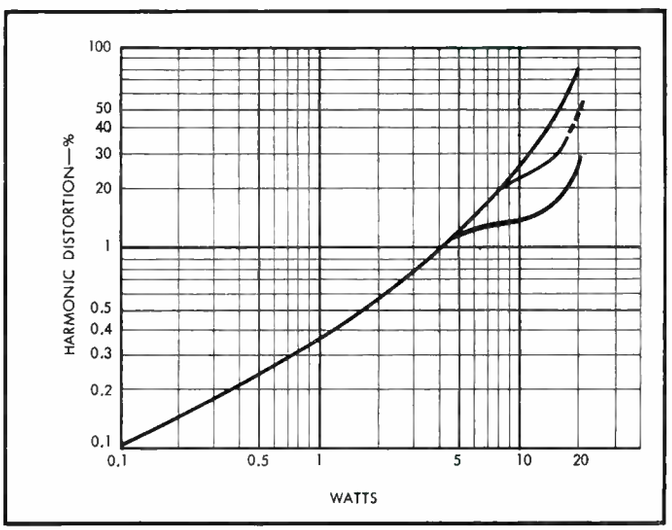

Fig. 2. Same curves as plotted in Fig. 1, but on logarithmic graph.

"When, however, such a power stage is used for the reproduction of speech and music, operating conditions are rather different. The mean-amplitude signal is now very small compared with the peak value which occurs from time to time, and the mean variations in cathode current are therefore also very small. Due to the relatively long time constant of the cathode resistor and its bypass capacitor, the shifting of the working point, even under peak-signal conditions, is small enough for the stage to be considered as working with a virtually fixed bias. If the normal class AB stage (cathode biased) is measured under the corresponding fixed-bias conditions with a sine-wave input, it is found that at high output levels the distortion is greater than when cathode bias is used. . . . In practice, a cathode-biased class-AB stage designed on a sinusoidal-drive basis will produce increased distortion when peak passages of speech or music are being reproduced."

The foregoing thoughts have presented a challenge to the author for some time, and so it was decided to attempt to verify or refute the low-loading idea through experiment. Mr. Ferguson presented a graph to illustrate his points, and tests were undertaken to verify the claims. Finally, similar results were obtained and are presented in *Fig.* 1. The conditions under which the measurements were made may be of some interest. The push-pull EL84's were resistance loaded and driven from an extremely pure dual-phase source. Adjustments were made at the zero-signal condition to maintain exactly 300 volts between the anodes and cathodes of the EL84's. Harmonic distortion was measured from anode to anode of the push-pull pair, as was the power level. There was no feedback. Curve A depicts the output stage distortion with a common 130-ohm bias resistor and an 80-μf bypass capacitor, with 8000 ohms anode-to-anode load. Curve B represents the same load, but with the bias fixed at the same point as zero signal for A. Curve C covers the optimum fixed bias condition with a 6600 ohm load. The voltages for the curves were:

	A	B	C
Anode voltage	310	300	300
Cathode voltage	10	0	0
Grid voltage	0	−10	−12
Screen voltage	300	290	290
A-A load, ohms	8000	8000	6600

* *1162 Fleetridge Drive, San Diego 6, Calif.*

As logarithmic scales are usually used to illustrate power and distortion as the ear hears them, *Fig.* 2 is simply *Fig.* 1 redrawn on logarithmic form, which tends to reduce the apparent difference in the three modes of operation. Nevertheless there is a substantial difference in the curves above the 8 watt point, and as power peaks could fall in that area, it was considered worth pursuing the subject further.

The quotation continues, "One method of improving performance is to adjust the quiescent operating conditions in the output stage so that they are nearly optimum for fixed-bias working, although cathode bias is still used. This entails a smaller standing current and lower anode-to-anode load resistance."

Proof of the Theory

An amplifier using EL84 output tubes was constructed using a 8000-ohm Triad S142A output transformer in the circuit of *Fig.* 3. The IM distortion was under 0.6 per cent up to 14 watts. A KLH Six speaker was used, and a recording voltmeter was connected to the common output-tube cathodes. Music was then played at increasingly louder levels until audible distortion was evident on extremely loud dynamic peak passages. It was found that the maximum deviation of bias was about 0.25 volts under these conditions, so that for practical purposes the bias was fixed. Audibly, distortion appeared at the same output level when either pentode or tapped screen output was used.

The amplifier was then converted to "low-loading" by substituting a 6600-ohm Triad S146A output transformer for the S142A. The self-bias network resistance was increased to 220 ohms to reduce the total cathode current in the EL84's to about 50 ma. Up to one watt output, IM distortion was under 0.1 per cent, and when tested with a steady input, distortion rose drastically as the drive was increased. At zero signal, bias was 11 volts. The same music as before was played over and over again at comparable and even higher levels, using the same speaker and input. A group of experienced listeners could detect no "break-up" or distortion. In this case the bias deviation was under 0.5 volt.

The amplifier was then arranged with both output transformers connected through a multicontact transfer relay that also changed the bias network when operated. This made possible almost instant switching between conventional and low-loading modes of operation. Listeners were allowed to switch back and forth at will, but with only the knowledge that they were trying two amplifiers. At low levels, there was no definite pattern of choice. At high-level listening, all 24 listeners chose the low-loading amplifier. Later, pentode and tapped screen "low-loading" modes were compared, with a fairly even split of choice. These trials were spread over a two-week interval.

A second amplifier, using EL34's and a 4000 ohm Triad S152A output transformer was built to check low-loading with more powerful tubes. The total EL34 cathode current was adjusted to 92 ma. See *Fig.* 3. At up to four watts this unit measures less than 0.1 per cent IM distortion, which rises quickly as steady sine wave input is increased, and as the bias increases. With music, the maximum bias deviation was 0.5 volts when driving the KLH Six, and 0.9 volts when driving an AR-1—again at levels near the testers' limit of tolerance.

This more powerful amplifier has been repeatedly A-B tested against the author's 60-watt fixed-bias amplifier, which was described in the March, 1959, issue. There is no detectable difference between the two in listening tests, although the author feels that the tapped screen connection improves the low-loading unit.

As a final series of tests, the AR-1 speaker was used with the conventionally loaded EL84 amplifier of *Fig.* 3. As the recording meter available was a two-trace device, the first channel was connected to monitor the power delivered by the amplifier, and the second channel was connected to a push button to act as a distortion-point indicator. Once again music was played at loud levels with the observers concentrating on operating the push button as they detected "break-up" or distortion. Even with this

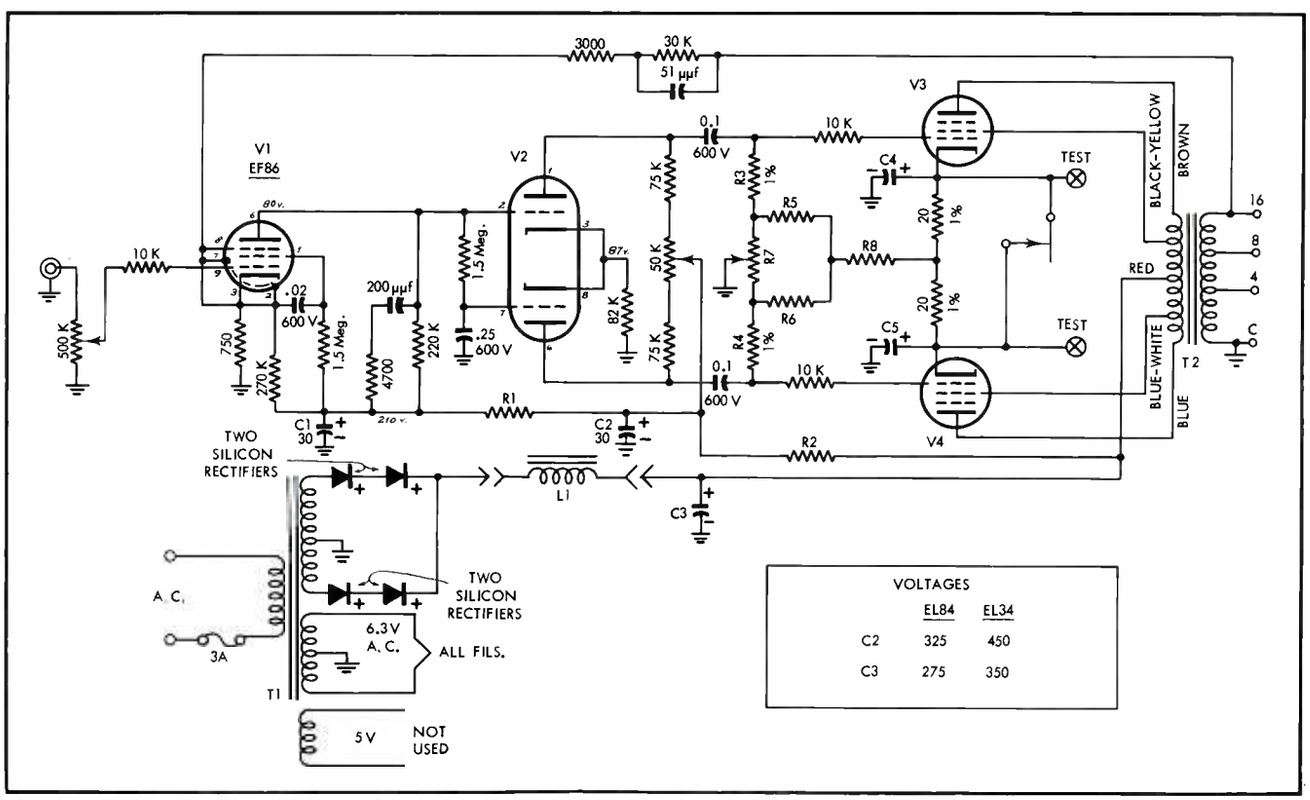

Fig. 3. Schematic of the amplifiers tested. See parts for values not on the schematic. The circuit is derived from the popular Mullard amplifier, and may be adapted for EL84 or EL34 output tubes.

very low efficiency speaker and moderate power amplifier, the average power required for music is quite low, running between two and four watts. Peaks where distortion occurred are a different case however, for they could not be measured accurately, but apparently ran frequently into the upper thirty watt level. The duration of peaks, however, was extremely short, and to the author's disgust, was once again unmeasurable with the test equipment available. The evidence of the meter indicates that extended periods of distortion, up to a second, are actually a series of peaks and not continuous high power.

Summary

From this last series of tests it was concluded that an ideal amplifier is one that will coast along with average sound, yet reach effortlessly and successfully for the peaks. Thus far it must be concluded that a fixed-bias amplifier, or a comparable low-loading unit, best meets this requirement. Of course the amplifier should be matched to the speaker in potential power to efficiency, and a pair of EL84's is not quite enough for the AR-1 or AR-3, but they will handle almost everything else available today if properly loaded.

To recapitulate:

1. Self-biased class AB amplifiers require cathode bypass capacitors, hence have a bias time constant, and with music and voice are effectively operating with fixed bias.
2. If such amplifiers are loaded and the current adjusted as for fixed-bias conditions, they appear to sound clean, but they cannot be measured with steady-state signals except at low levels.
3. Low-loading reduces current through the output stage, hence the output tubes are at a low dissipation level.
4. The low current reduces power-supply requirements, and transformers run cool by comparison.
5. Low-loading retains the simplicity and safety features of self bias.

The author realizes full well that empirical data from listening tests are far from conclusive. It has not been possible to measure transient or high-level distortion in low-loading amplifiers thus far, and it could be argued that we need a new method of distortion measurement using random signals similar to music wave forms. It could also be said that the effects of feedback are neglected in comparing the value of low-loading with conventional operation, but in this area it is difficult to refute the practical demonstrations previously cited, and which can be readily duplicated by anyone so minded.

It would appear appropriate to close with a final quotation from the Philips booklet, "The low-loading adjustment provides reduced distortion at peak levels, although the improvement may be hard to detect until the ear is accustomed to high-quality reproduction, because it affects such short intervals of time."

PARTS DIFFERENCES BETWEEN EL84 AND EL34 AMPLIFIERS

Part	EL84	EL34
C_1, C_2	30 μf, 450 v	30 μf, 500 v, electrolytic
C_3	60 μf, 450 v	60 μf, 500 v, electrolytic
C_4, C_5	50 μf, 50 v	50 μf, 150 v, electrolytic
L_1	Triad C10X	Not used
R_1	39 k ohms, 2 watts	100 k ohms, 2 watts
R_2	15 k ohms, 2 watts	39 k ohms, 2 watts
R_3, R_4 (1 %)	500 k ohms, 2 watt	300 k ohms, ½ watt
R_5, R_6 (wirewound)	100 ohms, 3 watts	50 ohms, 3 watts
R_7 (wirewound pot)	100 ohms, 4 watts	200 ohms, 4 watts
R_8 (Low Loading)	160 ohms, 10 watts	300 ohms, 10 watts
R_8 (Conventional AB)	70 ohms, 5 watts	200 ohms, 10 watts
T_1 (Low Loading)	Triad S-146A 6600 ohms p-to-p	Triad S-152A 4000 ohms p-to-p
T_2 (Conventional AB)	Triad S-142A 8000 ohms p-to-p	Triad S-146A 6600 ohms p-to-p

MISCELLANEOUS DATA

T_1	350-0-350 v at 200 ma; Triad R-20A or B
Silicon Rectifiers	Four required with minimum P.I.V. of 400 v and minimum d.c. output current of 0.5 a.
V_2	ECC82/12AU7, 6CG7 (pins 8 and 9 strapped), 6SN7, or ECC83
V_3, V_4	EL84 or EL34; when EL34's are used, pins 1 and 8 should be strapped.

Notes on the Amplifiers

The two amplifiers used for low-loading experiments derive directly from the 60-watt unit described in the March, 1959, issue. While these amplifiers use a full-wave center-tapped power supply, the voltage-doubler supply described in the earlier article is recommended for the larger amplifier using EL34 output tubes.

The circuit derives from the "Mullard" 510 and 520 circuits, and borrows the Ampex front end. The d.c. balance network is a variation of Williamson's original, and appears to be the most satisfactory arrangement yet devised.

D.c. balance of both units is simply checked with a meter across the test points, the shunting key is opened, and the balancing potentiometer adjusted for zero indication.

A.c. balance is best set with a distortion meter. The shunt key is held open, signal is applied, and output distortion is adjusted to the minimum point with the 50,000-ohm potentiometer. Alternatively, the following method may be used:

1. Reduce the value of R_8 to the conventional value.
2. Load the output with a power resistor load.
3. Connect a voltmeter to the test points. Use a 3-volt scale or lower.
4. Drive with 50- or 60-cps input to near maximum power.
5. Open the cathode shunt key.
6. Adjust the 50,000-ohm potentiometer to zero the meter.

A third and least accurate method is to adjust the 50,000-ohm potentiometer to 105,000 ohms between pin 6 of the phase splitter and the arm of the potentiometer.

The smaller amplifier, *Fig.* 3, makes use of a full wave center-tapped power supply, with an inductive input filter for good regulation. It is interesting to note that the same power supply may be used for the larger EL34 amplifier by simply eliminating the choke and changing the 60-μf capacitor to a 500-volt unit, thus delivering 450 volts with capacitor-only filtration. It is the author's opinion that additional filtering is superfluous.

The units run cool because they are idling most of the time. Hum and noise cannot be measured on the 0.01-volt scale of the a.c. meter available, and no hum or noise is detectable in any speaker that has been connected.

Both units are designed on an extremely conservative basis, and if at least 100 per cent dissipation margin is used in selecting resistors, both low noise and long life can be expected. In the test amplifiers, 2-watt carbon resistors were used at all points unless wire wound or 1 per cent resistors are specified. The perfectionist will probably use low-noise deposited carbon or metal film resistors.

There is some difference in components between the large and small unit, and these are covered in the parts list. Æ

Hi-Fi Performance from Small Speakers

CHARLES F. MAHLER, JR.*

Everyone talks about multiple-speaker systems using an array of small speakers, but hardly anybody does anything about them. This author is an exception, and the results seem to warrant the effort.

IT IS OF INTEREST to observe the relatively small amount of information available concerning the use of small speakers for high fidelity sound reproduction. The author has spent the last two years experimenting with these small speakers. A great deal of mis-information exists relative to the merit of inexpensive speakers.

The speakers selected for use during our tests were the six-inch size. These speakers were purchased for about two dollars each. The magnet sizes were generally under one ounce. The voice-coil diameter was 9/16 in. They were rated by the manufacturer as two-watt speakers, and the type generally found in inexpensive table-model radios. We selected this type of speaker because we felt that it represented the one easily obtained from many outlets at a reasonable cost.

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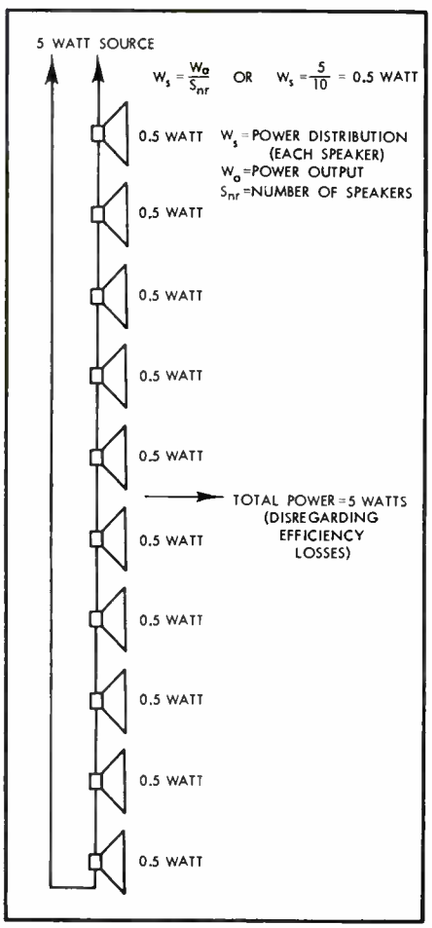

Fig. 1. Arrangement of ten speakers showing how the power is divided among them.

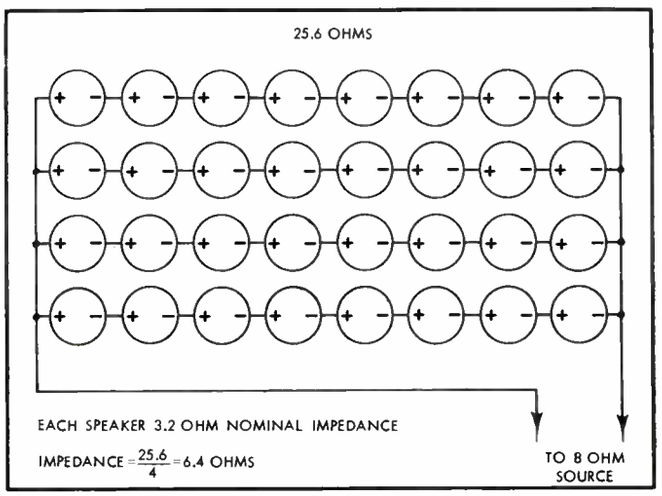

Fig. 2. A thirty-two speaker array divides the power into infinitesimal portions for each speaker. Note polarity of connections.

To qualify as high fidelity, a loudspeaker should be able to reproduce the entire audio range without exceeding a distortion level of 5 per cent. It also must reproduce this range at volume levels that may equal the original performance. The frequency response should not be less than from 30 to 15,000 cps within 5 db. The speaker should be able to reproduce sharp transients without excessive ringing or overshoot. The speaker resonance shall be below 100 cps in order to assure us of adequate bass response.

The above specifications are considered by many people as conservative and perhaps not good enough to be considered high fidelity. However, it is interesting to note how very few high-quality speaker systems on the market today do meet these specifications. In any case, we can safely say that the six-inch speaker described earlier will not be able to qualify under the terminology "hi-fi." So it seems as if we have talked ourselves out of considering six-inch speakers for hi-fi applications. Let us explore the possibilities of using more than one six inch speaker. Why not five, ten, or twenty? Why not as many as one hundred arranged as a large bank? We must then consider the six-inch speaker in a much different light than we did as a single unit.

Multiple-Speaker Systems

Before we get into the details of multiple speakers as used for h-fi, let us first review some of the problems encountered in reproducing the low bass frequencies. Many speaker systems which boast of reproduction down to 30 cps or lower simply do not reproduce these frequencies at a sound level that can be heard. True, they will reproduce these lower octaves of bass but the sound intensity or volume level is not sufficient to be *heard* unless you place your ear close to the speaker cone or cabinet. Because of this problem, most hi-fi users will add artificial bass boost in one form or another with their amplifier. This artificial bass emphasis cannot achieve the natural sound of true bass. Even the very finest systems available suffer from lack of bass power. The *quality* of the bass response might be excellent but the ability of the speaker system to drive this bass power into the listening area is almost always sadly inadequate. This

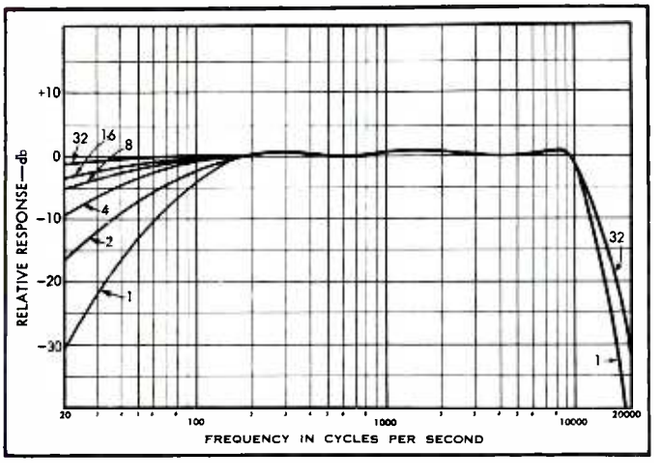

Fig. 3. Frequency response of multiple-speaker array.

is especially true at room listening levels encountered in the home. It is one thing to reproduce bass in a theatre at high volume levels, but another thing indeed when you try to move this into the home. Unless room acoustics are near perfect and unless the system is strategically located, we cannot hope to get natural bass response below 40 cps with single fifteen- or twelve-inch speakers. Again, may I emphasize that I am speaking of bass response you can *hear* without boosting of the bass.

It has already been shown by many experts in the field who have written about this subject before, that the cone excursions necessary for a fifteen-inch speaker to reproduce a 20-cps fundamental at a level which would be audible at a distance of twenty feet from the speaker, exceeds the design limitations which have been considered practical. This means that it is not possible to hear a 20-cps tone on a system that has the volume or gain control set for normal level of listening. Of course, we could turn up the volume and hear it, but the volume would be ear splitting for the rest of the frequency range. Bass boost or loudness correction or a little bit of both are the only alternatives if you like your bass to be heard. It is evident that the problem is one of "moving air" at these lower fundamental bass frequencies.

The answer to adequate bass response is not one of speaker size. The author has had a great deal of difficulty in convincing skeptics that a six-inch speaker will respond to a 10- or 20-cps tone. The only way to convince these people is to show them with their own ears. Suppose we take one of the small speakers mentioned and connect it to the output of a good audio amplifier. Then we connect a signal generator to the input of the amplifier. My generator happens to go down to 10 cps. When we apply this 10-cps signal to the speaker, we can see the cone move. We must be careful to keep the level down low so as to avoid overloading the speaker. It will be possible to count the vibrations of the cone at 10 cps. We cannot hear this 10-cps tone but we can see the cone move. Once we have established that this is true then the skeptic no longer doubts us and we have advanced further along in our experiment.

Cone Movement

This small movement by a single six-inch speaker is not enough to be of any value by itself. If we were to increase the gain of the amplifier so as to try and hear this tone from the speaker we would drive the voice coil out of its linear flux region. When this happens, the cone may be forced to move twice for every single cycle. This is called doubling. Instead of hearing 10 cps we will hear what seems to be a distorted 20-cps tone. Operating this small speaker at more than its rated ability will possibly result in damage to the voice coil.

The non-linear movement of the voice coil in the magnetic gas is the prime source of distortion at low frequencies. In order to use these small six inch speakers successfully we must operate them well within the linear portion of the magnetic gap or flux. If we keep the operating level below one watt we can be assured that the voice coil will stay within this area under all types of wave shapes likely to be handled. Let us now connect ten of these speakers across the output of the amplifier. If we adjust the output of the amplifier for a five-watt level, then we can assume that only one half a watt appears at any one speaker (see *Fig.* 1). We divide the number of speakers into the wattage. Let us carry this a step further and connect 32 of these six-inch speakers across the amplifier, as in *Fig.* 2. At this same output level of five watts from the amplifier, each speaker then only handles about 0.15 watts of power. At a 32-watt operating level, each speaker would only reproduce about one watt of the total power output. With 32 of these speakers as shown, it would seem that for all practical applications in the home, it would not be possible to overload this system. After all, who ever plays his system at a 32-watt level?

The effect of operating all 32 of these speakers from the output of an amplifier is no different than operating two or three 15-inch speakers. As far as the amplifier is concerned, it still is looking into an inductive and resistive load. If we connect the speakers in a series-parallel arrangement as *Fig.* 2, we can keep the impedance within acceptable levels. It is indeed possible to achieve a near-perfect impedance match, just as it

(*Continued on page 92*)

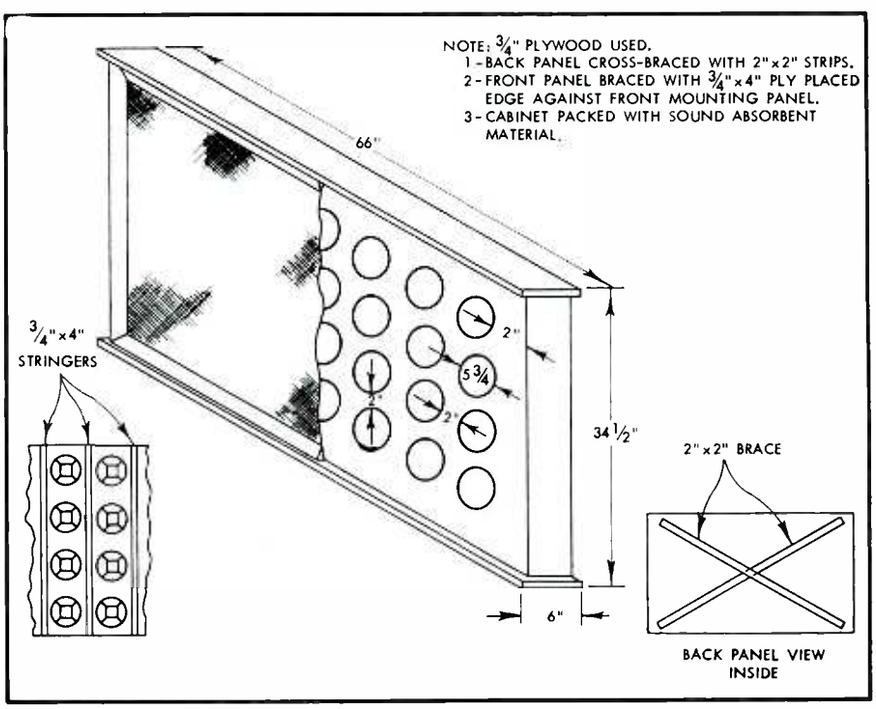

Fig. 4. Suggested cabinet construction for the thirty-two-speaker system.

Determining Screen Grid Dissipation in "Ultra-Linear" Amplifiers

A difficult parameter to measure, screen dissipation yields to this method. Designers should know what the dissipation is if ampliers are to operate satisfactorily over long periods.

LEONARD KAPLAN*

AN IMPORTANT CONSIDERATION in the design and adjustment of amplifiers using beam power tubes in screen-grid (grid No. 2) feedback circuits ("Ultra-Linear" amplifiers) is screen grid dissipation under maximum-signal conditions. In amplifiers of this type (see *Fig.* 1), grid No. 2 of each tube receives a fraction of the a.c. plate voltage of the tube, as well as a d.c. voltage, and contributes a portion of the power output. As shown in *Fig.* 2 the screen grid dissipation varies with the signal amplitude, and is always less than the product of the d.c. screen grid voltage and current. If this dissipation is less than the permissible screen grid input for the tube type used, it may be possible to obtain higher power output from the amplifier by an increase in the d.c. supply voltage E_{bb}. If this dissipation exceeds the permissible screen grid input, it will be necessary either to reduce E_{bb}, or to increase the fraction of the a.c. plate voltage applied to grid No. 2 to assure that the permissible input is not exceeded.

Determination of Screen Grid Dissipation

Although the screen grid dissipation in an "Ultra-Linear" amplifier circuit can be calculated by an involved integration procedure, a much simpler approach is to apply a sine-wave signal of maximum amplitude to the circuit, measure the a.c. and d.c. components of the resulting screen grid voltage and current, and then determine the dissipation from the relationship

$$P = EI - ei \qquad (1)$$

where P is the grid No. 2 dissipation, E and I are the d.c. screen-grid voltage and current, and e and i are the rms values of the a.c. screen-grid voltage and current.

A method for separating the a.c. and d.c. components of the screen grid voltage and current by the use of a blocking capacitor and high-impedance choke was suggested by F. Langford-Smith in *Radiotronics* for July, 1955. It is much simpler, however, to use the arrangement shown in *Fig.* 3.

In this arrangement, the d.c. screen grid voltage is assumed to be equal to E_{bb}, and measured with the d.c. voltmeter M_1. The d.c. screen grid current I is measured with the d.c. milliammeter M_2, and the rms value of the combined a.c. and d.c. screen-grid currents I_t is measured with the thermocouple milliammeter M_3. The power-output meter is used to measure the maximum-signal power output P_o delivered by the amplifier into its rated load resistance R_L.

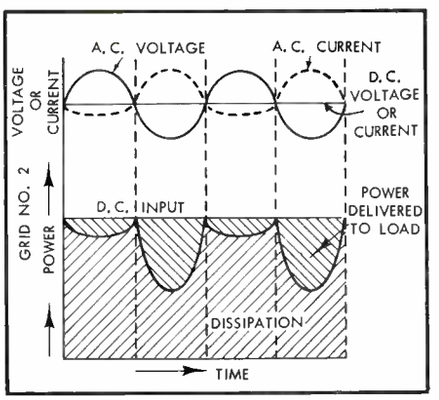

Fig. 2. Typical screen grid voltage, current and power waveforms in a screen-grid feedback amplifier.

Procedure

The circuit is adjusted to provide the desired operating conditions, and the maximum-signal values of P_o, E_{bb}, and I_t determined from the indications of the corresponding meters. The rms a.c. screen-grid voltage e may then be determined from

$$e = \frac{1}{2}\frac{N_s}{N_p}\sqrt{R_L P_o} \qquad (2)$$

and the rms a.c. screen-grid current i from

$$i = \sqrt{I_t^2 - I^2} \qquad (3)$$

(*Continued on page 98*)

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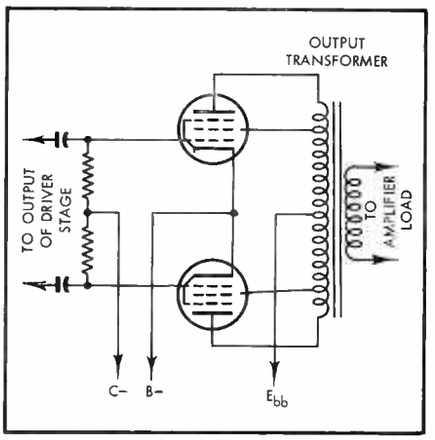

Fig. 1. Simplified circuit of amplifier using screen grid feedback.

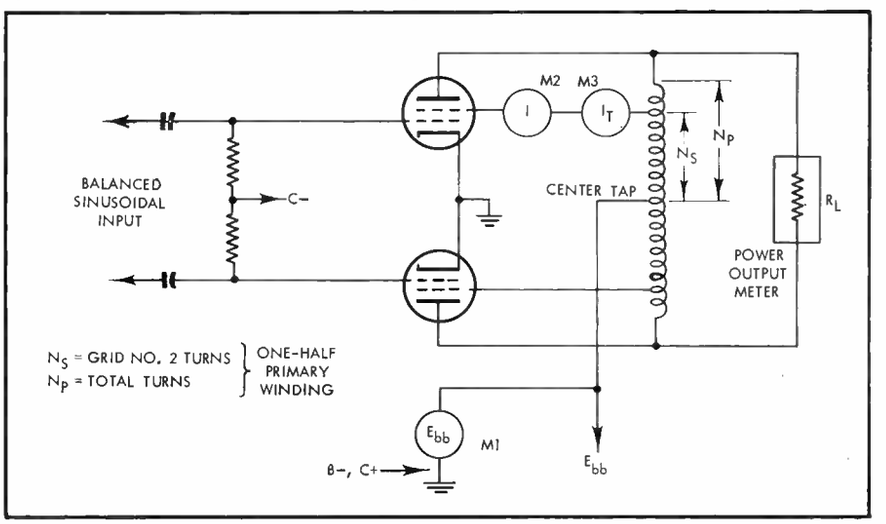

Fig. 3. Setup used to determine screen grid dissipation.

The Parabolic Attenuator

An approach to multiple loudspeaker volume control, with a table showing values for attenuators with various numbers of steps.

H. A. SCHWAN*

IT IS SOMETIMES desirable to separate a loudspeaker from it driving source by a considerable distance. Public address systems and domestic audio systems having speakers in various parts of the house are two common examples. The latter belongs to a class of equipment in which it is often desirable to control each speaker output independently and/or at the speaker location. The simplest approach to this problem is to equip each speaker with an attenuator and maintain a constant signal level on the line connecting the speaker with the amplifier.

The design of such attenuators is subject to numerous considerations, and a guide to their design can very much simplify the procedure. This article discusses an approach to step type "L" attenuators.

The ear has a logarithmic sensitivity characteristic. That is, it is sensitive not to changes in the power level as such, but to percentage power level changes. Ideally, then, an audio attenuator should change power output logarithmically. Thus it would add a given number of decibels to the output level for each step advanced.

A logarithmic step attenuator does not allow a mathematically (or acoustically) smooth characteristic which includes an off setting, (infinite attenuation). The question arises, how many decibels attenuation per step? This can be determined by various rules of thumb or by experimenting to determine the lowest desired output level.

Actually, all we want is an attenuator which has a good chance of containing a setting which is desirable at the moment. (The element of chance enters in since a step attenuator has a limited number of possible settings, but "desirability" is "continuously variable.") This suggests that an attenuator characteristic which is not logarithmic but which only resembles the logarithmic curve should produce the required result.

The Solution

In the active area the parabola has a shape resembling that of the logarithmic curve but it includes zero. This latter fact relieves one of making measurements or of making assumptions which may not be realistic, but it automatically results in an attenuator with characteristics close enough to the ideal to suit almost any requirement. We shall, then, assume that the attenuator characteristic is to be parabolic.

If we let N equal the total number of attenuator steps available (number of switch positions), and K equal the number of the step to which the attenuator is set (position of the switch), then the power to the load is:

$$P_o = P_{in}\left(\frac{K-1}{N-1}\right)^2 \qquad (1)$$

(Note that the off position is given the step number K of one.) This is an equation for a parabola.

The final consideration is that the input impedance of the attenuator with load be a constant to match the amplifier output. Let this impedance be Z_o. The actual load impedance, R_l, must then be equal to Z_o.

2	3	4	5	6	7	8	9	10	11	12 ← N	K ↓
∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	R_s
1	1	1	1	1	1	1	1	1	1	1	R_p
0	0	0	0	0	0	0	0	0	0	0	P_o
∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	db
1											
0	1	2	3	4	5	6	7	8	9	10	R_s
∞	2	1.5	1.33	1.25	1.20	1.17	1.14	1.12	1.11	1.10	R_p
1	0.25	0.111	0.062	0.04	0.028	0.02	0.016	0.012	0.01	0.008	P_o
0	−6.0	−9.5	−12.1	−14.0	−15.5	−17.0	−18.0	−19.2	−20.0	−21.0	db
2											
	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	R_s
	∞	3	2	1.67	1.5	1.4	1.33	1.29	1.25	1.22	R_p
	1	0.444	0.25	0.16	0.111	0.082	0.062	0.049	0.04	0.036	P_o
	0	−3.5	−6.0	−8.0	−9.5	−10.9	−12.1	−13.1	−14.0	−14.5	db
3											
		0	0.333	0.667	1	1.33	1.67	2	2.33	2.67	R_s
		∞	4	2.5	2	1.75	1.6	1.5	1.43	1.38	R_p
		1	0.563	0.36	0.25	0.184	0.141	0.111	0.09	0.074	P_o
		0	−2.5	−4.5	−6.0	−7.4	−8.5	−9.5	−10.5	−11.3	db
4											
			0	0.25	0.5	0.75	1	1.25	1.5	1.75	R_s
			∞	5	3	2.33	2	1.8	1.67	1.57	R_p
			1	0.64	0.444	0.326	0.25	0.198	0.16	0.132	P_o
			0	−2.0	−3.5	−4.9	−6.0	−7.0	−8.0	−8.8	db
5											
				0	0.2	0.4	0.6	0.8	1	1.2	R_s
				∞	6	3.5	2.67	2.25	2	1.83	R_p
				1	0.694	0.51	0.391	0.309	0.25	0.206	P_o
				0	−1.6	−3.0	−4.1	−5.1	−6.0	−6.9	db
6											
					0	0.167	0.333	0.5	0.667	0.833	R_s
					∞	7	4	3	2.5	2.2	R_p
					1	0.735	0.562	0.445	0.36	0.298	P_o
					0	−1.3	−2.5	−3.5	−4.5	−5.3	db
7											
						0	0.143	0.256	0.429	0.572	R_s
						∞	8	4.5	3.33	2.75	R_p
						1	0.765	0.605	0.49	0.405	P_o
						0	−1.2	−2.2	−3.1	−3.9	db
8											
							0	0.125	0.25	0.375	R_s
							∞	9	5	3.33	R_p
							1	0.79	0.64	0.528	P_o
							0	−1.0	−2.0	−2.8	db
9											
								0	0.111	0.222	R_s
								∞	10	5.5	R_p
								1	0.81	0.669	P_o
								0	−1.0	−1.8	db
10											
									0	0.1	R_s
									∞	11	R_p
									1	0.826	P_o
									0	−0.8	db
11											
										0	R_s
										∞	R_p
										1	P_o
										0	db
12											

TABLE I

The total number of attenuator positions available is located in the top row to the left of N. The vertical columns list the normalized values of the series and parallel branch resistors and the normalized load power for each attenuator position K. Loss in db is shown for each step.

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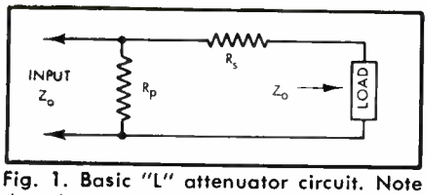

Fig. 1. Basic "L" attenuator circuit. Note that the input impedance must equal the load impedance.

From the foregoing it can be shown that R_s of *Fig. 1* is given by:

$$R_s = Z_o\left(\frac{N-1}{K-1}\right) - Z_o \qquad (2)$$

It can also be shown that R_p is given by:

$$R_p = Z_o\left(\frac{N-1}{N-K}\right) \qquad (3)$$

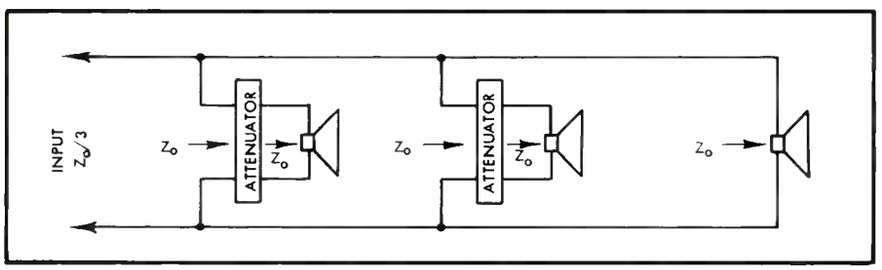

Fig. 2. Distribution system involving two attenuator-controlled speakers and one uncontrolled speaker as discussed in the text. In this case the input impedance to the system is one-third the impedance of each individual load.

The power dissipated by R_p is:

$$P_{R_p} = P_{in}\frac{Z_o}{R_p} \qquad (4)$$

and the power dissipated by R_s is:

$$P_{R_s} = P_{in} - P_o - P_{R_p} \qquad (5)$$

Use of Table

These five relations provide the designer with all the tools necessary to design a parabolic attenuator. However, for convenience the values of R_s/Z_o, R_p/Z_o and P_o/P_{in} are given in Table 1. The table is used as follows:

1. Determine the attenuator impedance, Z_o, so as to match the line or amplifier. If two or more loads are to be operated by the same amplifier at the same time, the impedance of each attenuator should be multiplied by the number of loads involved. (For example two attenuator-controlled speakers and one uncontrolled speaker to operate from a 250-ohm amplifier output. Z_o for each attenuator and for the uncontrolled speaker is 750 ohms.)

2. Determine the maximum value of average power delivered to each load. (For example, assume an amplifier capable of 15 watts average. Each of the three loads receives 5 watts.)

3. Determine N, the total number of attenuator positions available. (Assume 5 positions.)

4. Follow the horizontal column of numbers to the left of N in the table to the value corresponding to N as per step 3. (In the example, 5.)

5. Listed below this number in the table are the values of R_s/Z_o, R_p/Z_o and P_o/P_{in} for the various switch positions, K. (In the example, under 5 in the row $K = 3$: R_s/Z_o is found to be 1, (R_s sub-row); R_p/Z_o is found to be 2, (R_p sub-row); and P_o/P_{in} is found to be 0.25, (P_o sub-row).)

6. Multiply the values in the R_s and R_p sub-rows by Z_o as per step 1 to obtain the actual values of the series and parallel branch resistors for the various switch positions. (In the example, $R_s = 750 \times 1 = 750$ ohms and $R_p = 750 \times 2 = 1500$ ohms.)

7. Multiply the values in the P_o sub-rows by P_{in} as per step 2 to obtain the actual values of load power. (In the example $P_o = 0.25 \times 5 = 1.25$ watts.)

8. For each value of K substitute the values for P_{in}, Z_o and R_p into Eq. (4) to find the power dissipated in each of the various parallel branch resistors (In the example, $P_{R_p} = 5 \times 750/1500 = 2.5$ watts.)

9. For each value of K substitute the values of P_{in}, P_o and P_{R_s} into Eq. (5) to find the power dissipated in each of the various series branch resistors. (In the example, $P_{R_s} = 5 - 1.25 - 2.5 = 1.25$ watts.)

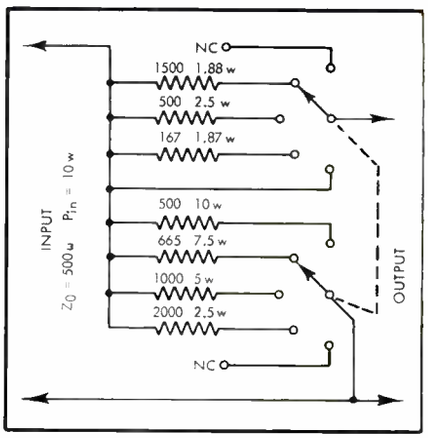

Fig. 3. A five-step attenuator. The ohmic values of the resistors and the power dissipated in each is determined from Table I and is given for one case.

All the values for the attenuator in the foregoing example are listed with *Fig. 3* along with values for a 500-ohm, 10-watt attenuator. Values for any attenuator with more than twelve positions will have to be calculated from the equations.

Small deviations from the calculated values should be acceptable in all cases. The RETMA value nearest a given calculated value will generally work virtually as well.

(*Continued on page 83*)

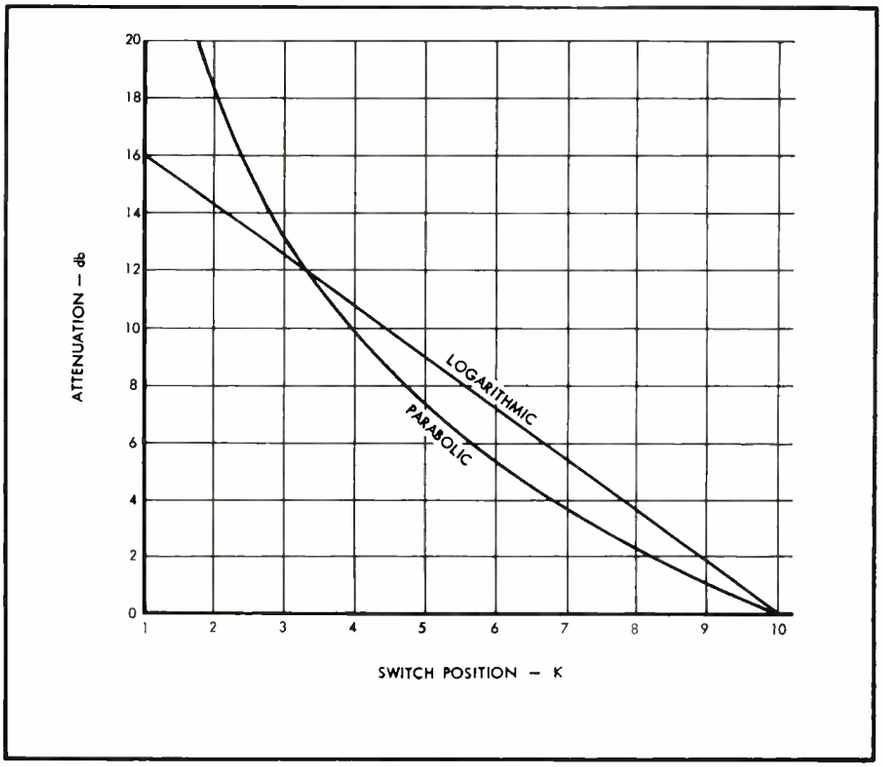

Fig. 4. Graph showing the difference between the characteristics of a ten-step parabolic attenuator and that of a comparable logarithmic attenuator. The parabolic type gives infinite attenuation at the first switch position.

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A Stereophonic Tape Recorder Control

R. A. GREINER*

If your tape recording facilities do not offer sufficient flexibility for your requirements, this unit may be the solution. Easy to build, it offers all the necessary switching for most recording operations.

THE CONTROL CENTER described in this article serves three important uses. First, it provides for very flexible use of the record-play operations of a stereophonic tape recorder. Second, it provides complete monitoring facilities for binaural headphones. Third, it provides a third channel consisting of a mixture of the two normal channels which may be used to augment stereophonic playback or which may be used to give balanced monophonic playback of stereo or mono tapes. While the author's tape machine is provided with monitoring facilities on each channel, it was desired to have a control center which would give added versatility to the machine.

There are several operations which have been found to be desirable when recording or playing stereophonic tapes. One is the ability to readily interchange the channels. Another is to be able to play either Channel 1 or Channel 2 through both of the speaker systems. If monophonic recording is desired, it is useful to be able to feed both record channels from a single source. Another feature which is convenient, is to have sound-on-sound facilities available. The latter is readily accomplished with a stereophonic recorder by recording on one channel and at the same time rerecording the information from the second channel to the first. To accomplish all of the above operations requires a bagful of patch cords and a great deal of inconvenience. The control amplifier described below accomplishes all of the above operations with the simple twist of a control knob.

Fig. 2. Rear view shows the very short connections to the tape machine amplifiers.

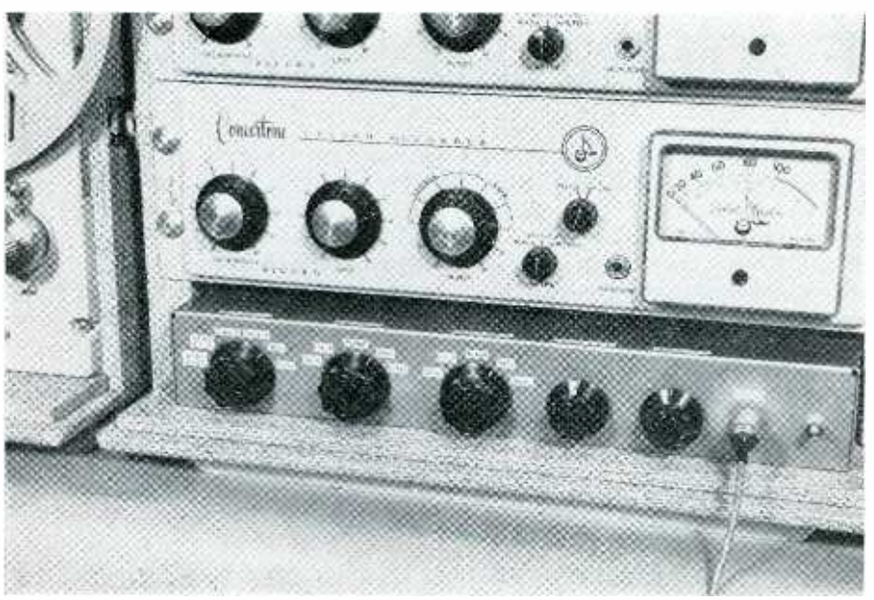


Fig. 1. Tape Recorder control shown in place in the carrying case.

We might stop for a moment to consider the worth of a third channel in normal two-channel stereophonic playback. It has been found by the author, in agreemeint with others, that the introduction of a third source of sound located between the two normal playback speakers frequently enhances the quality of the reproduction. The third channel contains a mixture of the two normal channels and is usually played at a considerably lower loudness level than the main speakers. Several serious defects found in stereo tapes are rectified using the third channel technique. The "hole-in-the-middle" effect for example can be cured completely without loss of spatial effects. In fact, tapes with distinctly different channels, that is, exaggerated stereo effect, can be made to sound better than some normal tapes. Well-balanced tapes sound as though

* *College of Engineering, The University of Wisconsin, Madison 6, Wis.*

press comment *on the*

AR-3

The American **RECORD GUIDE** *(Larry Zide)*

"Given a good stereo source, a pair of AR-3's comes as close to musical realism in the home, I believe, as the present state of the art permits . . . In sum, until someone comes out with something better that doesn't take up the entire house, the AR-3 is for me the reference standard."

high fidelity *(TITH report)*

"A major problem of tweeter design has been the beaming effect of very high frequencies . . . The "fried egg" **[nickname for the AR-3 tweeters]** appears to be a major step forward in the smooth dispersion of sound at extreme high frequencies."

HI-FI SYSTEMS

"In terms of bass response, these two speakers **[the acoustic suspension AR-1 and AR-2]** represent a phenomenal improvement in the state of the art.

"The complete AR-3 speaker system, in addition to containing a superb acoustic suspension woofer, which has enjoyed wide acceptance by professionals as well as audiophiles, constitutes, in our opinion, a mid and high frequency system which is in every way complementary to the bass quality. The new AR-3 rivals in overall quality the very best woofers and combinations."

The AR-3 is priced from $203 to $231, depending on cabinet finish ($216 in mahogany or birch). Literature is available for the asking.

ACOUSTIC RESEARCH, INC. **24 Thorndike St., Cambridge 41, Mass.**

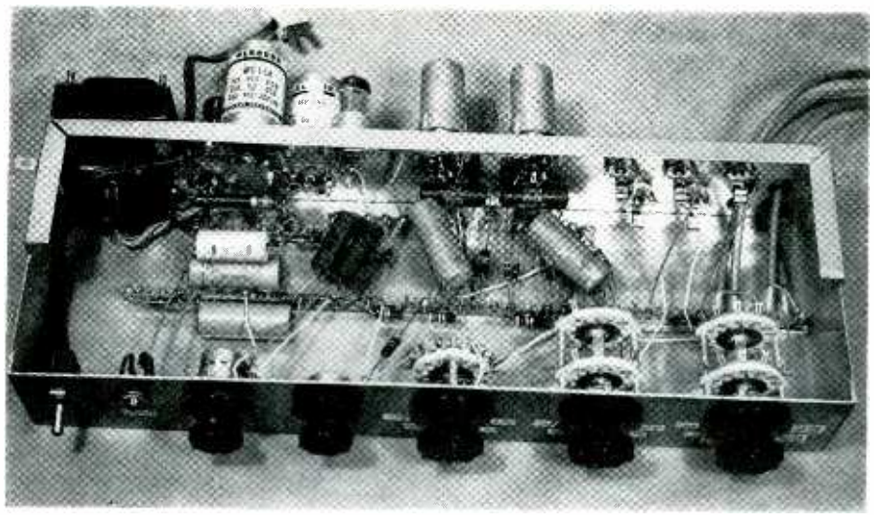


Fig. 3. Bottom view shows uncluttered construction and the cutaway front edge which fits the carrying case.

there were a more uniform spatial distribution of the sound source. The reasons for the latter enhancement of the spatial effects, so desirable with stereophonic reproduction, are obscure. This is not surprising, since stereophonic audition is itself not well understood at present. Many authorities on sound reproduction, however, testify to the enhanced quality of three-speaker reproduction of two-channel tapes. For example, the concept of the ghosted third channel introduced by E. T. Canby may be applicable in this case. We have, however, an electronic mixing with complete control of the loudness of the third channel in this system as opposed to a purely acoustical effect which he describes.

The equipment

The complete control center is shown in *Fig.* 1. The control was built in a standard $3 \times 6 \times 17$ in. aluminium chassis which happens to fit in the Concertone carrying case along with the two record-play amplifiers. The front edge of the chassis is notched up about $\frac{3}{8}$ in. and back about an inch to allow the control chassis to protrude forward from the front of the recording amplifiers. Very short cables are provided to go to the amplifiers as shown in *Fig.* 2. All external cables connect to five microphone jacks on the rear of the control. Three of the cables go to the three speaker channels and the remaining two are inputs at line level to the recording amplifiers. The wiring arrangement is shown in *Fig.* 3.

The complete schematic diagram of the circuitry is shown in *Fig.* 4. It is clear that the major portion of the control circuit is involved with switching.

(*Continued on page 95*)

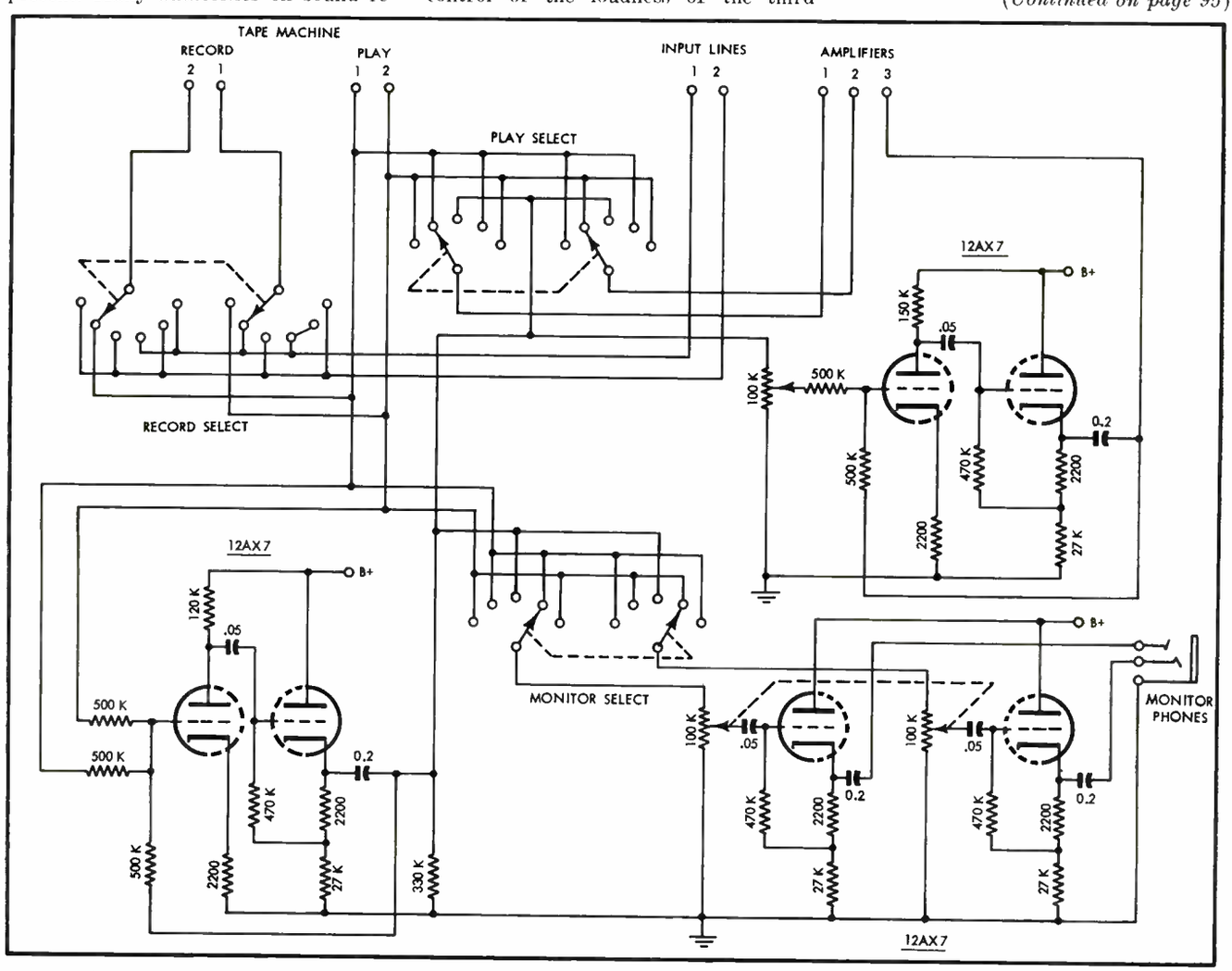
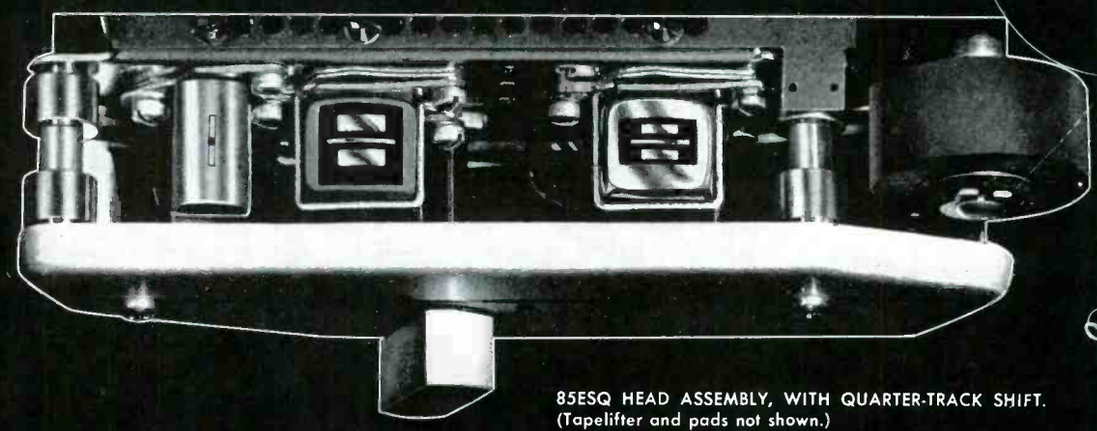
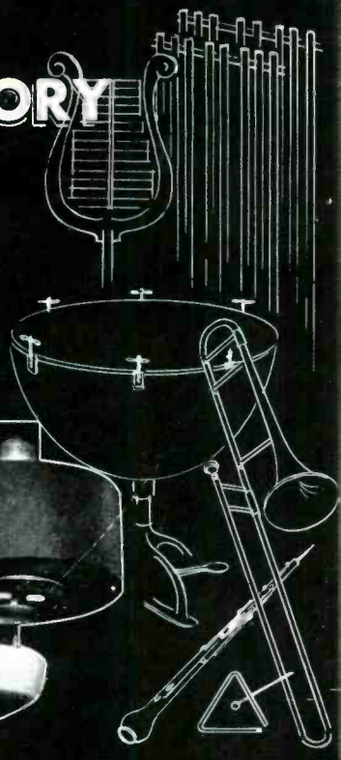


Fig. 4. Schematic of the complete control amplifier. B+ may be supplied from a separate power supply, and should be about 250 volts. All tubes are 12AX7's.

Viking builds the PERFECT MEMORY for your music system





85ESQ HEAD ASSEMBLY, WITH QUARTER-TRACK SHIFT.
(Tapelifter and pads not shown.)

The Viking 85 Series deck and Viking recording amplifiers provide the perfect memory for your high fidelity music system. Record monaural or stereo programs at the flick of a switch. Record with the full performance provided by laminated heads. Record quarter track if you prefer, but better still, use the brilliant, ultra short-gap quarter-track head for simultaneous monitoring from the recorded track.

All Viking 85 Series decks now feature laminated (not single laminar) half-track and quarter-track record and playback heads; the same heads used on the professional 95 Series. A laminated head permits a substantially higher recording level without saturation, requires less equalization for brilliant high-end performance and provides much longer head life.

All Viking "Q" model decks may be used equally well for playing the new 7½ i.p.s. four-track tapes and the 3¾ i.p.s. tapes featured in cartridges. Cartridge tapes may be removed from the cartridge and played reel-to-reel on the Viking 85.

Viking tape components are sold through high fidelity dealers, exclusively. Further technical information may be obtained by writing directly to Viking's Customer Service Department.

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Kinds of Tape

HERMAN BURSTEIN*

A compendium of information about all the kinds of tape that are available for the home and professional recordist with respect to the playing time, print-through, output, and backing material.

MAGNETIC TAPE is in essence a coating of iron oxide on a plastic base. The base may range from about 0.5 to 1.5 mils (thousandths of an inch) in thickness, while the coating may range from about 0.35 to 0.65 mil. By varying the chemical formulation of the coating, the type of base material, and the thickness of the coating and base, and by suitable attention to such factors as uniformity of coating and base, fine dispersion of the magnetic particles that constitute the coating, lubrication, and so on, the tape manufacturer controls the physical and magnetic properties of his product.

The magnetic properties of the tape principally concern the following:

1. Frequency response
2. Output (for a given level of distortion)
3. Noise
4. Print-through

The physical properties of the tape principally concern the following:

1. Playing time
2. Strength
3. Smoothness
4. Limpness

For selling purposes, manufacturers classify their tapes on the basis of the following four characteristics: playing time, strength, output, and print-through. For a given combination of the above characteristics, the purchaser may then decide what brand to buy, or which one of several tapes within the same brand to buy, on the basis of the following characteristics: frequency response, noise, smoothness, limpness, and other attributes to be discussed later. His choice may rest upon personal experience with various tapes, upon the recommendations of others (including advertising), or possibly upon price alone.

The extent to which differences may be observed among brands or within brands depends in part upon the tape equipment employed. To illustrate, the fact that one tape is less noisy than another may not be apparent in a low cost tape recorder which generates a substantial amount of noise, thereby over-riding tape noise. On the other hand, a high-grade tape machine may permit differences in tape noise to be obvious.

The likelihood of perceiving differences among tapes also depends upon how the tape equipment is used. For example, print-through may never bother some recordists because they record only at moderate levels or because they do not store recorded tapes for long periods before playing them (print-through increases with storage).

Before proceeding with the discussion of tape characteristics, it should be pointed out that it is not possible to produce a tape which produces maximum performance in all desired respects. Frequently, it is necessary to sacrifice performance somewhat in one respect in order to improve performance in another. On the other hand, it sometimes happens that an improvement in one direction also brings an improvement in a second direction.

The next four sections will deal with the characteristics generally employed to classify tapes. The fifth section will classify several leading brands of tape according to these characteristics. The last section will discuss other important characteristics.

Playing Time

A very simple and obvious, as well as important, distinction among tapes concerns playing time. We are speaking of different lengths of tape, depending upon their thickness, that may be accommodated on the same reel size. For convenience, we shall refer to the 7-in. reel, which is virtually standard for home use. Tape may be sorted into three categories:

1. Standard-play
2. Long-play
3. Double-play

Standard-play tape is about 2 mils (.002 in.) thick; the plastic base is about 1.5 mils and the coating about 0.5 mil. A 7-in. reel can accommodate 1200 feet of such tape; this translates into 32 minutes playing time if the tape is operated in one direction at 7.5 ips, which is the speed commonly used in the home for high fidelity reproduction. If the reel is reversed and the tape also recorded in the opposite direction—in the case of mono half-track or stereo four-track recording—the playing time is 64 minutes.

Long-play tape has a base of about 1 mil and a coating of about ⅓ mil, for a total thickness approximately two-thirds that of standard-play tape. Since tape length on a given reel size is inversely proportional to tape thickness, tape length can be increased by a factor of 3/2, which means 50 per cent more playing time on a reel. Hence one can obtain 48 minutes of playing time from a 7-in. reel of tape operated in one direction at 7.5 ips: or 96 minutes in both directions.

Double-play tape uses a base in the region of 0.5 mil; including the coating, total thickness is about 1 mil, which is one-half that of standard tape. Thus one

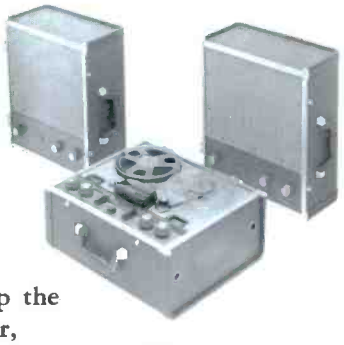
* *280 Twin Lane E., Wantagh, N. Y.*

AMPEX 960

STEREOPHONIC RECORDER/REPRODUCER

ABOVE--960 PORTABLE STEREO RECORDER/REPRODUCER

BELOW--MODEL 2560 PORTABLE STEREO SYSTEM CONSISTING OF 960 AND PAIR OF 2010 AMPLIFIER-SPEAKERS



Stereo Portable PLUS!

Guiding the Ampex engineers who created the 960 was a dual objective—that of building a machine which was not only a superb example of engineering skill, but one which would also offer its user a range of capabilities far exceeding that of any other recorder made today. The result was not merely an improved stereo recorder, but *an entirely new concept* in home entertainment.

The STEREO 960 fits into family life in literally dozens of ways, contributing many tangible benefits in musical, educational and recreational fun. You'll use it to keep up the family correspondence by sending "letters in sound", to tape stereo programs off the air, to preserve your best monaural and stereo discs on tape, and to acquire new musical and language skills. You'll have endless fun exploring the 960's many fascinating recording capabilities, including sound-on-sound, echo chamber effects, and other advanced techniques.

AMPEX STEREO — SIGNATURE OF PERFECTION IN SOUND

RECORDER/REPRODUCER

SPECIFICATIONS

The true values of a recorder are best assessed through careful evaluation of its performance specifications and operating features. It is worthwhile noting here that these specifications are based not on theoretical design parameters but on actual performance tests. They are specifications which the recorder not only meets or exceeds today, but which years from now will still hold true.

The Ampex Model 960 Stereophonic Recorder/Reproducer is capable of essentially distortionless frequency response from 30 to 20,000 cycles per second at the operating speed of 7½ inches per second, and from 30 to 15,000 cycles per second at 3¾ inches per second. Its precision-engineered timing accuracy is such that it offers perfection of pitch held to tolerances of less than one-third of a half-tone. Playing times, using standard (.002"), long play (.0015"), and extra-long play (.001") tapes are as follows:

	(a) 4-Track Stereo Tapes	(b) 2-Track Stereo Tapes	(c) Monaural Tapes, half-track
1200 foot reel	3¾ ips - 2 hrs. 8 min. 7½ ips - 1 hr 4 min.	3¾ ips - 1 hr. 4 min. 7½ ips - 32 minutes	3¾ ips - 2 hrs. 8 min. 7½ ips - 1 hr 4 min.
1800 foot reel	3¾ ips - 3 hrs. 12 min. 7½ ips - 1 hr 36 min.	3¾ ips - 1 hr. 36 min. 7½ ips - 48 minutes	3¾ ips - 3 hrs. 12 min. 7½ ips - 1 hr 36 min.
2400 foot reel	3¾ ips - 4 hrs. 16 min. 7½ ips - 2 hrs. 8 min.	3¾ ips - 2 hrs. 8 min. 7½ ips - 1 hr. 4 min.	3¾ ips - 4 hrs. 16 min. 7½ ips - 2 hrs. 8 min.

RECORD INPUTS: High impedance line inputs (radio/TV/phono/auxiliary) 0.3V rms for program level; high impedance microphone inputs

PLAYBACK OUTPUTS: Approximately 0.5V rms from cathode follower when playing program level tapes

PLAYBACK FREQUENCY RESPONSE: 30-20,000 cps at 7½ ips; 30-15,000 cps at 3¾ ips
Within ±2 db 50-15,000 cps at 7½ ips, 55 db dynamic range
Within ±2 db 50-10,000 cps at 3¾ ips, 50 db dynamic range

FLUTTER AND WOW: Under 0.2% rms at 7½ ips; under 0.25% rms at 3¾ ips

HEADS: Manufactured to the same standards of precision that exist in Ampex broadcast and recording studio equipment. Surfaces are lapped to an optical flatness so precise that they reflect specified wavelengths of light, resulting in uniform performance characteristics and greatly minimizing the effects of head wear. Azimuth alignment of stereo head gaps in the same stack is held within 20 seconds of arc, equivalent to less than 10 millionths of an inch — a degree of precision achieved through use of a unique process involving micro-accurate optical measurements within a controlled environment. Head gap width is 90 millionths of an inch ±5 millionths of an inch.

KEY TO THE EXCITING FUN FEATURES OF THE 960--

THE AMPEX STEREO-GRAPH

Here's the simplest, quickest answer to almost every question about how to perform the operations illustrated at right and numerous other recording functions. The Ampex Stereo-Graph shows you, quickly and clearly, the proper dial settings to make for more than a dozen of the most popular uses for the 960 . . . including sound-on-sound, language and music instruction,

and other special effects. A convenient tape footage/playing time indicator is included on the reverse side.

MODEL 2010
MATCHING AMPLIFIER-SPEAKER

The Ampex Model 2010's ten-watt (20 watts peak) amplifier section provides operating characteristics (unequalized) flat within ±0.1 db, with total harmonic distortion less than 0.5 of 1%, throughout the maximum range of human hearing ability, at rated output. Noise and hum are 80 db below rated output, and input sensitivity is 0.18V to develop rated power.

The specially designed 8" speaker provides smooth, peak-free response throughout a remarkably wide audio range. Such superior design features as its massive die-cast frame and edgewise-wound ribbon coil contribute effectively to higher levels of performance than ever before achieved with a speaker this size.

MODEL 960 DIMENSIONS: Portable cases 9" x 15" x 17½". Unmounted recorder 13" x 15" x 6⅛" depth below top plate, 1⅜" above. Recorder weight 36 lbs., speaker amplifier 31 lbs.

AMPEX AUDIO, INC. • SUNNYVALE, CALIFORNIA 9004

Relax and enjoy the show—let your Ampex do the narration! With the commentary on tape, your color slide shows are more professional, more complete, and more fun!

Your favorite LPs and Stereo Discs are at their exciting best while they're new and unscratched. That's when to tape them on your Ampex and preserve their original quality for keeps

When you tape it "off the air" your only cost is for blank tape. Yet your musical repertoire can soon equal that of all the stations you hear!

There's a real future in family fun like this—with your Ampex you can live such happy moments over and over again, with a quality so lifelike you're almost literally sucked back.

In the Ampex "Speech Testing Game", you pit your wits against the trigger-quick memory of the Ampex recorder/reproducer. You can't win, but it's fun trying.

Letter-writing is no longer a problem, with an Ampex in the house . . . now it's a family project. And even more fun than sending letters in sound is receiving them!

For "letters in sound", the 3" tape reel holds as much as a 10-page letter, mails first class anywhere in the United States for 8c.

For concert performance, exclusively for you! Whether you prefer jazz, pops, or classical, the privacy of stereophone listening is a unique pleasure. You don't disturb the rest of the family, and they don't disturb you!

The Ampex, in private rehearsal, can be a wonderful confidence-builder for people who normally develop rubber knees when faced with the prospect of speaking before a group.

Learning to speak a new language is made immeasurably easier on the Ampex; you can record your own phrases side-by-side with those of the instructor, and play them back for comparison at any time.

When you strike up the band in stereo, you don't need professional musicians to make a professional recording. Advanced techniques are amazingly easy on the Ampex.

TABLE I
TAPE PLAYING TIME
7-in. reel operated in one direction

TAPE SPEED ips	KIND OF TAPE		
	STANDARD-PLAY	LONG-PLAY	DOUBLE-PLAY
1.875	2 hrs., 8 min.	3 hrs., 12 min.	4 hrs., 16 min.
3.75	1 hr., 4 min.	1 hr., 36 min.	2 hrs., 8 min.
7.5	32 min.	48 min.	1 hr., 4 min.
15	16 min.	24 min.	32 min.

NOTES: A — For a 10-in. reel, double all playing times
B — For a 5-in. reel, divide all playing times by two
C — For a tape operated in two directions, double all playing times

can double the amount of tape on a reel and thereby double the playing time.

Table 1 shows the playing time obtainable from a 7-in. reel of each kind of tape operated in one direction at the various speeds encountered in home use —15, 7.5, 3.75, and 1.875 ips. For standard-play tape, the time ranges from a minimum of 16 minutes at 15 ips to a maximum of 2 hours and 8 minutes at 1.875 ips. For long-play tape the range corresponding is from 24 minutes to 3 hours and 12 minutes. For double-play tape the range is from 32 minutes to 4 hours and 16 minutes. If the tape is operated in two directions, all the above figures are doubled; then the minimum playing time would be 32 minutes at 15 ips for standard-play tape, and the maximum would be 8 hours and 32 minutes at 1.875 ips for double-play tape.

It may be noted at this point that the three kinds of tape are often identified in terms of their (approximate) base thickness. Hence the expression "1½ mil tape" signifies standard-play tape; "1 mil tape," long-play; "½ mil tape," double-play.

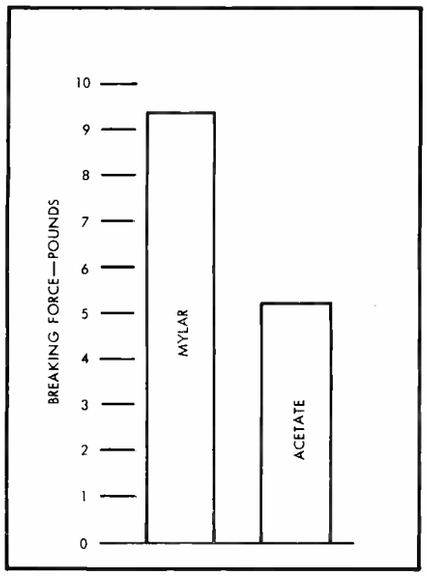


Fig. 1. Comparison of breaking forces for acetate and Mylar (DuPont brand of polyester film). (Orr Industries.)

In going to a thinner base in order to permit more playing time per reel, there is of course a sacrifice in tape strength, of which more will be said later. Hence the long-play and double-play tapes may be more easily subject to breakage or to elongation, which entails distortion. On the other hand, improvements in base materials, particularly the use of polyester film—Dupont's Mylar—instead of cellulose acetate as a base has made it possible for the long-play and double-play tapes to hold up satisfactorily. In addition, improvements in tape machines with respect to their handling of tape has made it possible to get away with weaker tapes.

Another disadvantage of the thinner tapes is increased print-through, because the thinner base offers less of a barrier to this magnetic phenomenon. To indicate how much the print-through increases as the base thickness is decreased, one may refer to the specifications for Reeves Soundcraft tape. Soundcraft long-play tape is stated to have 3 db more print-through than its standard-play tape, while its double-play tape is stated to have 6 db more print-through.

On the other hand, the thinner tapes have advantages as well as disadvantages. One benefit is that a thin tape tends to contour better to the shape of the head, which means intimate contact with the gap and therefore better high-frequency response. Moreover, the thinner coating tends to emphasize the high frequencies. The reason is that the lower frequencies penetrate the tape more deeply than the high ones do, so that reducing the thickness of the coating reduces the low frequencies more than the high ones; in relative terms, the high frequencies are emphasized. Altogether, the thinner tapes may be superior in frequency response at the very high end to the extent of 2 or 3 db or more.

Another advantage of the thinner tapes is that improved contact between the tape and the head tends to reduce dropouts, namely sudden, brief drops in sound level.

Tape Strength

Although at one time tapes with a paper base were quite common, these have virtually disappeared, and today the backing is either cellulose acetate or Mylar. In distinguishing between tapes as to strength, one is essentially distinguishing between those having an acetate base and those having the stronger Mylar as a base.

Tape undergoes various stresses as it is shuttled back and forth by the transport. During normal operation the tape is under tension due to the opposing pressures of the supply and takeup reels. There are other stresses during rapid wind and rewind, particularly when shifting quickly between these two modes of operation. And there are the stresses of quick starts and stops. Tape must be able to endure all these without breaking or stretching.

In addition to considerations of breaking and stretching, the term strength has to take into account the extent to which the tape is impervious to humidity, temperature, and age.

The differences between Mylar and acetate are indicated by data supplied by Orr Industries for its 1.5 mil tapes with each type of base. The force required to break the tape (*Fig.* 1) is 9.4 pounds for Mylar compared with 5.3 pounds for acetate. Mylar can be stretched 150 per cent before breaking, whereas acetate can be stretched only 25 per cent before breaking (*Fig.* 2). A force of 5.6 pounds is required to stretch the tape 10 per cent in the case of Mylar, and of 4.5 pounds in the case of acetate (*Fig.* 3). Thus, although Mylar may seem more susceptible to stretching (it can be stretched 150 per cent before breaking), actually a greater force is required to produce a given amount of

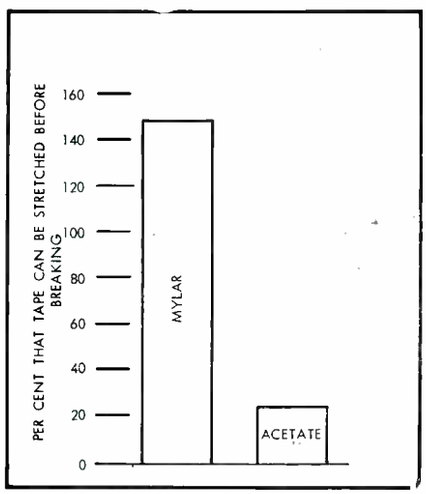


Fig. 2. Ability of 1.5-mil tape to stretch without breaking. (Orr Industries.)

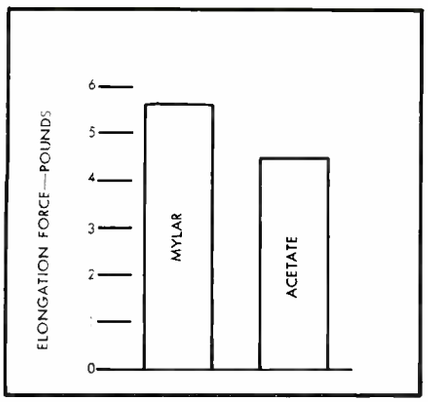


Fig. 3. Force required to elongate 1.5-mil tape ten per cent. (Orr Industries.)

elongation than in the case of acetate.

Moreover, Mylar recovers to a greater degree from stretching, as indicated by data on "residual elongation." This refers to the elongation after the tape has been stretched for a given period of time and then allowed to recover for another given period of time. Orr Industries indicates that residual elongation is but 0.75 per cent for the 1.5 mil Mylar compared with 2.75 per cent for the 1.5 mil acetate (*Fig.* 5).

Mylar is less subject to expansion due to heat and humidity. The Orr data indicate that Mylar expands to the extent of 2 parts in 100,000 per degree Fahrenheit, compared with 3 parts in 100,000 for acetate. In brief, acetate expands 50 per cent more under the same conditions of change in temperature. With respect to effects of humidity, Mylar has a very distinct edge over acetate. It expands to the extent of 1.1 parts in 100,000, compared with 15 parts in 100,000 for acetate.

The greater resistance of Mylar to the effects of humidity and temperature changes means it is more proof than acetate against the ravages of age. Hence Mylar does not tend to chip, crack, become brittle, dry out, stretch or shrink. In sum, the individual desiring a tape that can best withstand the stresses of normal tape recorder operation and the effects of age should consider investing in a tape with a Mylar

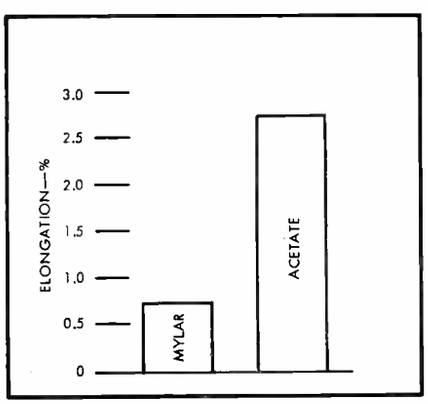


Fig. 4. Residual elongation of 1.5-mil tape. (Orr Industries.)

base. On the other hand, if cost is an important consideration, the savings obtained through the purchase of acetate tape may outweigh other considerations. Where an individual uses the same reel of tape over and over, a premium for Mylar tape may be of no consequence. But if he uses many reels of tape (for example in building up a library of recordings), the savings afforded by acetate tape can be considerable. Still, if this library is to be preserved for a substantial period of time, a minimum of deterioration requires a base of polyester film.

High-Output Tape

At the time of writing, to the best of the author's knowledge, only one company—Minnestota Mining and Manufacturing Company (3M)—offered the so-called high-output tape, which enables one to record a substantially higher signal level at a given amount of distortion than in the case of conventional tape. The increase in recorded signal level is claimed to be about 7.5 db (133 per cent).

This is achieved in part through the type of oxide used as a coating and in part through a coating of extra thickness. Whereas the 3M Company employs a 0.55-mil coating for its regular tape, the coating is 0.65 mil for the high-output tape. An increase in output level takes place in two ways: (1) For the same amount of signal (magnetic field) applied to each kind of tape, a higher recorded level is obtained on the high-output tape. (2) For the same amount of distortion, the high-output tape can accept a greater applied signal than regular tape.

In exchange for higher output, there is some sacrifice in *relative* high-frequency response. That is, high-frequency output relative to low-frequency output is about 3.5 db lower for high-output tape than for regular tape. It also appears that high-output tape is more subject to print-through because of the greater intensity of the magnetic field recorded on it.

It may well be that the individual possessing a tape recorder of mediocre quality in terms of hum and noise will find that the increase of about 7.5 db in signal-to-noise ratio possible through the use of high-output tape is a considerable blessing, well worth the slight drop in high-frequency response and the possible increase in audible print-through. But the individual owning a fine tape machine that generates virtually no audible hum and noise may find that the increase in output signal does not outweigh the other consequences of using high-output tape.

Low Print-Through Tape

Print-through (the transfer of the signal on a layer of tape to the adjacent layers, resulting in "pre-echo" and "post-echo") increases with recording level and with age of the recorded tape. To the extent that the recordist seeks to impress as much signal as possible on the tape without incurring appreciable distortion, thereby maximizing the signal-to-noise ratio, the print-through problem increases. Even though print-through may not be initially apparent—that is, when playing back the tape immediately or a few hours or days after the tape has been recorded—it may become apparent after a substantial period of storage. *Figure* 5 shows how print-through increases with time.

The data in *Fig.* 5 are for a 1000-cps signal recorded on conventional tape at a normal level (8 db below the level producing 3 per cent harmonic distortion). The figure also shows the noise level of a tape recorder of professional quality. It may be seen that about one week after recording, print-through has reached the point where it is at the same level as tape-machine noise and therefore is

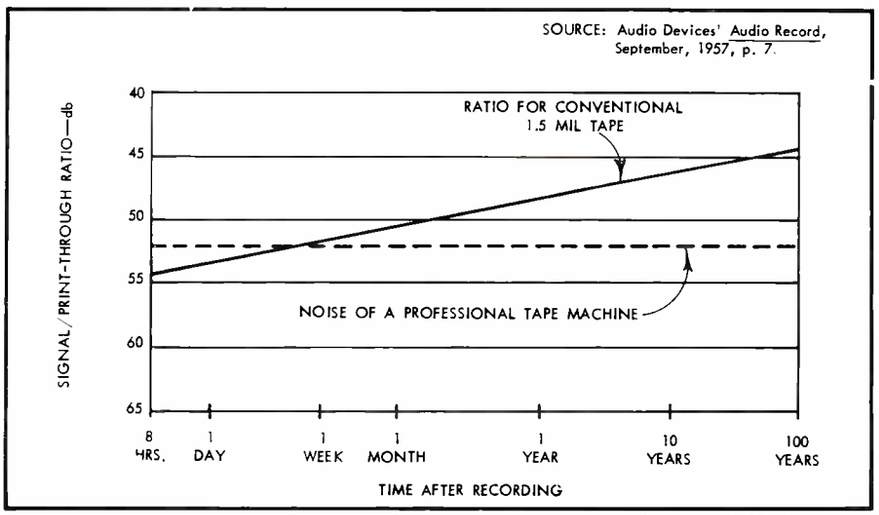


Fig. 5. Ratio of audio signal to print-through at normal recording level (8 db below 3 per cent harmonic distortion level).

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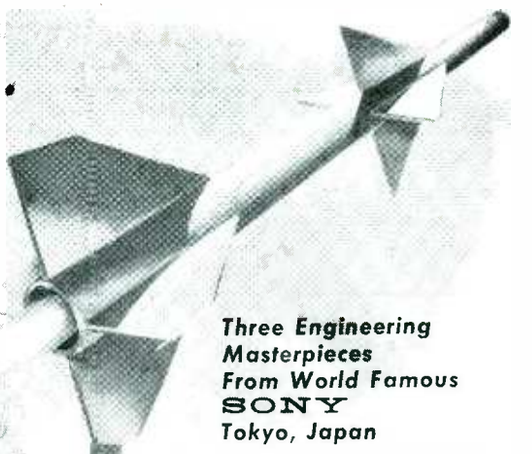

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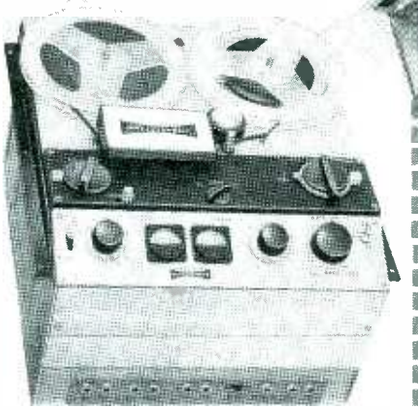

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TABLE II
TYPES OF TAPE SOLD BY FOUR COMPANIES

Based on data supplied to the author by the manufacturing companies

BRAND OF TAPE →	AUDIOTAPE	IRISH	SOUNDCRAFT	SCOTCH
STANDARD-PLAY				
Acetate:				
Conventional	X	X X X	X X	X
High Output				X
Low Print				X
Mylar:				
Conventional	X	X	X	X
High Output				X
Low Print	X			X
LONG-PLAY				
Acetate	X	X		X
Mylar	X	X	X	X
DOUBLE-PLAY				
Mylar	X	X X	X X	X

no longer obscured by such noise. Print-through continues to increase so that it becomes more and more audible.

On the other hand, if tape machine noise were greater than portrayed in *Fig.* 5, it would take longer for print-through to become noticeable. Therefore it is to be realized that the print-through problem concerns users of high-quality tape machines more than users of medium- and low-quality ones.

To reduce or eliminate the print-through problem, two tape manufacturers—Audio Devices and the 3M Company—have introduced tapes with especially low susceptibility to print-through, about 8 db less than for regular tape. *Figure* 6 shows the extent to which Audio Devices' "Master Audiotape" reduces print-through. According to the company's estimate, it would require over 100 years before print-through approached the level of tape machine noise, based on a normal recording level (8 db below 3 per cent harmonic distortion).

Low print-through is achieved by a combination of a special oxide, a relatively thick base, and a relatively thin magnetic coating. The thin coating limits the extent of the recorded magnetic field, while the thick base acts as a barrier between this field and the adjacent layers of tape. The output level of this kind of tape compares with that of regular tape, while high-frequency response is somewhat better (because of the thin coating, for reasons previously explained).

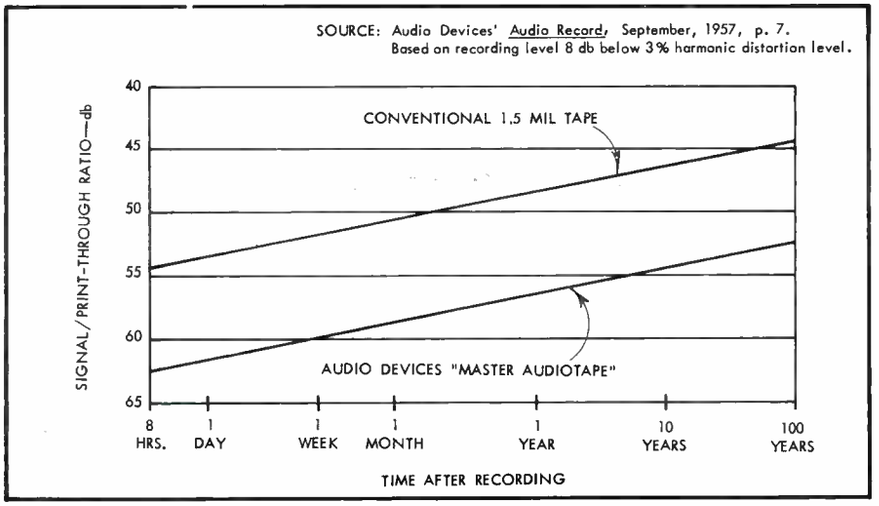

Fig. 6. Reduction in print-through obtained through use of a low-print tape.

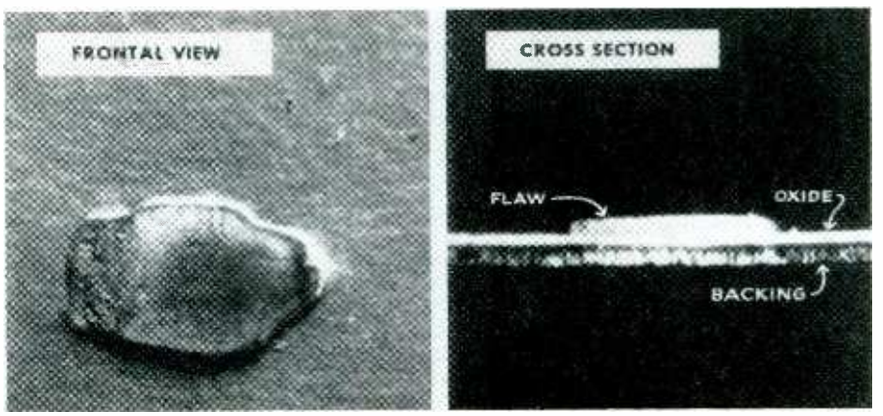

Fig. 7. Photomicrograph of an oxide flake imbedded in the coating of magnetic tape.

Comparison of Some Well-Known Brands

Without getting into the question of the merits of one brand of tape compared with another, Table 2 simply seeks to classify the varieties of tape offered by four prominent manufacturers. Their tapes are classified first by playing time, next by base material (cellulose acetate or Mylar), and then according to high-output and low print-through characteristics. An "X" indicates that the manufacturer produces a particular class of tape. Two or more "X's" indicate that the manufacturer produces a corresponding number of tapes within a particular category; there are quality differences among these tapes of the kind to be described in the next section.

Table 2 shows that no two manufacturers make exactly the same assortment of tapes. They all make tape of standard playing time in both the acetate and Mylar versions. Also, they all make the long-play and double-play tapes with polyester base. Three of the four make the long-play tape available in an acetate base for extra economy. None makes double-play tape with an acetate base because this would be too fragile.

Only one company produces a high-output tape. This is available only in standard-play tape, with either an acetate or Mylar base.

Two produce a low print-through tape. In each case this is available only in standard-play tape; in one instance the base is acetate or Mylar while in the other it is Mylar only.

In several instances a company has more than one tape in a given class. For example, Orr Industries offers three kinds of standard-play acetate tape, at varying prices and of varying quality. Two of the companies offer two kinds of double-play tape; in each instance the principal difference lies in the use of a superior form of Mylar with extra strength. Again, one pays more for the extra strength.

(*Continued on page 86*)

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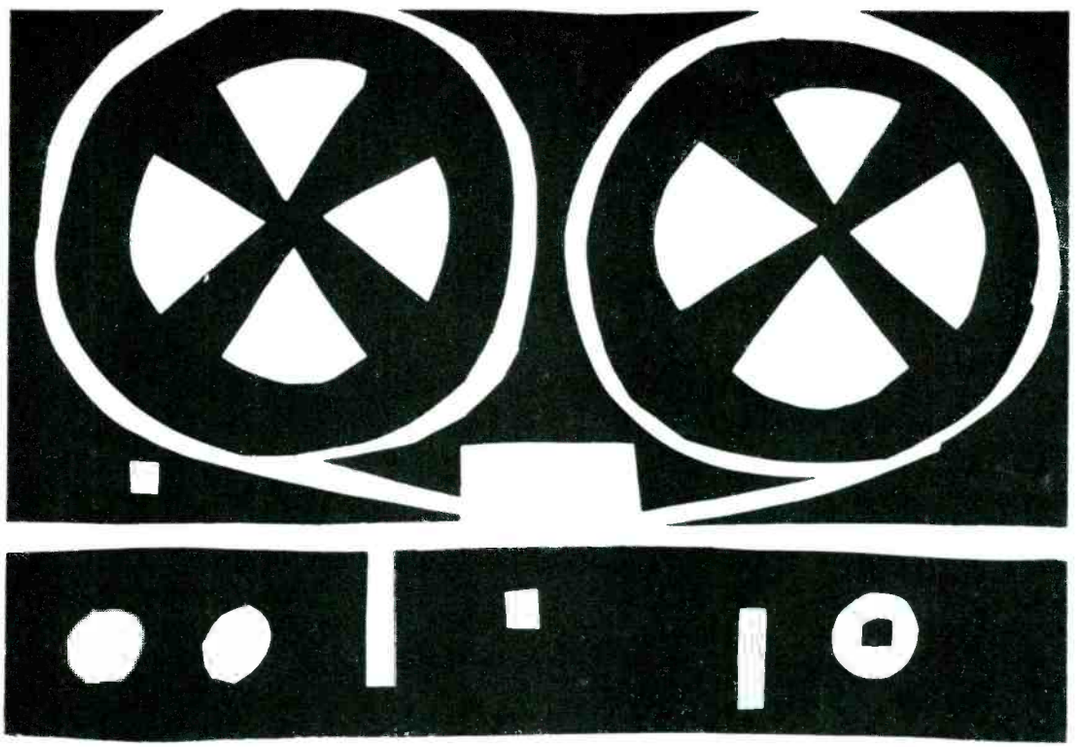

4 MACHINES: AMPEX BELL CONCERTONE CROWN EKOTAPE FERROGRAPH HEATH MAGNECORD NORELCO PENTRON ROBERTS SUPERSCOPE TANDBERG TELECTROSONIC UHER UNIVERSAL VIKING V-M WEBCOR WOLLENSAK 4 MUSIC: AUDIO FIDELITY BEL CANTO CONCERTAPES DECCA DOT ELEKTRA EVEREST HIFITAPES KAPP LIBERTY M-G-M MERCURY OMEGATAPE ROULETTE STEREO FIDELITY S-M-S VANGUARD VERVE VOX WARNER BROS WESTMINSTER WORLD PACIFIC

SIDJAKOV

Stereo Recording Techniques

RICHARD S. LEVY*

Practical and tested information about microphone placement in a variety of situations which will save hours of experimentation and many reels of tape.

THE WRITER is *not* a professional recordist. Using techniques outlined below, recordings of professional calibre have been consistently produced for various critical uses including a weekly radio series, dubbings, pressings, and demonstrations.

Here, insofar as it is possible to compile, are the prerequisites for stereo recordings of "pro" quality:

I. ADEQUATE EQUIPMENT

Most of the recording projects discussed in this article were recorded with two Altec "Lipstik" condenser microphones and an Ampex 601-2 stereo recorder and mastered, when necessary, on a Berlant series 30.

Less elaborate equipment may be used to produce effective stereo recordings, but with increasing probability of inferior fidelity, greater "wow" or flutter, and poorer signal-to-noise ratio. The results, in other words, may fall below true professional standards.

Recording tape should be selected with the ultimate use in mind. Low print-through tape has been found best for mastering and long-term storage. Many recordists advocate storage of valued tapes in "wound on" position and rewinding prior to each playback.

With any new tapes, be certain to remove the adhesive label at the head of the reel plus the entire first layer to insure against adhesive being transferred to recorder drive parts. In re-using tape it is good practice to bulk-erase existing material, which also lowers background noise.

If your machine or brand of tape has ever developed "tape skip" (a tightening spasm followed by a slack period which may repeat) it is good practice to rewind each raw reel prior to recording, which will exercise and free up most sticky tape.

The recordist must also be prepared with a good assortment of cables for microphone and power connections. All types of microphone stands may be called for as well as spare reels, spare tubes, and commonly used electronic parts. A "tube caddy" such as used by TV technicians—available at parts houses—is well compartmented and holds a generous supply of boxed 7-in. tape reels.

* *89 Oak St., Buffalo 2, N. Y.*

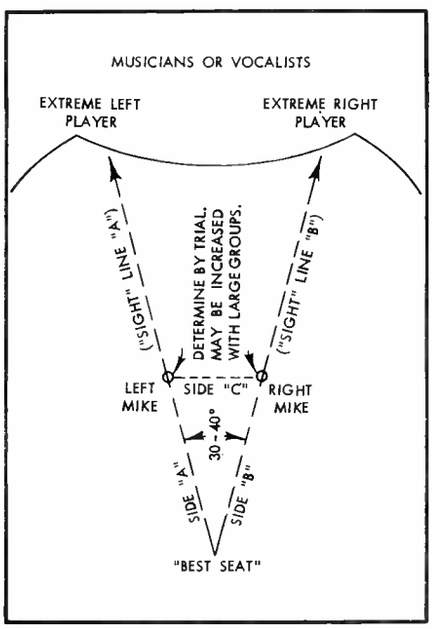

Fig. 1. Stereo microphone placement in school auditorium.

II. REHEARSAL TIME

It's wise to record for test purposes almost as much material—preferably the same selections—as you intend to include in the final recording.

If a choice exists, schedule recording sessions *without* an audience. You'll collect fewer coughs and less random noise and you'll experience less pressure to "get it right" the first time.

If your only opportunity to record is at a performance it's still possible to secure a very worthwhile recording but you'll find a few more obstacles. Musicians will probably do their best when facing a "live" audience.

III. PROPER TECHNIQUES

(1) *Microphone placement*

The new recordist may experience his greatest difficulty in proper placement of mikes because of several interrelated factors:

(A) Stereo effect (channel separation)

(B) Natural balance (loudness of instruments in relation to each other)

(C) Reverberation time and natural "brightness" of hall

(D) Physical facilities for mounting mikes and stringing cables.

Few hard and fast rules for mike placement may be found because varying conditions require different techniques. We shall, however, cover a few general rules and refer the reader to actual accounts of specific recording projects reported in detail later in this article.

General rules for miking

a) Ask permanent personnel at hall where other successful recordists or broadcast technicians may have placed microphones previously for similar pickups. Consider their logic in the light of information presented here and your own experience.

b) Select the "Best seat in the house." This should be the point at which desired sound blends best without annoying "bounces" or other unnatural effects. This is the seat for which you'd pay a premium to hear the same program.

From this seat, sight lines to the positions of the musicians or vocalists at the extreme right and left. It may help on your first try to mark these lines with spare cords laid across the tops of seats.

As an ideal situation, visualize a triangle with yourself at the vertex, the two longest legs pointing at the far right and left performers, and a third side half as long connecting the two legs in front of you. (See *Fig.* 1).

The purpose of the triangle is to place the microphones on a line with a 30- to 40-degree angle embracing the whole musical group as viewed from the "best seat." For the ultimate stereo effect the listener should duplicate this angle, with right and left speakers forming the same angle from his chair.

The actual dimensions of sides A, B, and C (distance between mikes) will vary with the size of the musical group and characteristics of the hall.

c) *Place mikes in best vertical plane.* It's often advantageous to "fly" (hang) microphones. If ceiling area seems to produce a relatively "dead" sound try lowering mikes closer to ear level. If no audience is present mikes may be placed on floor stands on seats and extended to maximum.

d) *Direct microphones.* These adjustments must take three factors into account:

1) Polar pickup pattern of mike (see manufacturer's specification for axis and diagram of pattern).

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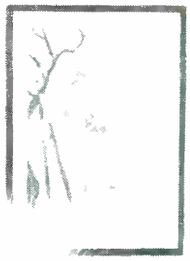

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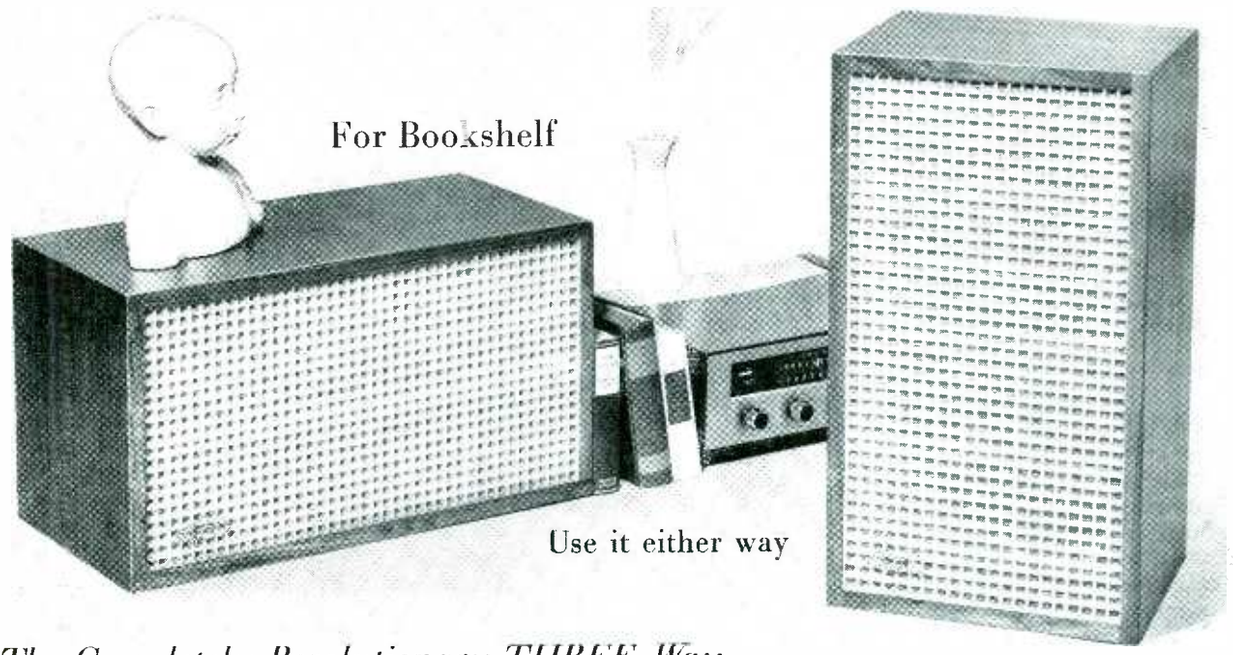

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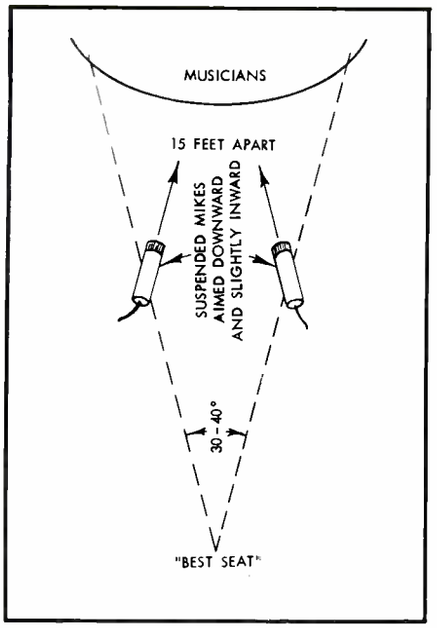

Fig. 2. Directing stereo microphones for typical orchestral pick-up.

2) Reverberation characteristics of room.

3) Types of instruments or voices involved.

High flown mikes may be pointed almost downward with a slight tilt toward the musicians. Medium-high mikes may be directed almost horizontally, while low mikes on stands may be aimed slightly upward. In a top view, mikes may often be directed with their axis forming a diamond with the 30- to 40-deg. "sight lines" from the best seat. (See *Fig.* 2). You will find exceptions, however, in some of the actual practice described below.

If increased reverberation is desirable (as in pipe organ pickup) try to vary the angle of the microphone axis towards the sidewalls to bring in a proportion of "bounced" sound. Caution: *This may distort* certain vocal or orchestral music and should be used sparingly.

(2) *Bracketing dynamic (loudness) range.*

a) Ask the conductor to rehearse the *loudest* crescendo which will be heard during the actual recording.

b) Set level controls to "peak" both meters *just below 100 per cent* or the point indicating over-modulation.

c) As rehearsal progresses check for any *quieter* passages which do not raise at least one of the meter needles from the rest pin. If any such passages are encountered *ask the conductor to call for increased expression* from the particular musician(s) concerned. This concept may seem strange, but a passage too low to register on one of two meters peaked as we have outlined will probably not be heard properly in the hall. It may also be obscured in the recording by the background level of tape hiss.

(3) *Balancing stereo channels*

After peaking, a further fine adjustment should be made to compensate for any variations between channels because one section of the orchestra may have registered more strongly during peaking.

A single sound, midway between microphones should be observed on the volume indicators. Here are a few common sounds: Applause for entrance of conductor, feedback of most P.A. systems, solo instrument or voice at center stage, and so on. Merely reduce the level of *highest* channel slowly until it is *equal* to meter reading of the opposite channel.

(4) *Accept natural dynamics*

After above adjustments are made SETTINGS OF LEVELS SHOULD NOT—REPEAT—LEVELS SHOULD NOT BE ALTERED. Any further variation during program will effectively change the listener's position or perspective. If the effect is too pronounced it may require re-recording to correct. A stereo performance will sound more natural and more pleasing without monitoring by the operator. (If you were recording on early discs, wire, or tape the new "let alone" technique might require unlearning, but the corrective urge should be curbed).

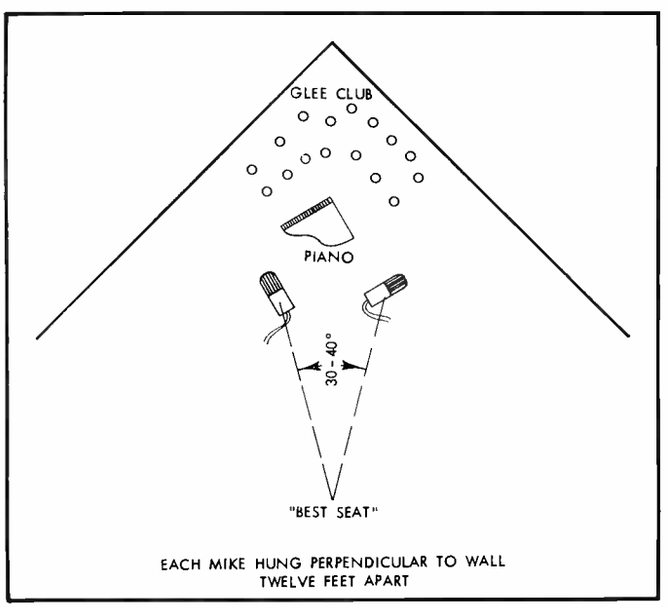

Fig. 3. Microphone placement and direction for pick-up of glee club singing in corner of hard-walled room.

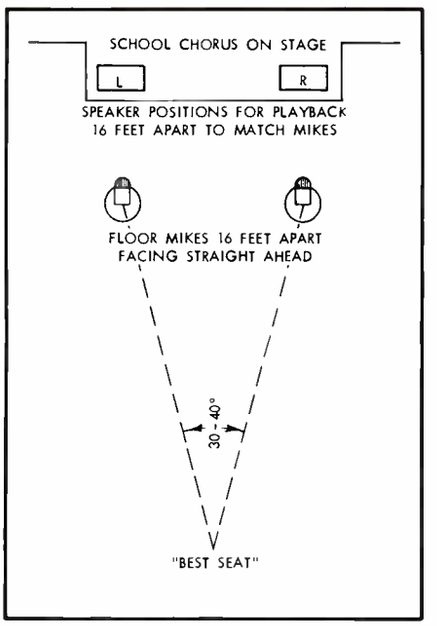

Fig. 4. Stereo pick-up of school chorus on stage.

(5) *Plan your program routine*

When the physical setup of all recording equipment has been completed secure a program or list of selections to be played. Ask the concertmaster or conductor for the approximate playing time of each selection, noting the time on the margin of your program or list alongside the title.

An elapsed-time stopwatch or timer should be a part of the recordist's equipment on every job. [A large, easily-read minute hand is an asset on the timer.] The timer should be operated whenever tape is rolling, showing minutes of recording time from the head of the reel.

Observe the conductor in rehearsal to learn how he gives the downbeat or starting signal to his musicians. Roll tape at least 10 seconds before the start of each selection to ensure that drive mechanism is operating with normal stability.

It's easiest and often best to allow machine to operate continuously through all movements and, unless an unusual delay is anticipated, between selections. Keep tape rolling throughout any applause. A prolonged ovation may be faded out in mastering, but it's difficult to deal with a "bump" if the machine is stopped abruptly during applause. A manual fadeout on applause means remembering and re-setting controls carefully before recording the next selection. Remember, too, that artists are heartened by their applause, and in permanent form it's even more flattering!

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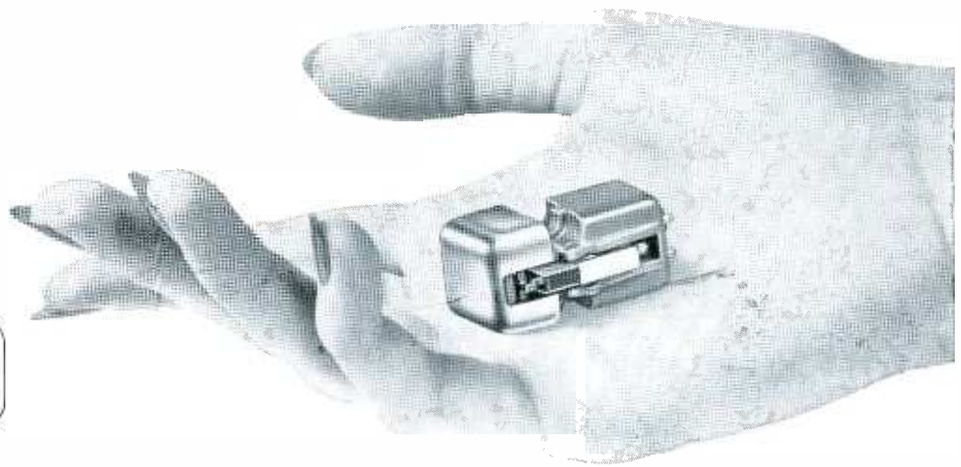

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"... the VR-227 is a top performer. The frequency response is as flat as any cartridge tested to date. Channel-to-channel separation in the vital area between 700 cycles and 8000 cycles was equal to the very best stereo cartridges now offered the public."

Wm. A. Stocklin
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Electronics World
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"... listening tests did not show up any flaws. Frequency response from 30 to 15,000 cps (limits of our test) was within 2.25 db of flat. Provides about the best channel separation available of any checked with the exception of [cartridge selling for $65.00] in the frequency range from about 5000 to 9000 cps."

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Editor
Audio
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"... is even better than its predecessor with respect to output, channel separation and extended frequency response and the two channels balance within ±2 db to 15 000 cycles. The shielding has been improved and the grounding of the shield and the method of shorting the two 'ground' terminals are well thought out."

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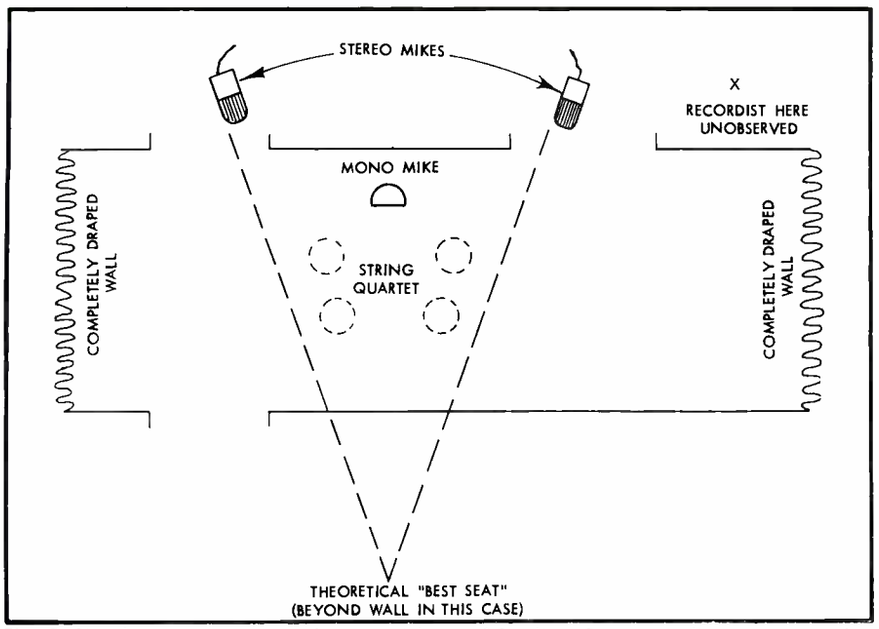

Fig. 5. Simultaneous stereo and mono pick-up of Sterling Quartet in livingroom studio.

TYPICAL RECORDING PROBLEMS

The preceding information should be helpful to the stereo recordist, but circumstances encountered will vary, requiring some changes in techniques. To illustrate we shall cite twelve actual stereo recording situations (one with exclusively mono end results) experienced by the writer, also the arrangements employed in each case.

I. ORCHESTRAL

(1) *Symphony orchestra in fan-shaped school auditorium:* 80 pieces in conventional arrangement on rectangular stage. Microphones were suspended through ceiling lamp holes above third row of auditorium seats about five rows ahead of theoretical "best seat." Mikes 15 ft. apart, dropped approximately 20 ft., flared slightly inward and forward towards musicians as in *Fig.* 2. Service catwalk provided access to area above auditorium ceiling, which was 35 ft. high.

(2) *Symphony orchestra in band shell of music hall.* 90 pieces. No catwalk available, but a pulley line was provided to fly mikes 38 ft. above podium on 12 ft. spacing. A T-shaped line arrangement from balcony was used to draw mikes a few feet towards audience.

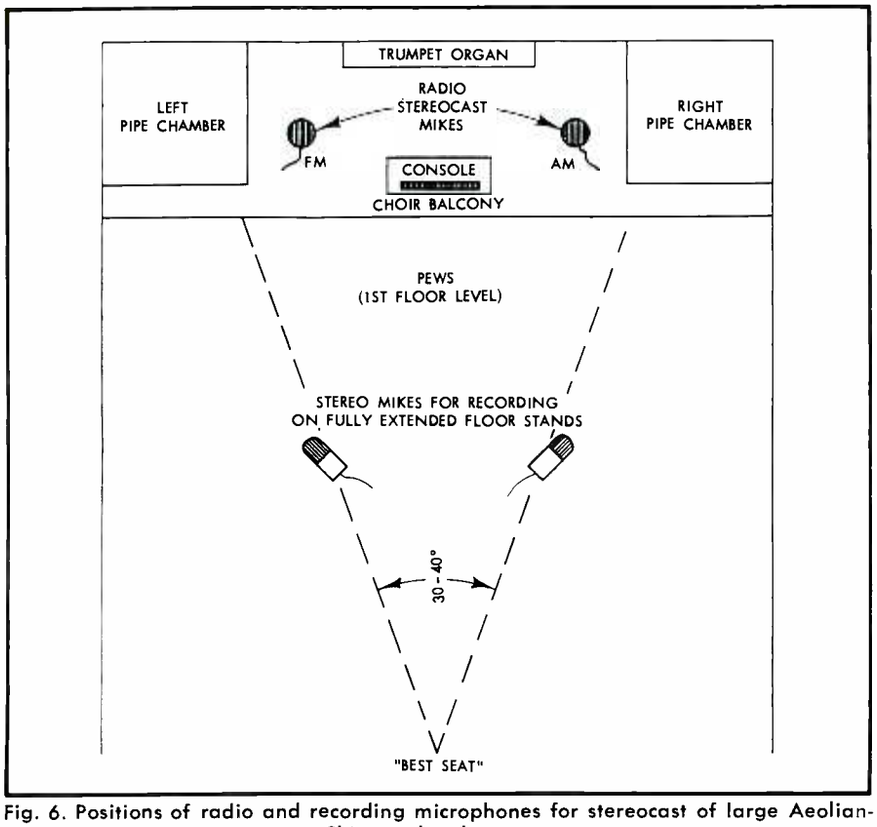

Fig. 6. Positions of radio and recording microphones for stereocast of large Aeolian-Skinner church organ.

II. CHORAL

(1) *Harvard Glee Club in concert formation on stage.* Procedure followed was very similar to that in I(*1*), (similar auditorium) except mikes were aimed straight towards stage to pick up fewer voices in each mike and improve stereo effect. Almost every one of the 48 voices seemed to stand out in the recording.

(2) *University Glee Club in assembly room.* 10 ft. ceiling. Voices arranged around piano in corner of room. Mikes suspended 1 ft below ceiling from louvres of lamps, 12 ft. apart and aimed at sidewalls. (See *Fig.* 3). Results were bright.

(3) *Elementary School Chorus on small stage.* 30 voices. Floor mikes placed 16 ft. apart, 10 ft. out from stage apron on auditorium floor. (See *Fig.* 4). Playback was later made for audience in same auditorium, darkened, and with speakers on stage apron spaced the same distance microphones were in the recording. Many persons believed they were listening to live chorus. A very clear LP pressing was made by equal mixing of both channels. The copies were sold to parents, with some sent to Japanese schools as part of an exchange program.

(4) *Community Choral Society.* In auditorium with band shell. Mikes placed 15 ft. apart on floor, 12 ft. in front of shell. Recorded in rehearsal and, as an experiment, a recorded stereo church organ accompaniment was played in the hall and mixed into the recording of their final selection.

III. CHAMBER MUSIC

(1) *String Quartet.* Recorded, as an experiment, simultaneously in mono and stereo. Stereo playback was somewhat more pleasing, easier for musicians to follow individual parts, but it was not spectacular in the full orchestral or choral sense. (Solo efforts are often wasted in stereo for the same reasons.)

Stereo microphones were placed on stands 10 ft. apart in archways leading into writer's living room. Mono mike suspended above center of group on boom. (See *Fig.* 5).

Members of the quartet were unaware of stereo recording gear operating in adjacent room. On playback, stereo and mono transports were set in motion together but only the mono was reproduced for the first three movements. A rapid cutover to stereo was made between third and fourth movements, puzzling the musicians, none of whom had previous stereo experience. None could explain exactly what had taken

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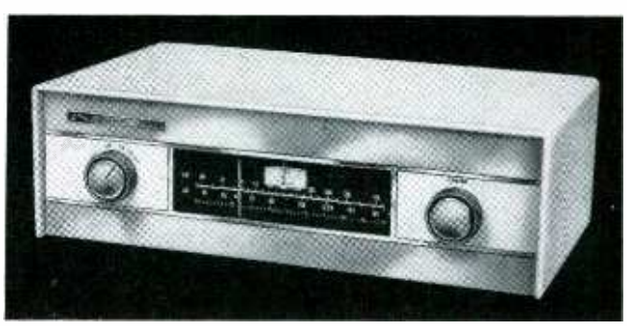

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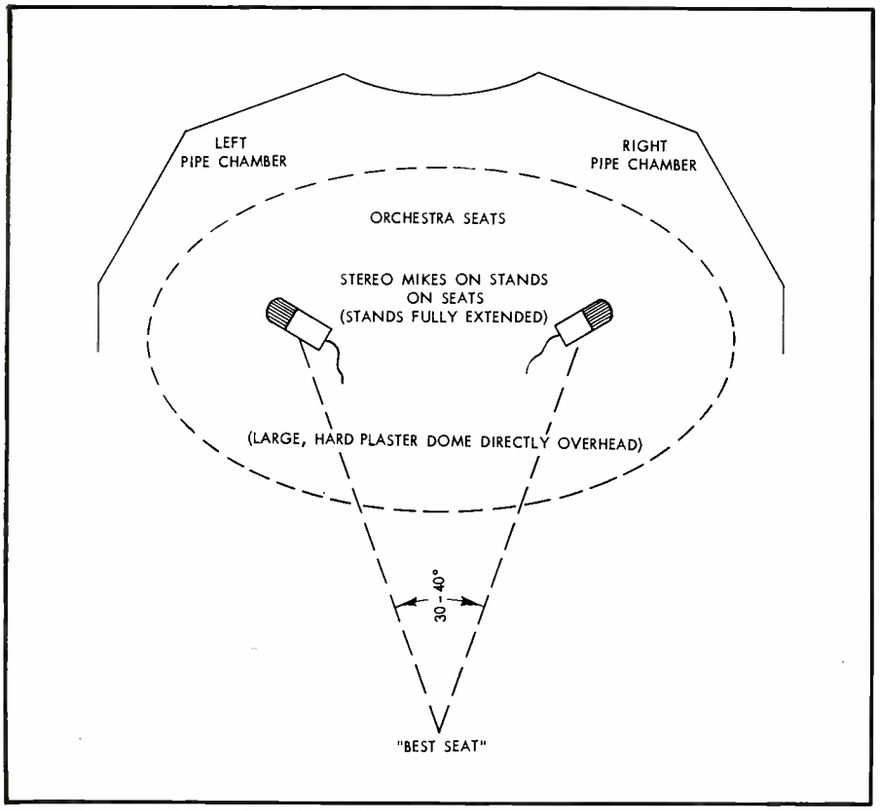

Fig. 7. Stereo pick-up of Wurlitzer theatre organ in acoustically live house. Reverberations excellent from domed ceiling.

place, but they did note some improvement in reproduction of the music.

IV. ORGAN

(1) *$110,000 Aeolian-Skinner Church Organ.* Mikes placed about one-third back in church on stands in pews about 22 ft. apart and directed towards extreme front corners to pick up some "bounce" from sidewalls. Organist later timed reverberation at 2 seconds—audible in each channel from *opposite* chamber.

A radio stereocast was also in progress on two occasions with station microphones 10 ft. to the side of each chamber of pipes. (See *Fig.* 6). A later A-B comparison with air-check tape convinced a jury of musicians that, while the broadcast reproduction had a slight edge in stereo effect, it had lost almost all of the powerful church-like reverberations.

(2) *Theatre Organ–live house.* Hard plaster dome in ceiling bounced brightness directly into orchestra seats. Mike stands extended fully and placed on seats about 25 ft. from each pipe chamber, about 25 ft. apart. Unusually wide-spacing of mikes increased the stereo effect and produced longer reverberation time from opposite chamber. (*Fig.* 7).

(3) *Theatre Organ–dead house.* The organ was a superb instrument—a five-manual Marr-Colton brought to peak condition—but sidewalls had been heavily draped to improve motion picture sound. Ceiling was also of sound absorbing material. Mikes finally suspended on wires about 10 ft. from each chamber, about 28 ft. apart and aimed almost straight ahead to catch a portion of sound from opposite chamber. (*Fig.* 8).

(4) *Schober Electronic Organ in chapel* with absorptive acoustical properties. This, of all projects described, presented the most problems and required the most trials. The instrument was recorded in mono because it has no interesting directional properties.

For the first attempt a mono microphone was placed in the center of the 50 × 80 ft. room. Pedal or bass notes registered heavily, far out of proportion to natural organ. Biting qualities of reed family were almost completely absent in playback.

The next attempt was to record an output signal directly from the organ bus feeding the power amplifier. No microphone was used. The reedy qualities and treble tones were recaptured, but most of the bass and all of the room tone had disappeared.

It was plain that a blend of output of the organ and a room mike was best. This was tried, but the heavy bass completely confounded the meter and monitoring headsets, and it was too difficult to judge proportions on this trial run.

A stereo recorder was finally connected, feeding organ output to one channel at normal meter readings. A room microphone, 10 ft. from rear wall facing hard surface of rear doors, fed the other channel at customary levels.

The results were later blended at home with two three-way corner speakers as monitors and it was found that a blend of approximately 25 per cent organ output to 75 per cent room pickup produced the most realistic effect on the composite master tape.

(*Continued on page 94*)

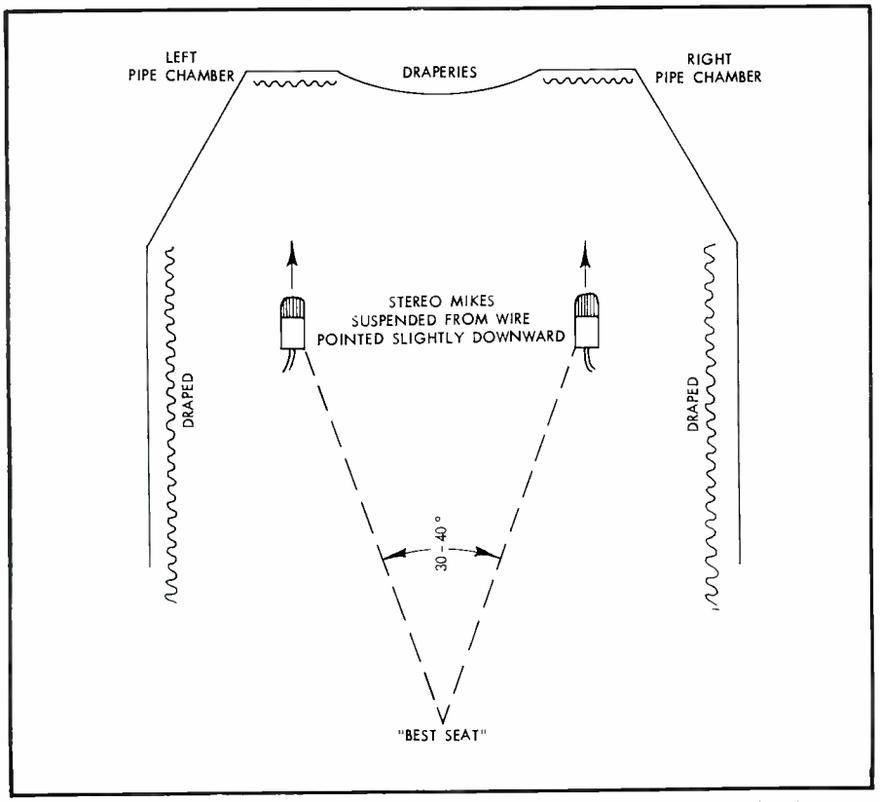

Fig. 8. Stereo recording of Marr-Colton five manual theatre organ in dead house.

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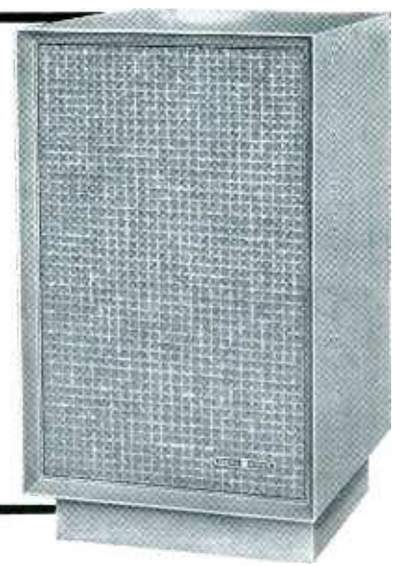

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THIS ARTICLE describes a three-transistor hi-fi preampliler for use with a magnetic cartridge. The proposed circuit should provide lower hum, more freedom from microphonics, a smaller package, and greater reliability than a comparable vacuum-tube preamp. The primary features of this design are a frequency response of ±1 db from 30 to 15,000 cps, less than 1 per cent total harmonic distortion, RIAA equalization, and separate bass and treble tone controls. The rated output is 1 volt peak into a 2000-ohm load. The power supply voltage is not critical and may be obtained from either the high-voltage B supply in any vacuum-tube power amplifier or a low-voltage supply from an all-transistor hi-fi system. These specifications should be acceptable to all but the most hypercritical audio fan.

The schematic of *Fig.* 1 shows the preamp with proper equalization for a G.E. magnetic cartridge. Other cartridges can be accommodated with a few simple resistor changes. The necessary conditions for RIAA equalization are: $R_1 = 22 \times R_2$; $R_2 = 100 \times R_3$; $R_3 = L/5$ (where L is the inductance of the cartridge in mh).

* *Texas Instruments, Inc., P. O. Box 312, Dallas, Texas.*

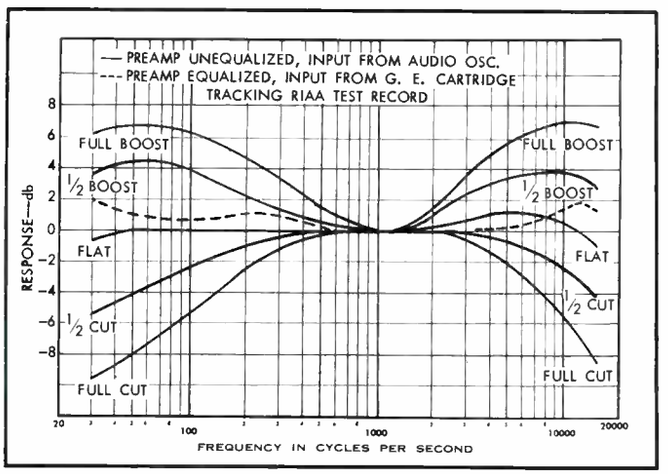

Fig. 2. Frequency-response curves for the transistorized preamp.

If a selector switch is placed at point X, the volume and tone controls can also be used for tuners, tape players, etc., provided the output impedance from the auxiliary equipment is 25,000 ohms or less. For good performance, the input signal should have a flat frequency response with an amplitude from 0.5 to 1.5 volts.

In *Fig.* 2 the solid family of curves shows the response of the preamp to signals applied at point X with various positions of the tone controls. The dashed curve is the output response of the preamp with tone controls in the flat position and a signal from a G.E. magnetic cartridge tracking an RIAA test record.

All specifications except frequency response can be obtained by using any 2N185/2N1274 type transistors with components of the tolerances noted. The frequency response will vary slightly with the choice of transistors but will in all cases be better than ±2 db from 30 to 15,000 cps with a magnetic cartridge source.

Those wishing to use the pre-amp with a vacuum-tube power amplifier should use connection No. 1 in the schematic. Connection No. 2 should be used with a transistorized power amplifier or when the preamp is battery-powered. The same performance is realized with either connection. Æ

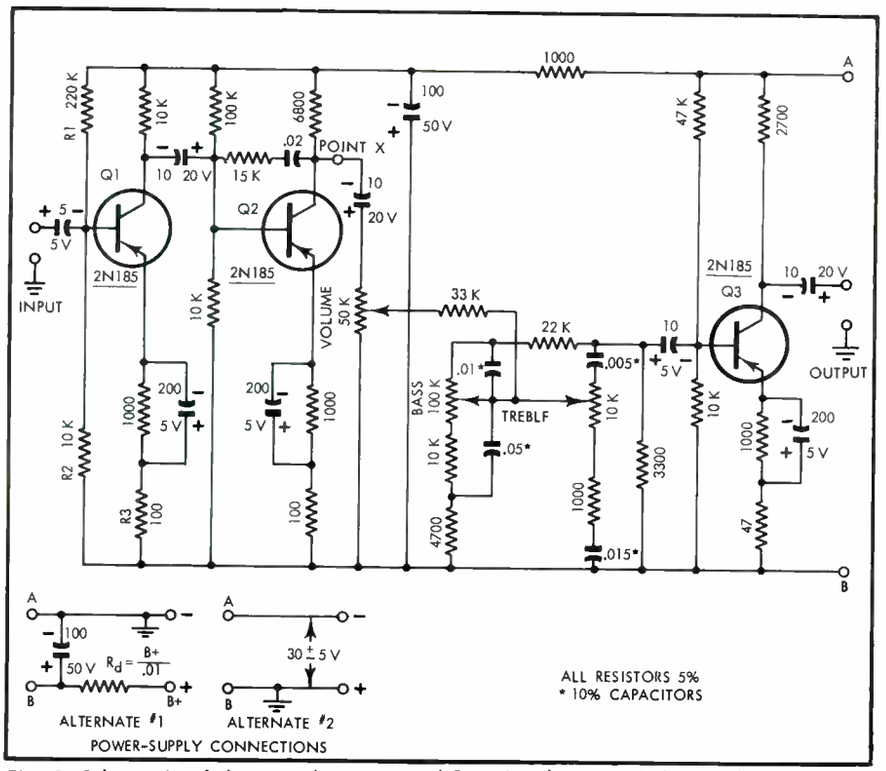

Fig. 1. Schematic of the complete preamplifier. A selector switch may be introduced at point X for high-level inputs.

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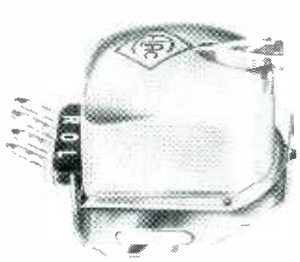

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W. B. BERNARD*
CAPTAIN, USN

WHEN THE BROADCAST of stereo programs by means of FM multiplex was begun the problem of designing and building a suitable adapter presented itself. One of the principal problems facing the designer was the lack of standards for such a broadcast service. This is still a problem. The possibility of the change of any standards adopted for experimental purposes makes it very desirable to design the adapter so that modifications can be made easily and inexpensively to permit reception of signals that conform to ultimately adopted standards.

Sub-carrier frequencies of from 27.5 to 67.5 kc and bandwidths from just a few kilocycles per second up to 50 have been suggested by the advocates of the various systems. In addition, it has been suggested that two or more sub-carriers might be accommodated with a single primary program thus complicating the design problem even more.

It seemed impractical to design a unit which would accomplish the filtering at the sub-carrier frequency and would be easily adjusted to any standard which might be adopted in the future. There were other problems associated with filtering at the sub-carrier frequency which it seemed best to avoid if possible. The expense of high-quality inductors suitable for filters in this frequency range, the difficulty of obtaining a suitable phase response from a complex T- or π-section filter and the difficulty of post-detection filtering to prevent overloading of audio systems which might have considerable response at the sub-carrier frequency were foremost in this category.

It was decided that the problems stated could be eliminated or at least greatly minimized by heterodyning the sub-carrier to a new frequency where conventional coupled tuned circuits could be used for band pass filtering. The block diagram of such an adapter is shown in *Fig.* 1. The adapter can be made responsive to any sub-carrier frequency which can be used with the present FM system by choosing the proper beating oscillator frequency and the bandwidth of the filter system can be varied over wide limits by the choice of Q of the tuned circuits and the coupling between them. Such a system also allows the use of conventional methods of amplitude limiting the sub-carrier and detecting the modulation carried by it. Some experimental adapters were built to prove out the principle.[1] They proved to be very satisfactory.

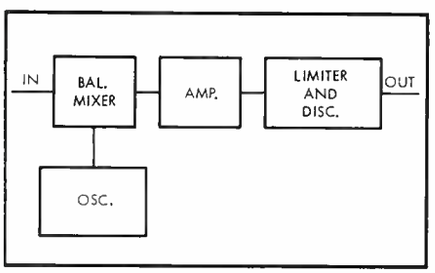


Fig. 1. Block diagram of the author's multiplex adapter.

Some of the parts used in the experimental models were not easily available and in some cases the required modifications could not be accomplished easily without a well equipped shop. Further work was carried out to develop an adapter which could be constructed with commonly available parts, the modification of which would be held to a minimum to permit the construction of the device using the facilities available to the average experimenter. This goal was missed only in that the alignment of the unit should be done with a frequency-swept signal generator and an oscilloscope.

Circuit Description

The circuit of the adapter is shown in *Fig.* 2. The sub-carrier signal is fed into the grid of the cathode follower through the 100-μμf capacitor. This capacitor and the 470-k resistor connected from the grid of the cathode follower to ground act as a simple high-pass filter which reduces the amount of the primary program reaching the grid of the cathode follower. The output impedance of the cathode follower is sufficiently low that the signal at that point can be inserted into a balanced mixer using a pair of 1N34 crystal diodes. It should be noted that the diodes are so connected that each of the two offers a different polarity to the common connection point. The carrier for the balanced mixer is furnished by the other half of the 12AT7 connected as a Colpitts oscillator. The mixer output is connected into T_4 which selects the components of the output that fall in the vicinity of 455 kc and impresses them on the grid of the 6AU6 amplifier. Capacitive coupling is used to increase the bandwidth of T_4. For a 10-kc bandwidth, a 6-μμf capacitor is used; for a 20-kc bandwidth a 10-μμf capacitor; and for 50 kc a 17-μμf capacitor. The secondary of the transformer is resistance loaded. For 10 kc the loading resistor is 100 k; for 25 kc it is 47 k, and for 50 kc it is 22 k.

The output of the 6AU6 amplifier feeds a capacitance-coupled pair of tuned circuits consisting of one winding each of T_3 and T_2. The other windings of T_3 and T_2 are used as traps to prevent energy at the oscillator frequency from loading up the limiter when a very-low-frequency sub-carrier is used. The trap windings are coupled to their associated active windings with 5-μμf capacitors.

The active windings of T_3 and T_2 are coupled with the same value of capacitors as is used to couple the windings of T_4. The limiter grid leak furnishes sufficient loading on this coupling network for all bandwidths.

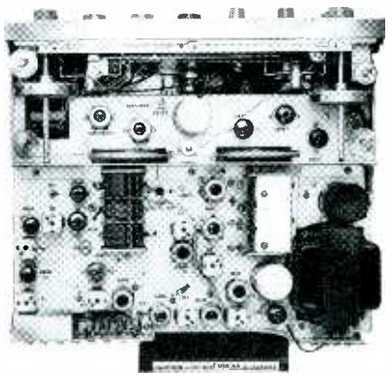
The output of the 6AU6 limiter passes through the discriminator transformer and is detected by two 1N34 crystal diodes. The output of the discriminator is passed through a de-emphasis network consisting of a 68 k resistor and a 1000-μμf capacitor.

The signal at this point is the modulation which was carried by the sub-carrier and, in the case where this is a signal independent of the primary modulation, the signal is ready for the intended use.

* *3151 South Glebe Rd., Arlington 2, Va.*

[1] W. B. Bernard, "Tunable FM multiplex adapter." *Electronics,* April 10, 1959.

There are two ways to design a piece of equipment: One is to fix the cost and design around it. The other is the Pilot way: produce the finest unit possible and then price it accordingly. If we knew of another useful feature to add to our Pilot 690-A, you would find it in the list below. Not cost for cost's sake, but for performance's sake.



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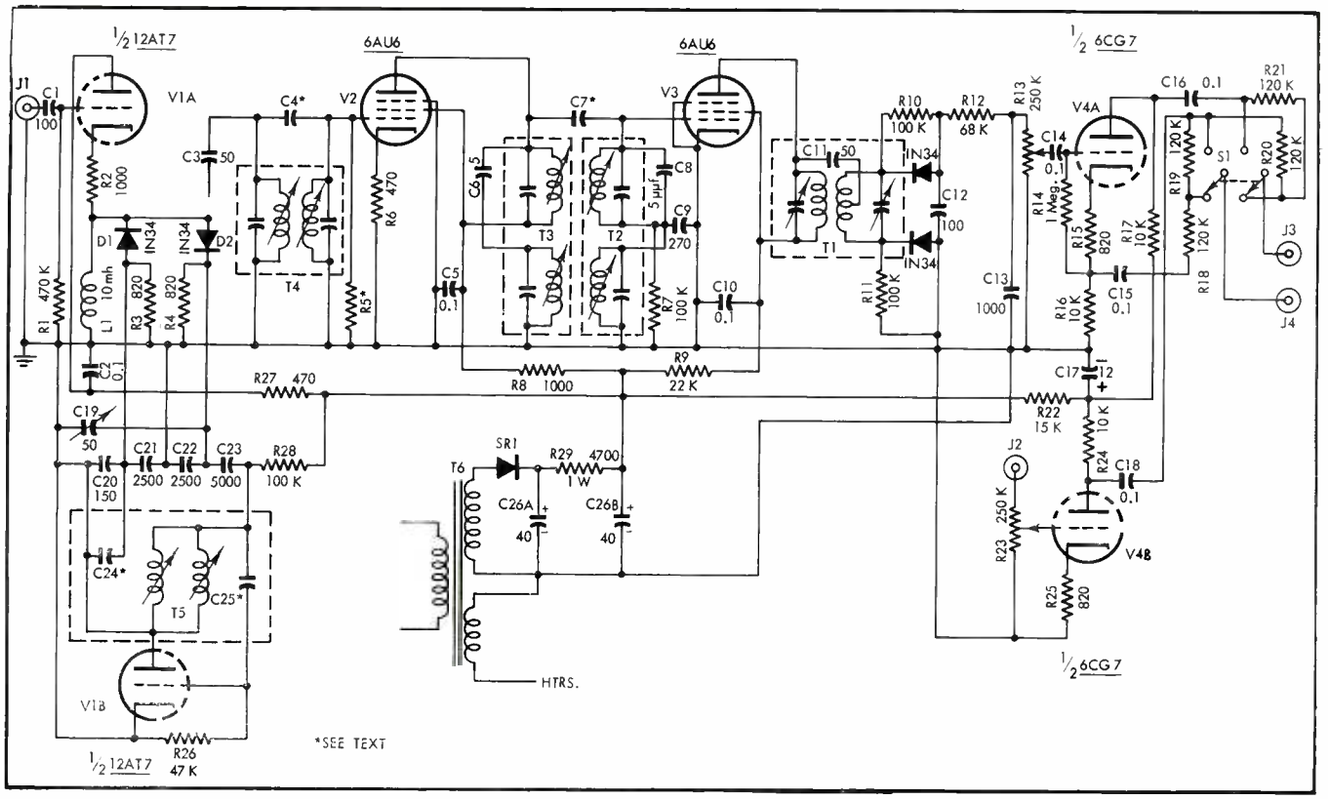

Fig. 2. Complete schematic of the heterodyne multiplex adapter.

Where, as in the Crosby System, the multiplexed and the primary channel signals are interrelated it is necessary to run the two signals through a matrix to recover the two stereo signals. For explanation the individual stereo channels are labeled A and B. The sum of the two channels (A + B) is carried on the primary circuit and is detected and furnished by the FM receiver as audio. This is fed into J_2 and thence into the primary-channel level control. From the level control the signal is fed into an amplifier consisting of one half of a 6CG7. In the plate circuit of this tube the phase of the signal is reversed so we have –A–B. This is fed to contacts 5 and 6 of S_1 through 120 k isolating resistors. The multiplex signal is the difference of the two stereo channels (A–B). This signal is passed through the multiplex level control and into the grid of the other half of the 6CG7 which is used as a phase splitter. The signal in the cathode circuit of the phase splitter is in phase with the input signal (A-B). This signal is fed, through a 120 k isolating resistor, to contact 5 of S_1 where it combines with the –A–B signal from the primary FM signal to give –2B.

The plate circuit signal of the phase splitter is –A + B which is fed through a 120 k resistor to contact 6 of S_1 where it combines with the –A–B primary signal to give –2A. Since there is a minus sign in front of both of the signals they are in the correct relative phase for stereo reproduction and the minus quantity has no meaning. When S_1 is thrown so that contacts 3 and 5 are connected and contacts 4 and 6 are connected, these reconstituted stereo signals appear at jacks J_3 and J_4. When S_1 is thrown so that contacts 3 and 1 are connected and contacts 4 and 2 are connected, the primary channel audio signal appears at J_4 and the multiplex audio signal appears at J_3.

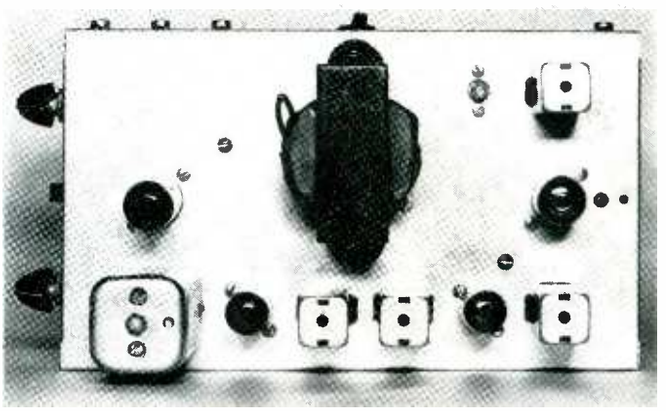

Fig. 4. Plan view of heterodyne multiplex adapter.

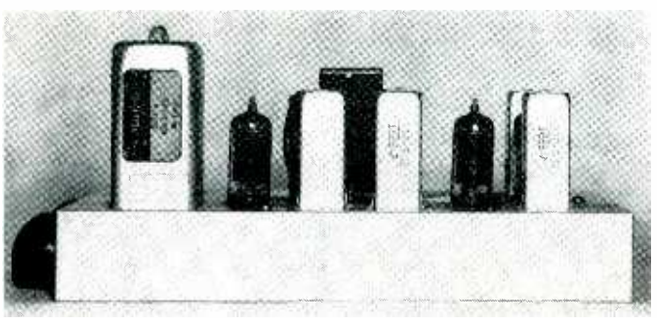

Fig. 3. Side view of adapter chassis.

Construction

The physical layout of the unit is shown in *Figs.* 3, 4, and 5. It is constructed on a $5\frac{1}{2} \times 9\frac{1}{2} \times 1\frac{1}{2}$ inch aluminum chassis. Starting at the left of *Fig.* 3 we have T_1, the 6AU6 limiter, T_2, T_3, the 6AU6 amplifier, and T_4. Looking at *Fig.* 4 at the left center of the chassis we have the 6CG7 matrixing amplifier and at the right center we have the 12AT7 cathode follower and oscillator. The power transformer is located in the center of the chassis and T_5 at the upper

A Truly "Complete" Stereo Amplifier

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Now on the market is the PIONEER's stereo amplifier model SM-Q140. This amplifier is a truly "complete" stereo amplifier incorporating two entirely independent tuners, one an AM-Shortwave tuner and the other an AM-FM tuner. Thus, in addition to high fidelity reproduction of disc records or tape recordings, stereophonic broadcasts of all types can be tuned in. Since the two channels are entirely independent of each other, the two speakers may be placed in separate rooms to enable simultaneous reception of two separate programs.

NOTE THESE FEATURES !!

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3. In monophonic operation, the output circuit functions as a EL84/6BQ5 pushpull circuit, while in stereophonic operation, the output circuit is transformed automatically into two independent circuits.
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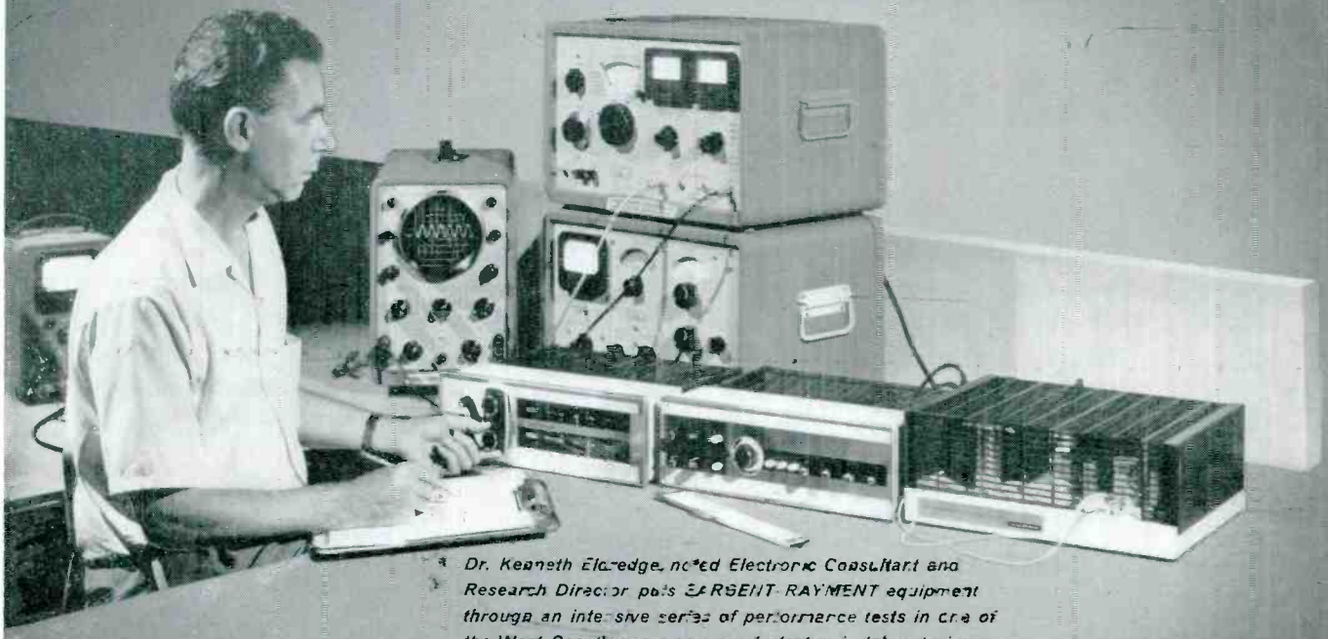

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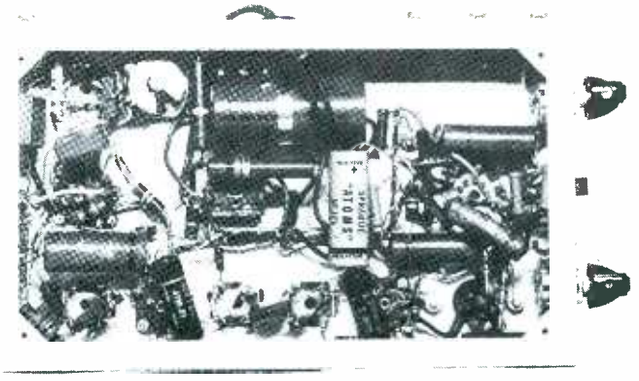

Fig. 5. Underside of adapter chassis showing parts placement.

right. *Figure* 5 shows the general placement of the parts under the chassis.

T_1 and T_5 must be modified. The magnetic coupling between the primary and secondary of T_1 must be increased. The simplest means of accomplishing this is to wind a 9-turn link of #26 DCC wire next to each of the windings. The phasing should be as shown in *Fig.* 6. A 50-μμf capacitor is connected from the "hot" side of the primary to the center tap of the secondary to finish the conversion to a discriminator transformer. In the case of T_5 the finish end of each winding is carefully broken loose from the terminal lug to which it is connected. It is then rerouted and connected in parallel with the start of the other winding thus connecting the two windings in parallel. The wire used in the windings of these transformers are heat stripping so the insulation need not be stripped from the wire before soldering to the new terminal lug. An ohmmeter may be used to check the connections.

The larger capacitor C_{24} built into the base of T_5 is used as part of the tuning capacitance and the other, C_{25} is used as the grid capacitor of the oscillator. A 50-μμf trimmer may be connected as shown in *Fig.* 2 if it is desired to make frequent changes of oscillator frequency.

The power supply consists of the transformer, selenium rectifier, and an RC filter system as shown in *Fig.* 2.

After the construction of the unit is completed it is necessary to align it. The 12AT7 should be left out of the socket during alignment. As mentioned at the beginning of the article it is necessary to have a swept frequency signal generator covering the vicinity of 455 kc and an oscilloscope and, if available, a marker generator. First the discriminator transformer is aligned. The signal generator is connected to the grid of the 6AU6 limiter, the oscilloscope is connected to the output of the discriminator and the signal generator is set to give a ±100-kc sweep centered at 455 kc. The secondary of T_1 is adjusted to give the zero crossing at 455 kc and the primary is adjusted to make the curve symmetrical. Next the signal generator is moved to the grid of the 6AU6 amplifier and the oscilloscope is connected to the upper end of the limiter grid resistor. The generator should be switched to amplitude modulation and set to the frequency of 455 kc plus the lowest subcarrier that it is desired to receive. Should this be 50 kc, for instance, the generator should be set for 505 kc. The trap windings of T_2 and T_3 should be adjusted to give minimum output on the screen of the oscilloscope. After the traps are set the signal generator is set again for ±100 kc centered at 455 kc and the other windings of T_2 and T_3 are adjusted to give the pattern shown in *Fig.* 7.

Next the signal generator output is moved to the cathode contact of the cathode follower socket and the windings of T_4 adjusted to give the pattern shown in *Fig.* 7. Now the 12AT7 may be inserted into the socket and allowed to warm up thoroughly. After it is warmed up one of the oscilloscope amplifiers should be connected across either of the 2500-μμf capacitors in the oscillator circuit and the signal generator should be connected to the other oscilloscope amplifier. The signal generator is then adjusted to 455 kc plus the desired subcarrier frequency with no modulation. The slugs of T_5 are then adjusted until the adapter oscillator frequency coincides with the frequency set up on the signal generator as shown by the pattern on the screen of the oscilloscope.

Connections

The adapter is now ready to connect into the system. If your FM tuner has a multiplex jack it is simply connected to J_1. If it does not have such a jack it will be necessary to connect a cable into

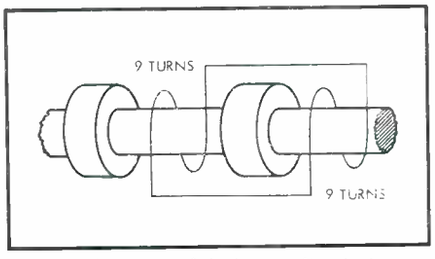

Fig. 6 Phasing of link on discriminator transformer.

the audio system of the tuner ahead of the de-emphasis network to furnish the signal to the adapter. The output of the adapter may then be connected into one of the high-level inputs of your preamplifier or control amplifier system. At this point you should be able to hear the multiplexed program. The frequency of the oscillator may be adjusted precisely by connecting a VTVM between the top of the discriminator load and ground and adjusting either of the slugs of T_5 or the trimmer capacitor if used for zero voltage making certain that it is the zero between the positive and negative peaks.

If a very low sub-carrier frequency is used it may be necessary to increase the coupling of the trap windings in T_2 and T_3. This is best done by connecting a sweep signal generator and oscilloscope as for the alignment process and watching the result of increasing the coupling on the oscilloscope. The coupling capacitors between the signal windings and the traps of the two transformers may be increased until a reduction of response in the desired pass band is observed. Should this still not give sufficient suppression of the oscillator frequency an additional transformer can be connected to T_4 to give a transformer pair similar to T_3 and T_2. Also in the case of a very low sub-carrier frequency the balance between the two 820-ohm resistors and the 2500-μμf capacitors should be checked in order to insure that the minimum amount of carrier is present in the output of the balanced modulator.

The adapter described here was not designed to be switched to all types of services as a matter of routine; for such use the previously described unit[1] is better suited. It is designed for use on a specific system where there is a possibility that the finally established standards will be different from those now in use in which case the change to the new standards can be made in a few minutes at the cost of two small capacitors and one resistor. If there is no service in the reader's listening area which would require the matrixing amplifier the unit may be operated without it with the knowledge that there is space reserved for it on the chassis and that it may be added when needed. By building this adapter the reader is pretty well assured that whatever happens to the multiplex standards his adapter can be adapted and therefore will not become obsolete.

PARTS LIST

C_1, C_{12}	100 μμf, 500 v, mica
C_2, C_5, C_{10}, C_{14} C_{15}, C_{16}, C_{18}	0.1 μf, 400 v. paper
C_3, C_{11}	50 μμf, 500 v, mica
C_4, C_7	6, 10, or 17 μμf, ceramic disc, see text
C_6, C_8	5 μμf "gimmick"—4 turns insulated wire wrapped around one transformer terminal lug but not connected; wire soldered to other terminal
C_9	270 μμf, ceramic disc
C_{13}	1000 μμf, 500 v, mica
C_{17}	12 μf, 150 v, electrolytic
C_{19}	50 μμf, trimmer; see text
C_{20}	150 μμf, silver mica, 500 v
C_{21}, C_{22}	2500 μμf, 500 v, mica
C_{23}	5000 μμf, 500 v, mica
C_{24}, C_{25}	part of T_5; see text
$C_{26a,b}$	40–40 μf, 150 v, electrolytic
D_1, D_2	1N34 germanium diodes
J_1, J_2, J_3, J_4	phono jacks
L_1	10 mh, r.f. choke
R_1	470 k ohms, ½ watt
R_2, R_8	1000 ohms, ½ watt
R_3, R_4, R_{15}, R_{18}	100 k ohms, ½ watt
R_5	22 k, 47 k, or 100 k ohms, ½ watt; see text
R_6, R_{27}	470 ohms, ½ watt
R_7, R_{10}, R_{11}, R_{28}	100 k ohms, ½ watt
R_9	22 k ohms, ½ watt
R_{12}	68 k ohms, ½ watt

(*Continued on page 98*)

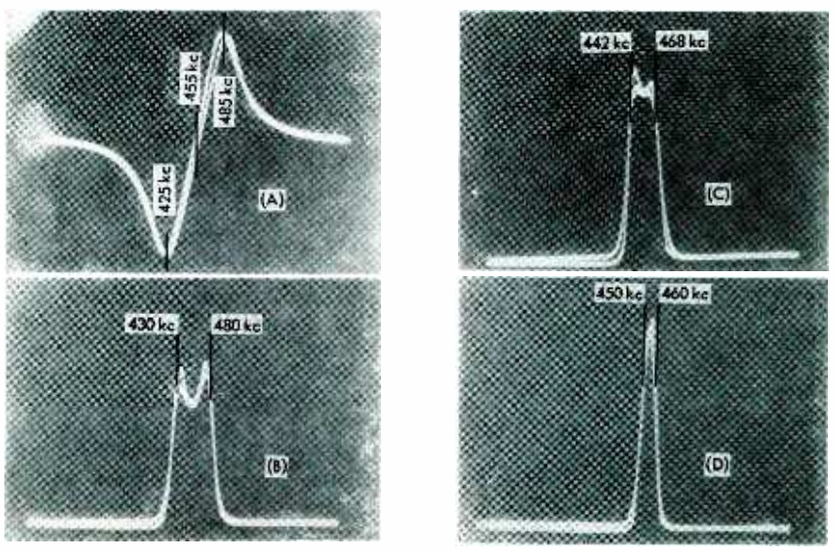

Fig. 7. Typical 'scope traces obtained during alignment. (A), discriminator response; (B), amplifier response at 50-kc bandpass; (C), response at 25-kc bandpass; (D), response at 10-kc bandpass.

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Whatever your recording, broadcast, or public address needs you can select with confidence when you choose microphones developed through ALTEC'S experience and research.

MODEL 661A, B, *omnidirectional*

The 661 dynamic brings you an exclusive new principle of microphone sound-entry, Altec's *sintered bronze filter*. This new filter development provides Acoustic Front Damping to the microphone diaphragm to extend high frequency response and eliminate high frequency peaks. The *sintered bronze filter* completely protects the pressure element against harmful iron filings, dirt and moisture for extra long life. Its superior performance, durability and reasonable price make the 661 a popular choice where quality is a must.

MODEL 680A, *omnidirectional*

A peripheral sound entrance channel or "acoustic gate" provides Acoustic Front Damping in the Altec 680A. High frequency response is extended over a wider range without high frequency peaks. The narrow sound entrance channel protects the pressure element against harmful dirt and moisture. The 680A is the world's finest professional quality dynamic microphone.

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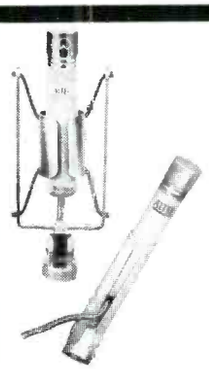

M30, *Cardioid Microphone System*

The exceptional M30 Cardioid Condenser Microphone System has a frequency response of 20-20,000 cycles with a directional cardioid pattern of outstanding discrimination. It is the first miniature directional microphone capable of translating the entire frequency and dynamic range without false accentuations.

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The M20 is the world's smallest and most versatile quality microphone. It is widely used in recording, broadcast and public address work and is chosen in medical and laboratory recording units because of its extreme sensitivity, smooth response and reliability. The military version of the Altec M20 is used in many missile development projects because it operates efficiently even under extreme temperature and moisture changes and punishing vibrations.

MODEL 670B
Variable

The rugged 670B broadcast microphone provides a ribbon element plus a controllable acoustic labyrinth for variable pickup including the three basic directivity patterns: pressure, cardioid and velocity. The 670B's frequency range covers the complete audio spectrum.

MODEL	680A	661A, B	M30	M20	670B
Pickup pattern	Omnidirectional	Omnidirectional	Cardioid	Omnidirectional	Variable
frequency response	30-15,000 cps	30-15,000	20-20,000 cps	10-15,000 cps	30-16,000 cps
output level	−55dbm/ 10 dynes/cm²	−55dbm/ 10 dynes/cm²	Unbalanced (600 ohms)−54 dbm/10 dynes/ cm² Balanced −53dbm/10 dynes/cm²	Unbalanced (600 ohms)−49 dbm/10 dynes/ cm² Balanced −48dbm/10 dynes/cm²	−56dbm/10 dynes/cm²
output impedance	30/50 ohms 125, 250 ohms	A-30/50 ohms B-30/50, 150/250, 20,000 ohms	Unbalanced 30,150,600 & 10,000 ohms; Balanced 30, 150 & 600 ohms	Unbalanced 30, 150, 600 & 10,000 ohms; Balanced 30, 150 & 600 ohms	30/50 ohms 150, 250 ohms
dimensions	1"x 11/2"x 7"	5 3/6"x 1 5/8"	25/32"x 3/4"	3 1/8"x 5/8"	61/2"x 21/2" x 3 3/8"
price	$99.00	$49.50/$59.40	$334.00	$236.00	$138.00

12-89

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AUDIO ETC.

(*from page 14*)

alive and isn't likely to let you rest in peace for long with your stuffy old two-speaker stereo. The only trouble is, again, that the center channel poses some formidable complications in the unraveling, the derivation of one, convincing, natural, accurate sound out of removed parts of two other sounds, supposedly complete in themselves. Redundancy, duplication, cancellation, confusion, all are serious dangers. Theory and practice must move hand in hand or, better, handcuff to handcuff. Sometimes they are—or seem to be—at diametric odds. Some people make their center channel from out-of-phase elements in the two main channels, for instance, elements that in theory ought to be everywhere *but* in the center—and the darned thing sounds quite reasonable in the listening, sometimes. Differences that you'd think ought to be huge turn out to be trivial. Theoretically zany systems sound pretty good; theoretically correct arrangements just don't pan out. . . . Nope, it isn't easy, all this.

Constructive Questions?

Sometimes the best approach to clarity in this sort of area is not to make statements but to ask questions. There's nothing like a question, unanswered, to clear up the thinking process. Therefore, before I deal briefly with something specific called Triophonic Stereo with Equalized Sound, I'll pose a few compound questions and toss in some tentative answers, here and there, as the spirit moves.

1. Does a center-channel (full-range) speaker help to widen the effective listening area in which spatial relationships are heard as reasonably natural?

Well, I dunno. I suspect that it does help in putting a close-up solo instrument in the center for people listening off towards the sides. It doesn't do a thing for the ends of the sound-spread and I doubt if it really helps the side listeners to hear the *background* center—the center of the orchestra in a symphony—in any truer relationship.

If a center channel is out of balance, or the speaker too far forward, it can do much more harm than good, destroying the illusion of space towards the rear that is produced by the cooperating outer speakers.

2. What happens to the listening when the phase of the center components is juggled? A + B, or A − B? Ideally, the center channel should contain the sum of the identical elements in the two channels—those sounds which ought to, and will appear automatically in the middle; what effect do you hear when instead of A + B, there is A − B in the central channel? Does this "inside-out" condition, with the center speaker carrying elements that ought to be on the outer edges, sound as bad as it ought to?

Darn it, no. Sometimes I think that any old sound will do in the middle, so long as it's the same piece of music. Tentative reasoning suggests strongly to me that most stereo sound is already so hashed up by room reflections and general acoustic confusion that the ear doesn't even notice a few discrepancies in the center area, unless called sharply to attention. We fool ourselves all the time, anyhow; the idea is to do it with the best aesthetic effect and for the most pleasure.

Note well that stereo sound is far more positive in a dead listening situation than in live acoustics—though generally we rather like the reverberation of the live room. As mentioned last fall here, a *really* live room brings you no audible stereo whatsoever. Just a jumble, if a nice one.

3. Is the rgihtness—or wrongness—of a central channel reproduction enhanced by three-track stereo originals (via two-track commercial stereo, of course)?

That's a very interesting question with a theoretically answer that should be no, but probably isn't. The third-track stuff, in phase and identical on the two commercial channels, appears automatically in the middle in any good two-speaker stereo system, in phase. If the speakers are reversed, it is thrown to the ends and all is chaos. Most people rather like this chaos—it's "stereo" to them, i.e. and exaggerated separation. Just like the dealer said.

In an ideal three-channel reproducing system the original third-track stuff should, in the same way, appear at the center speaker. In theory, it should sound exactly the same as with two speakers, at least from a central listening point. From the sides, as suggested previously, it should, maybe, have a slightly greater centralization.

But can you tell a two-track original from a three-track original on such a Three-Tweet system? Well, can you tell the difference on a *standard* system? I can —sometimes. Nevertheless, I can't help suspecting that a good three-way system will respond gracefully to a three-channel recording, restoring a good part of the original center segment to an independent, if a fused life. Fusion is taken for granted as essential in stereo. Lots of people don't like it.

4. What if the phasing of the original third channel was out, or partly out, due to multimike mix-ups? Has happened, can happen.

Answer: utter confusion in the listening, and you can't do a thing about it. But you'll probably love the sound.

5. Does a center speaker and channel really full up the famous hole in the middle?

What hole? If there's a hole, maybe the record producer wanted it that way, so why fill it up? If your speakers are out of phase you'll get a fine hole, and you'll find that your guests will ooo and aah at the superb stereo separation.

6. Can you get Fusion with a regular two-speaker set-up?

Sure. Just pick yourself two *identical* speakers with good high distribution forward (not up), find a medium-live living room and pick a *symmetrical* wall for the speakers, with conditions on both sides the same achitecturally, opposite right to left; set 'em at least five feet apart and maybe more, set yourself at the point of a rough equilateral triangle, choose a well-made stereo record. . . .

7. Is the bass in stereo music really nondirectional? Can it really come from any old place?

The lower you get, the less direction and less stereo effect there is—it doesn't just happen all of a sudden. Down at the bottom, bass is surely non-stereo, non-directional and the principle is clearly solid enough to put into practice in the One-Woof manner, as above.

But remember that bass *music* is full-range, that "bass" sounds, like a bass fiddle, are definitely directional because of the overtones present. Too many of us are casually confused on that. To make a bass fiddle non-directional you must remove its very soul, its highs. If you can manage to extract only the bottom, from 200-or-so cps down, for your One-Woof speaker, you can let the fiddle's top overtones go out where they belong and the entire instrument will seem to be out there, bass and all.

But let the slightest trace of lower-middle sound get into your "Woof" speaker and it becomes a point source. Bad. Unless, of course, that's where the sound is supposed to be. Say, under the couch.

TRIOPHONIC

And with that, and with apologies to Weathers for lack of remaining space, I come to that company's tricky three-speaker system, two books and a box, that you'll see advertised as TrioPhonic. It's not a three-channel system at all in the sense of my arguments above; it's a pure One-Woof, and so intended. The two side speakers are amazingly small, and the company has got them so they look like books, with rounded rear and a gold metal screen where the spine ought to be. A big book, about the size of a small dictionary, and it contains a tricky cone speaker around nine inches long and two inches wide, damped by a piece of cottony stuff in front. The frequency range of these little satellites is quite astonishing, ranging down into the very low hundreds of cycles and up to the top. They produce a lot of volume, too, with good efficiency, and you'll find it surprisingly hard to make them blast in overload.

Now maybe I'm running counter to the company's intentions, but I found these little book-speakers extremely useful as two-channel playbacks, for portable stereo listening in great convenience and also for general stereo of surprisingly good over-all quality. Yes, the bass was "thin"—i.e. missing at the bottom. But there was a lot more of it than in most portables, and the usual boomy, peaky bass quality was entirely absent. No doctoring for false bass. I find that for a second system, easily installed or moved about, these two speakers are quite invaluable. Their tone is clear, the range wide, their slight tinniness is mainly, I think, an aural effect of the bass roll-off

(*Continued on page 90*)

another Presto precision recording tool to make your job easier.

new PRESTO recorder/reproducer converts instantly from ½" to ¼" tape!

The new Presto 850 is the only professional tape recorder that converts in seconds from ½" to ¼" tape, and vice versa—and it's from Presto, makers of more professional sound-recording equipment than any other manufacturer in the world. The new, flexible 850 ends the need to keep expensive equipment sitting around idle. Conversion from ½" to ¼" tape head assemblies requires only a screwdriver and a few seconds.

Based on the successful 800, the use-proved 850 provides such exclusive features as: an edit switch for one-hand runoff during editing and assembly of master tapes, eliminating messy tape overflow • a molded epoxy-resin drum brake system with double shoes to end brake-maintenance headaches • four-position plug-in head assemblies instantly interchangeable without realignment • three-track stereo master control (optional) for special recording effects • three Presto A908 amplifiers stacked on an easy-to-work-at console, in portable cases or for rack.

The 850 delivers a high production editing rate at significantly lower operating costs. Separate switches provide correct tension even when reel sizes are mixed. Pop-up playback head shield for right-hand head disappears in STOP and FAST, completely exposing all heads for easy sweep loading and fast, sure editing. Safe tape handling at top speed is assured. Interlocks prevent accidental use of RECORD circuit.

To get complete specifications on the new 850, which is available in console, portable and rack-mounting models, mail this coupon today.

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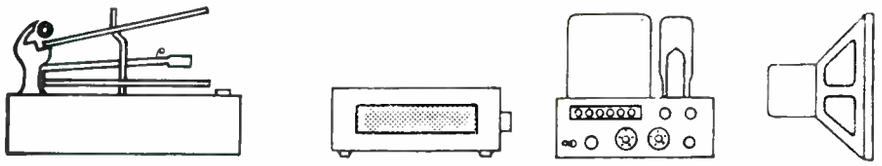


SONY 555-A-4 STERECORDER

In the realm of tape recorders, you can take your pick all the way from around $100 to whatever your budget will stand, and in every case you are likely to purchase more and more facilities as the price goes up. Whatever your needs, there is at least one machine on the market which will fulfill them, but it is reasonable to presume that for optimum performance you will have to go well above the lowest figure. Not that some of the lower-priced tape decks are inadequate for certain purposes, particularly for playback only, where the modern preamplifier is capable of furnishing all the necessary electronic equipment, but when you must have high quality, combined with all the traditional facilities of the tape recorder/reproducer, $100 just won't do the job.

There are four models of Sony Sterecorders: DK-555-A and 555-A, chassis and portable models respectively of a two-track stereo and mono recording and reproducing unit; and DK-555-A4 and 555-A4, chassis and portable models of a similar unit with the addition of a four-track playback head. None of the machines is able to record four-track tapes. All models are arranged for two speeds—7½ and 3¾ ips—and all have built-in power amplifiers; the portable models have a monitor loudspeaker installed and connected to Channel 1, together with space for storage of tapes and microphones. The DK-models may be converted at any time to portables by purchasing the model PC-2 case. In addition, two types of cases are available for loudspeakers—PSC-100-8 and PSC-100-12 for mounting 8- or 12-in. speakers—and model PSC-212 is furnished with two JBL D-123 extended-range 12-in. speakers mounted. The two halves of the speaker cases fit together to form one unit approximately the same size as the portable recorder case, shown in *Fig.* 1, which is 19 in. wide by 15⅞ in. deep by 10¾ in. high. Access to all circuits is through the jacks visible in the opening in the front of the case, while the a.c. cord plugs into the left side of the chassis. For deck mounting, there are two brackets which attach to the side of the chassis and permit the unit to be mounted on a flat surface.

The controls of the Sterecorder are mounted on two panels. The forward section has, from left to hight, the stereo-mono switch, channel 1 volume and tone, the two meters, channel 2 volume and tone, the monitor playback level control, and the power switch. The channel controls consist of a black knob, which controls recording or playback volume, and a concentric clear plastic knob which controls high-frequency equalization on playback only, thus serving as a tone control. Each machine is furnished with a calibration setting at which point the response is flat when reproducing a standard frequency tape. Thus when the knob is set to the calibration point, the user is assured of normal response, yet if the reproduction does not sound right, due to a tape which was recorded on another machine perhaps, he can change the equalization easily without having to resort to internal adjustments. The equalization range is from −10 to +10 db from normal at 10,000 cps. The two meters are connected to the recording circuits with fixed calibration (internally adjustable) when recording, and to the output circuits when in the playback mode. The monitor/playback control is a dual unit, and affects monitor or playback volume on both channels simultaneously. Thus the individual channel controls may be used to balance the two outputs, with the dual control thereafter used as the volume-controlling element. The stereo-mono switch makes all necessary changes in circuitry between one and two channels; in the mono position both monitor outputs are fed from channel 1, and the indicator lights under the channel-2 control and meter are extinguished. In stereo operation, both dials and meters are illuminated.

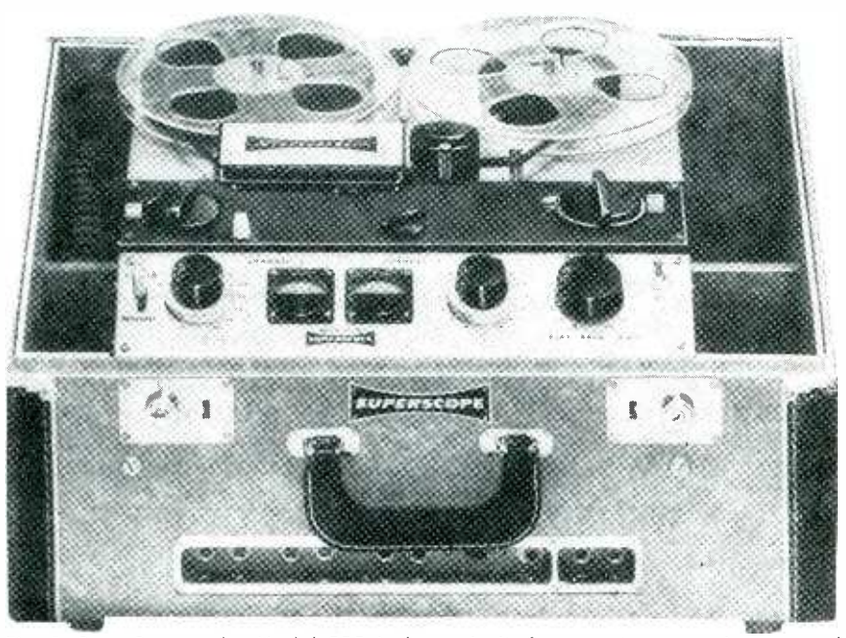


Fig. 1. Sony Sterecorder Model 555-A shown in its luggage-type carrying case which provides space for tape, microphones, and accessories.

Along the front apron of the chassis, the first two jacks are for channel 1 and 2 microphone inputs, accommodating high-impedance mikes; the next two jacks are for high-level inputs; the next two are line outputs feeding from cathode followers. The loudspeaker switch is next, and in the off position the amplifiers are terminated with fixed resistors. This is followed by the monitor jack—a three-circuit jack to accommodate stereo headphones—and the two speaker outputs. A switch on the underside of the chassis permits adjustment of the output circuits for 4-, 8-, or 16-ohm speakers.

Both channels are identical, with an EF86 as a pentode for the first stage, followed by one-half a 12AT7 (or 12AZ7) as voltage amplifier, with the second half serving as the equalized recording-head driver stage in the recording mode. The voltage amplifier stage drives the 6AQ5 output stage while recording, as well as two halves of another 12AT7—one as meter amplifier and the other as the cathode-follower line-output stage. In the playback mode, the recording-head driver becomes a second voltage amplifier and feeds the output stage. Bias and erase current are furnished by a 6AQ5 oscillator, and a 5AR4 is used as rectifier. The speed switch changes the equalization of the recording head driver to provide the correct curve. Any variation in playback equalization can be accommodated by an adjustment of the "tone" controls.

The transport mechanism employs a hysteresis-synchronous motor, and the motor capacitor, normally connected for 60 cps, includes another section which is strapped across the first for 50-cps operation.

The mechanism itself is ruggedly constructed, with all parts mounted on a cast aluminum frame. The drive is from the motor shaft by friction to the flywheel, which rides on a single ball thrust bearing. The inside rim of the flywheel drives the take-up transmission wheel, which in turn drives the take-up reel through a belt. To change speed, the flywheel and capstan are raised mechanically so a smaller diameter rim of the flywheel rides on a larger section of the motor shaft, thus giving the slower speed.

In the off, rewind, and fast forward positions, the head shields and pressure pads are lifted clear from the heads, allowing free entry of the tape to the head assembly. When the instantaneous stop lever is

why the most advanced professional cartridge...

has ceramic elements!

For more than 35 years, Electro-Voice has been a leader in the development and manufacture of dynamic microphones and loudspeakers. Why then, with this extensive experience in designing and producing electro-magnetic devices, is Electro-Voice introducing the new Magneramic 31 Series stereo cartridge using ceramic elements?

The reason is that Electro-Voice is genuinely convinced that a precision ceramic cartridge is the finest type that can be made today . . . definitely superior to the magnetic type. The superiority of the Magneramic 31 is demonstrated in these three areas.

GREATER FLEXIBILITY — The 31 Series cartridge will operate perfectly at any stylus pressure from 2 to 20 grams. The same stylus assembly can be used for operation on both turntable and record changers; performance need not be compromised by using a special, stiff stylus assembly for record changers. Record wear is the only criterion in setting stylus pressure — cartridge operation is not affected. Thus, when converting from a changer to a turntable, or vice versa, replacement of the stylus assembly is not necessary when using the Magneramic 31.

HIGHER OUTPUT — Along with the trend toward less efficient speaker systems, more amplifier power has become a necessity. While most stereo amplifiers are now designed with input sensitivities to match the typical 5-millivolt output of magnetic stereo cartridges, nearly all monaural amplifiers were designed for at least 8-millivolt input. These cannot be driven to full output with a magnetic stereo cartridge. The Magneramic 31 develops a full 8-millivolt output and couples directly into any "magnetic" preamp unit. This higher output should especially be considered by those planning conversion to stereo utilizing existent monaural amplifiers.

FREEDOM FROM HUM — The increased amplifier gain required to satisfactorily drive low-efficiency speakers coupled with decreased cartridge output has significantly increased system hum problems. Also, conventional methods of hum elimination used in monaural magnetic cartridges become difficult or impossible to apply to stereo magnetics. The Magneramic 31 completely eliminates these problems — it is non-inductive and has adequate output.

The Electro-Voice Magneramic 31 MD7 cartridge directly replaces any monophonic or stereophonic magnetic cartridge now on the market. It feeds into the preamp input-jack specified for magnetic cartridges and does not require adaptors or circuit modifications.

SPECIFICATIONS — MAGNERAMIC 31 MD7

Response Range: 20 to 15,000 cps ± 2 db
Compliance, Vertical: 3.5 x 10^{-6} cm/dyne
Compliance, Lateral: 3.5 x 10^{-6} cm/dyne
Isolation: 28 db @ 1000 cycles
Tracking Force: 2 to 4 grams in transcription arms
4 to 6 grams in changer arms
Styli: .7 mil diamond
Output: 8 millivolts
Recommended Load: 22,000 to 47,000 ohms
(Magnetic phono inputs)
Elements: 2, Lead Zirconium Titanate (Ceramic)
Weight: 8 grams
Terminals: 4, standard .050" connectors
Mounting Centers: ½" and 7/16" fits both
Audiophile Net: $24.00

Want more information? Write to Dept. 129A for the booklet entitled, "FACTS ABOUT THE ELECTRO-VOICE MAGNERAMIC CARTRIDGE"

Electro-Voice® INC.

BUCHANAN, MICHIGAN

Fig. 2. Head assembly of Model 555-A4 Sterecorder showing position of four-track head.

moved only part way, the pinch roller is lifted from the capstan, permitting manual operation of the tape backward and forward for editing purposes. In case the user wants to make accurate markings on the tape during editing, he simply lifts off the head cover which fits onto friction pins.

Operation

Normal operation of the transport is handled by a single knob. The center position is stop, which applies the brakes, retracts the pinch roller, and lifts the head shields and pressure pads. The left position is rewind, and the right position is forward, with the pinch roller engaged and the head shields and pressure pads in place. A lever operating concentrically with the control knob engages the fast-forward mechanism and remains in place until the main control knob is turned to stop, at which time the lever returns to normal. Thus in changing from fast forward to play, the control knob is simply turned to stop and then immediately back to forward, at practically no loss of time. Brake action is exceptionally smooth, and stopping from all modes of operation is practically instantaneous without any undue stress on the tape. It is just not possible to operate the control knob quickly enough to break the tape when changing from rewind to forward, for example. As far as we could determine, the only thing that can cause a tape loop to be thrown is to turn off the power switch during either of the fast operations.

To record, the left control knob is turned to the record position (after depressing the safety interlock) and the right control knob turned to forward with the record interlock button depressed. For monophonic recording, a single volume control knob is used; for stereo, two. If recording mono, only the channel 1 meter and control are illuminated; both are illuminated for stereo. Monitor and speaker volume is controlled by the playback knob without affecting the recording at all, and if external speakers are being used, they may be switched off, if desired, leaving only the monitor jack energized.

For playback, the left large knob is turned to the play position and the transport started. Channels may be balanced by the individual level controls, and the playback control adjusts both line and speaker outputs simultaneously. Thus the machine may be left permanently connected to a typical amplifier in a home installation without need for any changing of external connections. On the whole, the Sterecorder is simple to operate, and would require a minimum of instruction to operate.

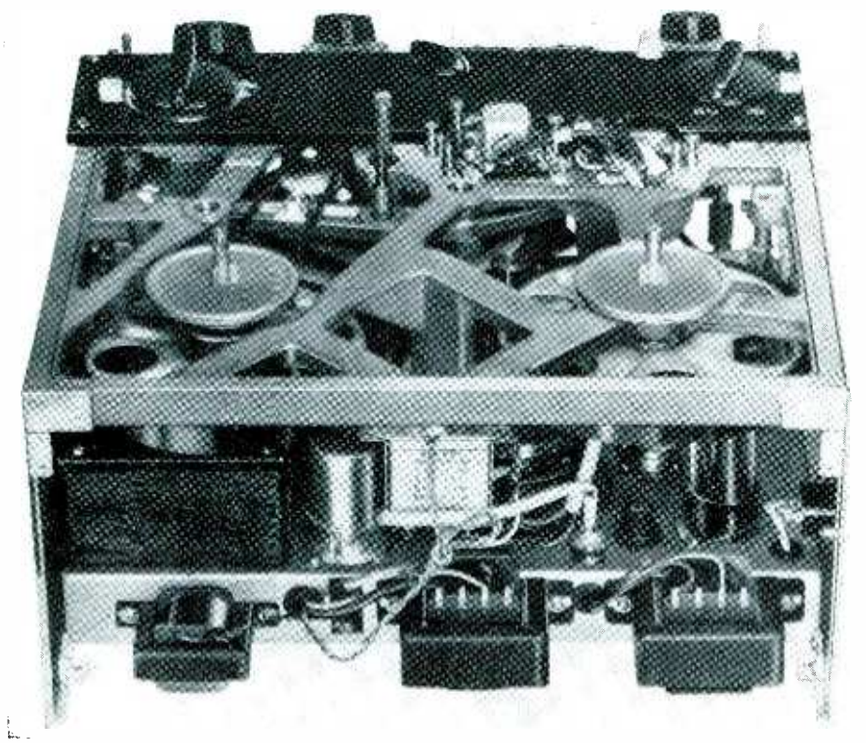


Fig. 3. Heavy cast chassis of Sterecorder is shown in this internal view of Model DK-555-A.

Performance

Measured response from a standard test tape shows less than ±1.2 db variation from flat from 50 to 10,000 cps on either channel on two-track operation, with a maximum variation between channels of slightly under 1 db over the same range. On four-track operation (requiring a slightly different setting of the equalization control), response varied no more than ±1.7 db over the same range, and channel-to-channel variation was no more than 1.2 db, with all measurements made at the line output jacks. At the speaker output terminals, across a 16-ohm termination, the response was within ±1 db from 100 to 10,000 cps, with a 2.5-db droop at 50 cps. The range indicated—50 to 10,000 cps—represents that of the standard tape used.[1]

From high-level input to line output, which includes the amplifiers twice and the tape, response measured within ±2.2 db from 20 to 15,000 cps at 7½ ips, and within ±2.4 db from 30 to 9,000 at 3¾ ips; in both instances, channel-to-channel variation was less than 2 db throughout.

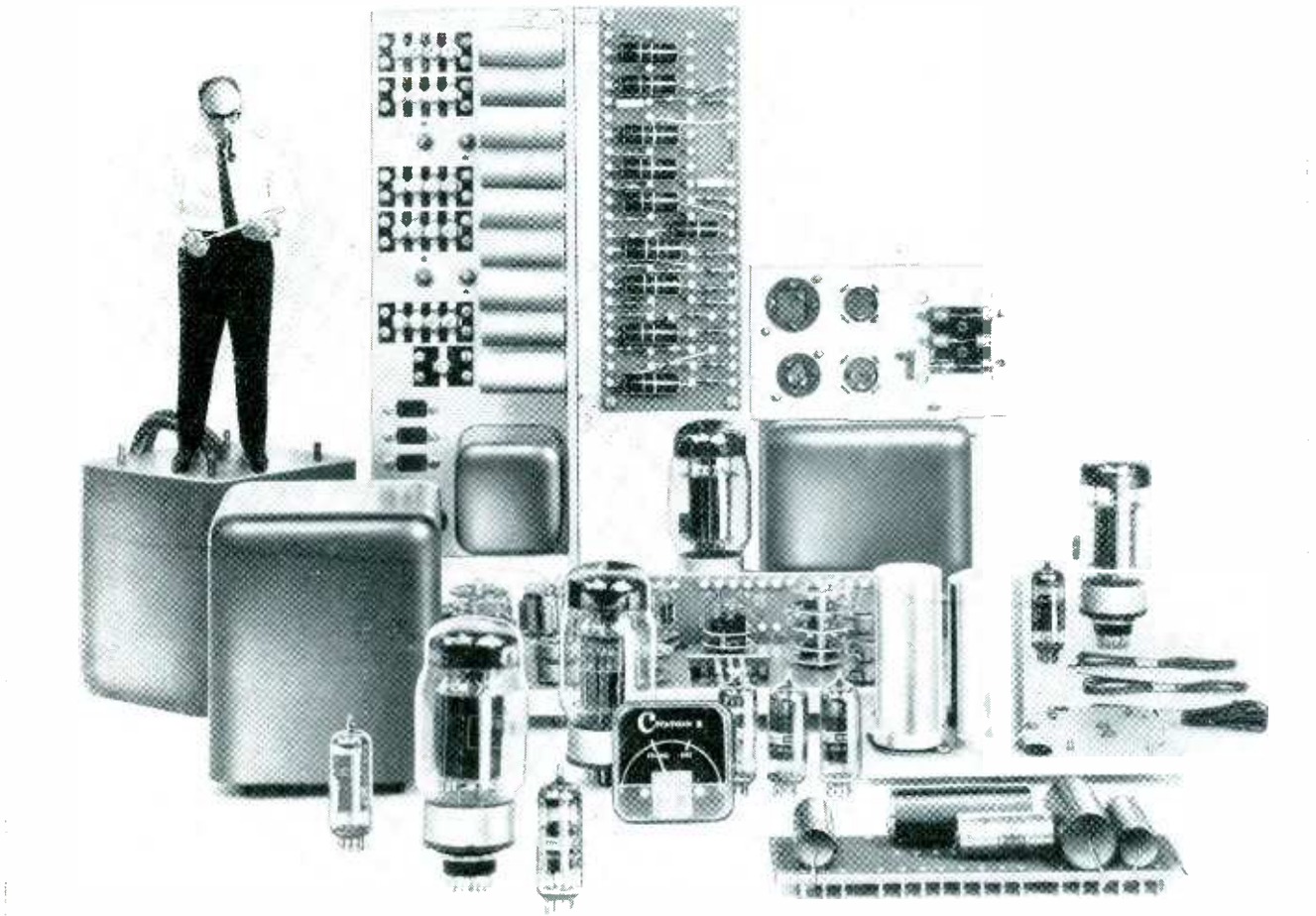
The internal amplifiers provided a 4-watt output at 0.7 per cent harmonic distortion, and on the line outputs the signal was measured at 4.1 volts maximum, with harmonic distortion of 0.4 per cent at 2.5 volts. Signal-to-noise ratio, measured by NARTB standards, was 52 db. Specifications call for 0.2 per cent maximum for flutter and wow at 7½ ips, and a maximum of 0.3 per cent for 3¾ ips; although no measurements were made to substantiate this, it must be said that no *audible* flutter or wow was observed, and we know that 0.5 per cent is readily detectable by ear.

Actual comparison recordings were made from other sources, both records and tapes, and on playback no difference could be heard on direct A-B switching. We had previously encountered this same facsimile performance with an earlier model, the 555, during some dubbing of material for a demonstration, and measurements and further listening bear out this impression.

Among the interesting features of the Sony Sterecorder is the built-in head demagnetizing circuit, which makes it possible to reliminate residual magnetism without any additional equipment. The method is sufficiently simple that it may be employed every time one starts a recording or playback session. A second interesting feature is the fact that the capstan continues to turn for some two minutes after the motor is disengaged, which is one of the reasons it is possible to shift from one operation to another without tape damage. A third feature—and a very important one—is the use of deposited carbon resistors throughout for low-current applications.

The appearance of the Sterecorder is attractive, the controls intelligently designed and placed, and the performance leaves little to be desired. The only disadvantage we have been able to encounter so far is that for portable use its 40 pounds make it somewhat of a chore to transport it up many flights of stairs. It is this very same weight, however, which makes it such a sturdy machine. The Sterecorders are distributed in the United States by Superscope, Inc., Sun Valley, California. **M-27**

[1] Ampex #5563.



We don't pack an engineer into each new Citation Kit but...

...the engineering *built into* each kit is so precise that the unit constructed in the home will be the equal of the factory-produced instrument.

It is far more difficult to design a kit than to produce a completely manufactured product. In the plant the engineer can control his design from the moment of inception until the final packaging. The kit builder has only his tools, his ingenuity and little, if any, test equipment.

Therefore, the complex process of in-plant production and control which guarantees the fine finished product must somehow be *embedded* in the kit design. The Citation engineering group at Harman-Kardon, headed by Stewart Hegeman, has succeeded in doing just this in the design of the new Citation I, Stereophonic Preamplifier Control Center and Citation II 120 Watt Stereophonic Power Amplifier.

Only heavy duty components, operating at tight tolerances, have been selected for the Citation Kits. As a result, even if every component is operated at its limit — remote as this possibility is — the instruments will perform well within their specifications.

Rigid terminal boards are provided for mounting resistors and condensers. Once mounted, these components are suspended tightly between turret lugs. Lead length is sharply defined. The uniform spacing of components and uniform lead length insure the overall stability of the unit.

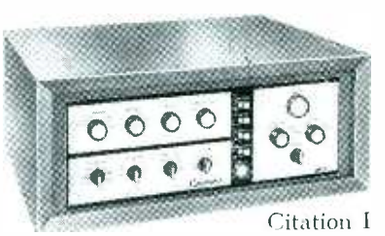
Improper routing of leads, particularly long leads, can result in unstable performance. To prevent this, the Citation II is equipped with a template to construct a Cable Harness. The result: each wire is just the right length and in just the right place to achieve perfect performance.

These truly remarkable achievements in Control Engineering are only a few of the many exciting new developments in kit design from the Citation Division of Harman-Kardon.

THE CITATION I, *Stereophonic Preamplifier Control Center,* is a brilliantly designed instrument, reflecting engineering advances found only in the best professional equipment. The control over program material offered by the new Citation I enables the user to perfectly re-create every characteristic of the original performance. (The Citation I — $139.95; Factory-Wired — $239.95; Walnut Enclosure, WW-1 — $29.95.)

THE CITATION II, *120 Watt Stereophonic Power Amplifier,* has a peak power output of 260 Watts! This remarkable instrument will reproduce frequencies as low as 5 cycles virtually without phase shift, and frequencies as high as 100,000 cycles without any evidence of instability or ringing. *At normal listening levels, the only measurable distortion in this unit comes from the laboratory testing equipment.* (The Citation II — $159.95; Factory-Wired — $219.95; Charcoal Brown Enclosure, AC-2 — $7.95.) All prices slightly higher in the West.

Harman-Kardon has prepared a free detailed report on both of these remarkable new instruments which we will be pleased to send to you. Simply write to Dept. **A-12,** Citation Kit Division, Harman-Kardon, Inc., Westbury, L. I.



Citation I

Build the Very Best **CITATION KITS** *by* **harman kardon**

Fig. 4. Madison Fielding Series 360 Master Stereophonic Console.

MADISON FIELDING SERIES 360 MASTER STEREOPHONIC CONSOLE

Rather a large mouthful of a name, but also rather a large handful of performance is wrapped up in this latest preamp-amplifier combination from one of the industry's newcomers, Madison Fielding, now a part of Crosby Electronics, Inc. This dual 20-watt amplifier incorporates some interesting features in design along with its performance.

This unit consists of two identical sections ending up with a pair of 7189 beam power output tubes in each, and powered with a GZ-3 rectifier. A 12AX7 is used as a preamp for phono and tape-head inputs to each channel, followed by one-half a 12AU7 as a voltage amplifier which feeds the tone control, noise, and rumble filter networks. This is followed by the two halves of another 12AX7 as amplifier and phase splitter, and the latter drives the 7189's directly.

Phono and tape-head equalization is derived from a feedback network around the two sections of the preamplifier, with switching of source following the preamp stages. Each channel has its own level control, panel mounted, which provides the same function that a balanced control would without the need for the additional knob, and besides it allows the user to set the loudness compensation to any degree that he wishes. Tone controls are separate for the two channels, and output tubes are balanced by the simple expedient of adjusting the bias on only one tube of each pair of 7189's.

One unique and extremely valuable feature of the amplifier is the "Aural Zero Null" circuit which enables the listener to adjust both channels of the amplifier to *exactly* the same gain and frequency response. This is effected by momentarily connecting a resistor from the output circuit of channel 2 back to the feedback-return point of channel 1, with the channel-2 amplifier disconnected from its loudspeaker and terminated with a resistor. To adjust the two channels to exactly the same gain and frequency response, therefore, the user sets the mode switch to the mono position, adjusts the channel 1 level control for a comfortable listening volume and then depresses the nulling switch. He then adjusts the channel-2 level control for minimum signal from the loudspeaker, and makes any final adjustments to obtain a null with the tone controls. When he releases the nulling switch, he is assured that both channels are in balance with respect to gain and frequency response. This is most effective so long as identical loudspeakers are being used, but would not serve to adjust aural outputs if the loudspeakers were different in sensitivity or frequency response. However, since most users will employ identical speakers for both channels in a stereo system, the method of nulling is quick and effective.

Another effective feature in the amplifier is the use of a "pseudo ground" for the preamplifier section of channel 2. All circuitry of the 12AX7 used for this preamp are returned to the "pseudo ground" which is then connected to the main ground of the complete amplifier through a 68-ohm resistor—a trick that eliminates most of the hum troubles which have been encountered in installations where the stereo cartridge and/or its wiring ended up with two "hot" leads and a single ground. Practically all cartridges now have four leads, as do most record players and changers, so the troubles encountered so often in early stereo conversions are seldom found now. This circuit arrangement does improve stability of the amplifier, however, even with four-terminal inputs.

Performance

The 360 has more than enough gain for any installation, since it takes less than 1 millivolt of signal at the magnetic phono and tape-head inputs to produce a 1-watt output, while a 50-mv signal at the high-level inputs will provide the same output —in both cases with the volume and level controls at maximum, where they would rarely be operated. Both phono and tape equalizations measured within ± 1.5 db of standard, and tone controls were capable of boost and cut of 20 db measured at 20 and 20,000 cps. Rumble and noise filters are fairly gentle, with the former rolling off approximately 12 db at 30 cps, and the latter beginning at approximately 5000 and rolling off some 7 db at 10,000 cps. While these figures may not appear to be as severe as those often encountered in amplifiers, it is felt that they are completely adequate, since it is rare that anyone ever uses the most severe positions of these controls anyhow, particularly since we no longer have to accommodate the scratch from 78-rpm shellacs.

Power output was measured (at 1 per cent harmonic distortion) at 19 and 22 watts on the two channels, respectively, with intermodulation distortion below 0.5 per cent up to 6 watts, below 1 per cent to 11 watts, and at 2 per cent at 20 and 22 watts on the two channels. With controls set for a 10-millivolt input signal and a 1-watt output on phono, hum and noise was measured as 60 db down, and on tape-head input with controls set for a 3-mv input signal and a 1-watt output, hum-measured 57 db down. On high level inputs, with controls set for a 1-volt input and a 1-watt output, hum and noise measured 76 db down—all being good figures for an amplifier with high gain. Part of this is, of course, attributable to the use of d.c. on the heaters of the preamp stages, which are excited by the plate current of the combined output stages.

The 360 is comparatively small, measuring 14½ in. wide, 5⅞ in. high, and 12 in. deep, and an individual ventilated cabinet is available for those who do not wish to mount the unit in other cabinetry. The panel is brushed brass in finish, with designations in black. The channel and source indicator lights, seen in *Fig.* 4, are of five colors—one for each input. The upper row refers to channel 1 and the lower to channel 2. In stereo or stereo reverse positions, both lights of a given input are illuminated at relatively low brilliance, since the two lights are then in series across the a.c. heater supply.

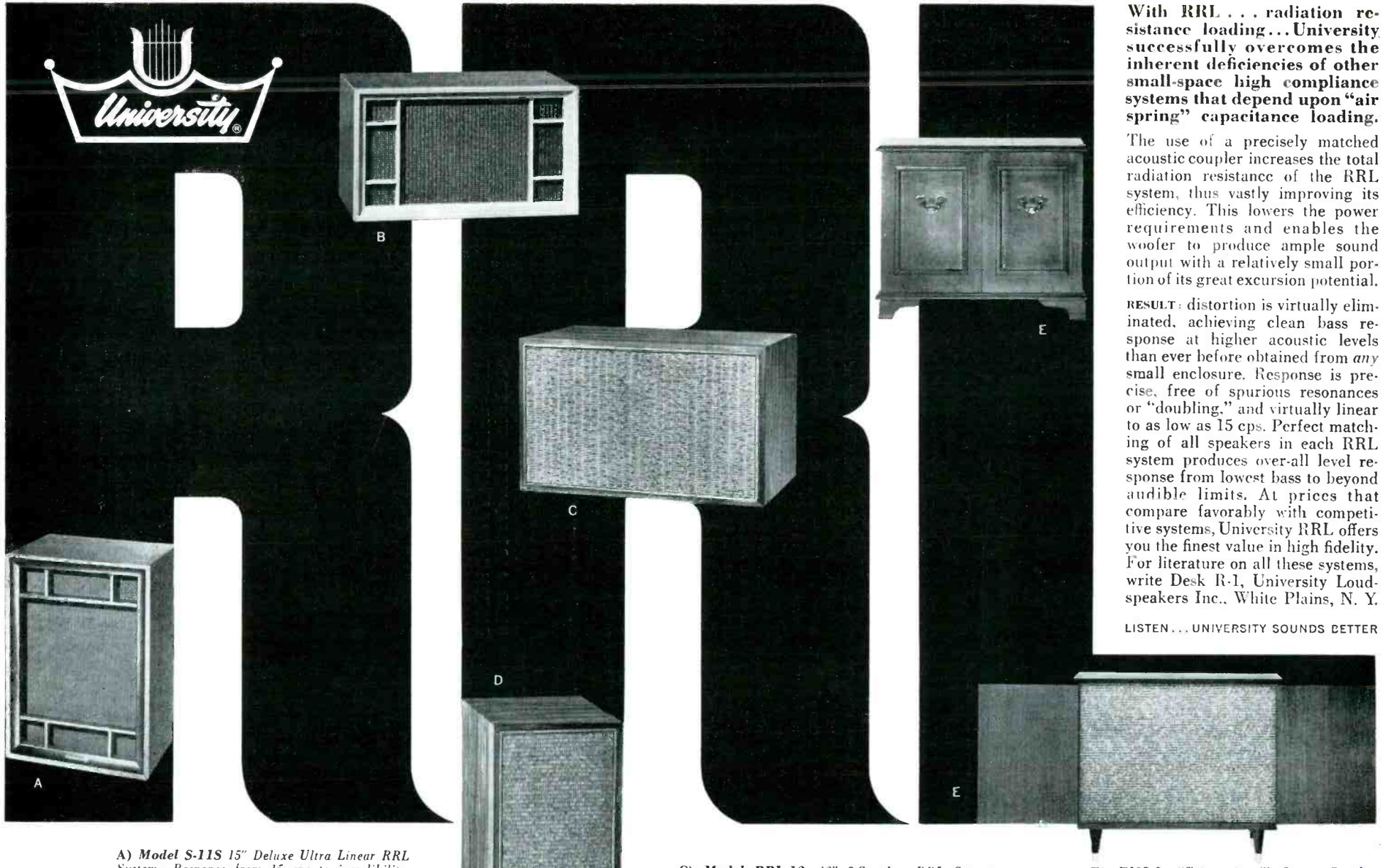
The 360 has practically every needed feature for a control center, and we are pleased to see a panel-mounted phase-reversal switch, which we still feel is a definite necessity with any stereo system. The unit is neat and attractively styled, and provides a compact amplifier in one chassis.

M-28

ACOUSTIC RESEARCH AR-3 LOUDSPEAKER

Describing the listening qualities of a loudspeaker is always somewhat like trying to convey an impression of the gustatory qualities of a culinary masterpiece in terms which would create the same taste sensation in the reader that they did in the mouth of the original taster. For what one person likes in sound quality may not be what another likes, and we have always believed that though the manufacturers all undoubtedly attempt to put together a loudspeaker which reproduces the original sound as closely as possible, they do not all sound exactly alike by any means.

The AR-3—though something over a year old—is the newest of the Acoustic Research loudspeakers. The original AR-1 woofer embodied a completely new principle—acoustic suspension—in which the cone is made to have a very low resonant frequency in free air, taking advantage of the fact that an air-tight enclosure of small dimensions will raise the resonant frequency to somewhere around 40 cps with a comparatively small cabinet. The air in the enclosure serves as most of the restoring force to the cone itself, and is thus applied



With RRL . . . radiation resistance loading . . . University successfully overcomes the inherent deficiencies of other small-space high compliance systems that depend upon "air spring" capacitance loading.

The use of a precisely matched acoustic coupler increases the total radiation resistance of the RRL system, thus vastly improving its efficiency. This lowers the power requirements and enables the woofer to produce ample sound output with a relatively small portion of its great excursion potential.

RESULT: distortion is virtually eliminated, achieving clean bass response at higher acoustic levels than ever before obtained from *any* small enclosure. Response is precise, free of spurious resonances or "doubling," and virtually linear to as low as 15 cps. Perfect matching of all speakers in each RRL system produces over-all level response from lowest bass to beyond audible limits. At prices that compare favorably with competitive systems, University RRL offers you the finest value in high fidelity. For literature on all these systems, write Desk R-1, University Loudspeakers Inc., White Plains, N. Y.

LISTEN . . . UNIVERSITY SOUNDS BETTER

A) ***Model S-11S*** *15" Deluxe Ultra Linear RRL System—Response from 15 cps to inaudibility. Available as highboy or lowboy. 26⅞" x 19½" x 17½" d. From* ***$260.00*** *net.*

B) ***Model S-10S*** *12" Deluxe Ultra Linear RRL System—Response from 20 cps to inaudibility. Available as highboy or lowboy. 25" x 14 x 14½" d. From* ***$154.00*** *net.*

C) ***Model RRL-12*** *12" 3-Speaker RRL System—Response from 25 cps. New Sphericon Super Tweeter goes out to 40,000 cps (± 2 db to 22,000 cps). Finished on all four sides. 25"x15⅝"x12½" d. From* ***$114.95*** *net.*

D) ***Model RRL-8*** *8" 3-Speaker RRL System—Response from 28 cps to 20,000 cps. Finished on all four sides. 22¼" x 12¼" x 10-5/16" d. From* ***$95.50*** *net.*

E) ***TMS-2*** *"Trimensional" Stereo Speaker System—Integrates two complete 3-way speaker systems in one compact enclosure. Provides fully balanced stereo throughout the room. Contemporary model: 30" wide x 25" high x 12½" deep. From* ***$258.00*** *net. Early American model: 30" x 24¾" x 13½" deep.* ***$279.95*** *net.*

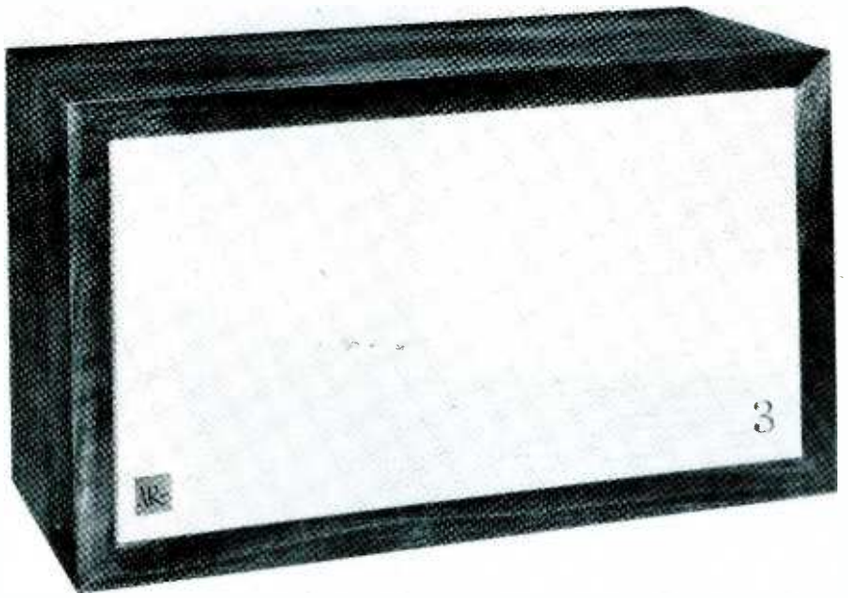


Fig. 5. Acoustic Research's AR-3 loudspeaker, 25 x 14 x 11⅜ in. deep.

to the entire surface of the cone rather than to the voice coil and cone edge by means of the spider and the surround. With this type of enclosure, there are three basic parameters to the design which can be juggled to provide any given value for one at the expense of the other two. These parameters are resonant frequency, size, and efficiency, and it should be possible theoretically to produce a speaker of this type in less than half a cubic foot with a resonant frequency of 30 cps, but it might require 100 watts to drive it satisfactorily.

Be that as it may, one of the reasons for the success of the AR speakers is that they are available only in the enclosure designed for them, and it is not possible to buy the speaker mechanism separately and house it in whatever cabinet you see fit. Therefore when you do buy an AR speaker after deciding in the showroom that you like it, you may be sure that it will sound the same way in your own home, assuming the room acoustics are somewhat similar.

The AR-3 employs the standard type of AR-1 woofer and with it two tweeters, also of unique design. Both of the tweeters employ only a voice coil and an aluminum dome, with the coil being supported in what would normally be called the air gap, except that the gap is filled with a foamed synthetic rubber material. There is no cone, no spider, no surround, but only the aluminum dome which radiates the sound. The entire structure—dome and voice coil—weighs just slightly more than one gram, giving the desired lightness to the moving part. Furthermore, the dome approximates the ideal radiator—a pulsating sphere—so that off-axis radiation does not show the droop encountered with conventional tweeter types. The dome of the larger of the two tweeters is 2 inches in diameter, while the smaller is 1⅜ inches across.

In listening quality, the AR-3 is similar to the earlier AR-1 throughout the lower ranges, with its well known solidity of bass down to around 35 cps, and over-all response is smooth without any audible peaks whatever up to the limit of our hearing which is somewhere in the vicinity of 14,000 cps, although measurable response, using an uncalibrated microphone, is observable to at least 17,000 cps. Response 30 deg. off the axis of the speaker is down less than 2 db at 10,000 cps, and only down about 4 db at 15,000 cps. At 45 deg. the figures are 3 and 5 db respectively. The speaker is not efficient, being approximately 10 db down from a high-quality speaker system in a reflex enclosure, but adequate levels result from the use of a 20-watt amplifier in medium sized listening rooms. For large rooms somewhat more power should be available. The AR-3 has attained considerable popularity since its introduction, and to most ears it is likely to be a very satisfactory loudspeaker.

M-29

EICO MODEL HF85 STEREOPHONIC PREAMPLIFIER KIT

Obviously, no stereo preamp can be really simple, but EICO has done a creditable job of making this kit just about as simple as possible without leaving out any really necessary functions. Employing only five 12AX7 tubes and a 6X4 rectifier, it manages to give a good account of itself on test, and together with the FM and AM tuner kits HFT90 with HFT94, or the new stereo tuner, HFT92, all of which it matches in size and appearance, it furnishes the basis for an effective stereo system at an economical cost.

The HF85 has low-level inputs for microphone, phono, and tape head, and high-level inputs for tuners, multiplex, and two auxiliary sources. The tuner inputs provide for FM on channel 1 and AM on channel 2 in one position, and for FM and Multiplex on channels 1 and 2 respectively in the other. Low-impedance outputs (1400 ohms) are provided to feed a tape recorder, and the normal channel outputs are 8000 ohms. The preamp section, used for mic, phono, and tape-head inputs, derives its equalization from feedback around the second half of the tube, with a separate slide switch accommodating 7½ and 3¾ ips tape speeds. The next 12AX7 in each channel follows the volume/loudness control, with unequalized feedback to reduce gain slightly and to offer a low impedance to the tape output and the Baxendall-type tone control circuit. The output in each channel is one-half of the remaining 12AX7. The power supply is conventional, using adequate filtering to ensure low hum level. Clutch-type volume and tone controls allow independent operation when desired, yet either the inner or outer knob will operate both sections simultaneously when the clutch is engaged. A switch is provided to select between flat and compensated volume control action.

It is the policy of this department to review kits only when they are furnished in standard kit form for our own construction because it is felt that for the novice, the successful construction of any kit depends very much on the quality of the instructions furnished. And since we always seem to have a number of kits on the backlog, it fell the lot of the assistant editor to assemble this one. Her comments:

"The writer and her equally novitiate husband built the HF85 in 32 hours construction time, which did not include the time for testing the unit before putting it into use. The amount of time previously spent with a soldering iron between the two of us probably amounted to about 30 minutes, but off we went, plunged into the box of parts, and started to put little wires into little lugs and solder them permanently in place.

"Actually, for an initial venture, we

(Continued on page 99)

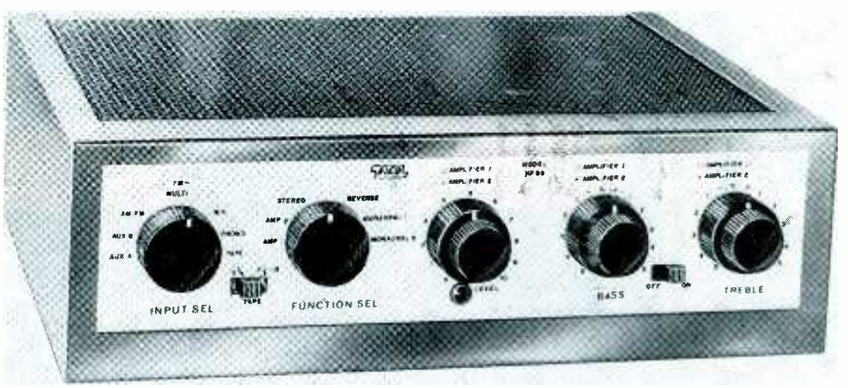


Fig. 6. EICO HF85 stereophonic preamp-control unit.

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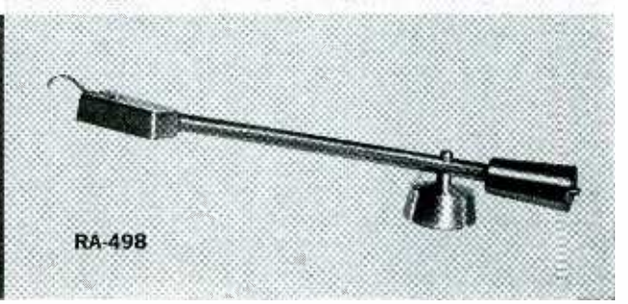

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Record Review

EDWARD TATNALL CANBY*

1. FOR CHRISTMAS (AND LATER)

The Spirit of Christmas. Christmas Carols sung by the Mormon Tabernacle Choir. **Columbia MS 6100 stereo**

Here's to the spirit of Christmas and to more and more Singing Mormons. This melodius and hearty bit of solid Western Americanism will be my Xmas offering for this year. You won't do better in this department—if you happen to be looking for carols of a light and tunesome sort, sung spontaneously, accurately, with the words said clearly and in good American English. Also some superb choral sound, thanks to the chorus, to the famed Tabernacle acoustics, (or so I assume) and to Columba's deft stereo that has the sweetly singing sopranos ever so nicely to the left, the rest, right down to the basses, spread evenly out, all the way over to the right.

Who ever started the idea that we ought to buy Christmas-music records at Christmas? With all due respect to the season, I can't help observing that the standard Xmas repertory is slightly limited and has long since been covered a thousand times in the grooves. My idea is—give *records* for Christmas. Any kind. Like what follows, for instance.

Schubert: "Trout" Quintet. Hephzibah Menuhin, piano, members the Amadeus Quartet, J. Edward Merett, bass. **Angel S 35777 stereo**

"Trout" Quintets have been a dime a dozen in recent releases but—ah!—this is *the* "Trout." I found it delightful from start to end, in both the playing and the recording. And, for once, the artful double bass is exactly, ideally placed in the picture, to give that tantalizingly dainty shove to the bottom of the harmony, just audible but harmonically overpowering, that the music must have for its right impact. What a lovely bottom! Half the time it is no more than half-a-transient, the string barely touched.

This is a true chamber stereo recording, taken close-to and spread out in a large liveness but with a sense of nearness and almost visible cooperation among the players that imparts a marvelous feeling of being right on the scene, sitting in on an actual playing. If you think stereo isn't helpful to small ensembles, just try this one.

The Amadeus Quartet—three of its players here—is a top Romantic group. Hephzibah Menuhin, last heard by me in those famous child recordings with her brother Yehudi made in the 'Thirties, is an engaging and lively piano personality, brimming over with enthusiasm for the musc and thoroughly up on her finger technique as well. Angel—congrats to you.

At the Drop of a Hat. Michael Flanders, Donald Swann. **Angel S 35797 stereo**

I first heard these British music-hall satirists as a phono background to an evening party, full of conversation, and I wasn't greatly amused. Missed about half of it, anyhow—people *will* put on spoken recordings as background stuff.

This re-do, in stereo, follows their American opening and is brought up to date in a number of ways, including cracks about stereo in the short sizzler concerning hi fi. Ouch, is all I could say. How right they are . . . in a way. ("Of course you can only get the stereo effect if you sit over in that cupboard. . . .")

Everything and anything gets a touch of the satirical play here, but it's a lot milder than old Jonathan Swift, an earlier Britisher in the trade. Some of it is just so much stuff, like the piece about the gnu (pronounced ga-noo), who gets mixed up with words like ga-nash and ka-nowing (knowing).

Mr. Flanders is in your left speaker, Mr. Swann, at his piano, is off to the right, and the two-point recording is joined together by the audience, which is out back and middle. An excellent stereo effect, adding a lot to the theatrical impact of the show. In fact, I highly recommend it, my only beef being that I find the music excruciatingly dull, though amusing. Purely pussonal; I like a bit of salt in my harmonies.

Beethoven: The Nine Symphonies. Columbia Symphony Orch., Westminster Symphonic Choir, solos, Bruno Walter. **Columbia D7S 610 (7) stereo** (*Also separately; also mono*)

Too often I find myself putting aside such monumental albums as this for "later" perusal, at proper leisure—and then do not get to review them at all; for a really honest survey of this work should take months, years. I merely report, rather than review, though I have heard some of the recordings already.

This is a book-record album, first, of the new and inspiring documentary type pioneered by Angel and often presented by Columbia for special subject matter. The album contains seven records; the huge booklet has 48 pages; their complementary value is great. Columbia's Charles Burr, who is a good researcher, has collected a vast number of short commentaries on many an aspect of Beethoven's music and times and has simply set them forth in legible print, with provoking titles to catch the eye. (Why not make reading easy, after all . . .) A brilliant array of illustrations, facsimile score-samples, letters, in the new documentary style, makes these pages glow with interest. The text material ranges from concert reviews of the original performances, quotes from such as Wagner, Berlioz, Weber, anecdotes of Beethoven's day, bits out of the famous biographies, a poem by Millay and a philosophical note by Leonard Bernstein—it's a fascinating hodge-podge, held together by the loose continuity of the nine symphonies themselves, and it allows you to draw your own conclusions, from these disparate sources, as to changing attitudes rampant during these 150-odd years. Excellent.

As for the music—this immense, dedicated operation, the biggest work of the conductor, upon the largest scores of the composer, via the grandest effort of the well-known recording firm—I dare only make a few generalities on it, short of that year's worth of further study. John McClure's own characterization of Walter's impact on the Columbia personnel as of "gentle and incandescent greatness" serves well to set the style of the project, as against the more flamboyant Nine by Toscanini. Toscanini's were incandescent, too, but not exactly gentle; Walter's are thus an image of his own self-concept, his legacy to posterity out of sixty-odd years of experience. Where Toscanini flamed, Walter is devoted.

This is, I'd guess, a somewhat overdone humility. Walter is no weakling and his own personality is as much a part of these playings, even to certain mild eccentricties of rhythm, as is Beethoven's. But the dramatic tone of dedication surely helps the music, strengthens the classic German tradition of performance, chastens the musical outlines, vitalizes the performers to do their best, without hysteria.

No performance, remember, is ever perfect, nor ideal, nor unchangeably definitive; even Beethoven must change along with us. This album is surely a noble monument in the progress of music on records and that is enough and plenty.

Schütz: 14 Motets from "Geistliche Chormusik." Norddeutscher Singkreis, Wolters. **Archive ARC 73122 stereo**

The Archive series is my despair and delight—redoubled now that the project has gone stereo. I was so absolutely set on getting every last one of the records that I rashly promised Decca (U.S. agent) I'd do a whole piece on this series, if I could just, please, have *all* of them. It's coming, and this is merely a holding-effort, to signalize my respect.

Schütz! An obscure, distant Seventeenth century composer out of the Thirty Years' War (obscure for most Americans until recently) who in his modest and economical way was actually one of the really top men of Western music. He was less dramatic than the incomparable Monteverdi, makes tougher listening than his Italian teacher, Gabrieli, but once you get onto his special Germanic idiom, Schütz is a lively composer with a direct emotional appeal—especially in his treatment of words—that is not unlike that of Schubert, in a later time. Straight to the heart. (My sentences are long, but Schütz' musical phrases are usually very short, like motto-ideas.)

Here you have sixteen of his unaccompanied German motets, done in what was then the "old" style, contrapuntal and without instruments in the outward manner of Palestrina—but for our ears nothing could be more unlike Palestrina than this highly personal, sweetly emotional music, gracefully instrumental in concept at the same time that it is so beautifully set for voices. Follow the texts yourself, and see what I mean. (German and English provided.)

Sweet, gentle stereo, too, adds its touch to this music, notably in the sections for double chorus, or "choirs" within the single chorus; you won't find a better example of stereo's ability to further the highest intentions of the musical language. Jet planes and roaring racers, my eye! Give me stereo Schütz for a *real* stereo demo.

Swift: Gulliver's Travels; The Voyage to Laputa, The Houyhnhnms. Read by Michael Redgrave. **Caedmon TC 1099**

The first of Swift's voyages by the satirical Gulliver was to the land of Lilliput and its midgets; as Caedmon points out, these stories were intended as a most savage satire on humanity, "to vex the world rather than divert it, to make folly bleed"—but that first voyage has become a children's classic, in spite of the author. The others, however, are of sterner stuff, as this superb recording reminded me when I thought back to the shock with which in College English I had finally come to read the rest of Gulliver.

Michael Redgrave's wonderfully matter-of-fact delivery (dramatic in its understatement) makes the enormously imaginative satire of Swift much easier to absorb than in the reading of the somewhat oddly constructed text itself; he modernizes it, in effect, simply by speaking it straight out.

The Laputa episode is a satire on the academic mind—both scientific and philosophical.

* *780 Greenwich St., New York 14, N. Y.*

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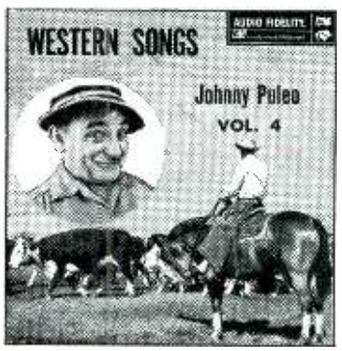

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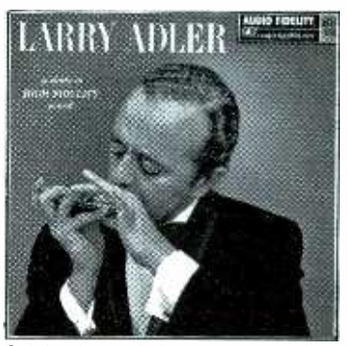

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LEON BERRY, Vol. I at the Giant Wurlitzer Pipe Organ . . . includes "Poinciana", "Elmer's Tune", "Saints". **AFLP 1828/AFSD 5828**

LEON BERRY, Vol. II includes "Syncopated Clock", "No Other Love", "Boulevard of Broken Dreams". **AFLP 1829/AFSD 5829**

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These people are so absent-minded they have to have special assistants to flap them on the mouth when they're supposed to say something, or on the ear to make them listen. They inhabit a literally elevated world of the mind; it floats in the air, hovering above the strange continent where the ordinary people live, and is a mile or so across. Many of the barbs concerning the impractical life of these souls will strike you as particularly pointed today—especially if you are mixed up in what is called "pure" research or, even better, the "applied" variety. Take the case of the Laputian scholars whose task was to extract sunbeams from cucumbers. They weren't a bit discouraged—probably aren't yet.

As for the Houyhnhnms, they are a race of noble and educated horses, whose beasts of burden are called Yahoos, a particularly disgusting form of animal in the shape of a human being. The roles are reversed, and Swift takes vicious cuts at the meanness of the human race in general during this acid and powerful satire. Especially if you think horses *are* noble.

Nope, definitely not for the kids, these Gulliver voyages, but almost any adult will find the stuff fascinating in the audible form.

Korngold: "Much Ado about Nothing" Suite. Austrian Classical Marches (Beethoven, Schubert, Krenek, Berg, Strauss). Boston Chamber Artists, Boston Concert Band, Eric Simon.

Boston BST 1012 stereo

Boy, does this invite punning. All is not Korngold that glisters, or something even cornier—because that's what's the matter with the music. It has pretentions to real quality, but it ends up too often in the corny category. The effect is of sounding brass, not gold.

At his best, Korngold has a Strauss-like talent (Richard) and those who know "Le Bourgeois Gentilhomme" Suite will find harmonic resemblances here, quite piquant. But then, too, there are stretches of derivative Korn, out of Percy Grainger, Edward German, Victor Herbert. For those who like 'em, all three, this side of the record is a natch.

The Classical Marches are terrific. They are wonderfully played by a "military" band that squeaks slightly out of tune in an utterly musical way and bangs and whangs its percussion with tremendous gusto. I'm tired of so-called concert bands that play this military stuff in an academic and over-fussy way, right out of the conservatory. Not this group!

The selection is amazing. It'll bring any house down. Starts with two Beethoven practical marches for actual military use, then goes on to a "military" arrangement of one of Schubert's "Marches Militaires" (intended originally for nonportable drawing-room piano) and then plunges wildly into the darndest band music you ever heard, a 1921 Krenek parody of a country-style band, complete with addled snatches of Offenbach and, maybe, Sousa (I couldn't make up my mind). This, in turn, is followed by a frighteningly serious modern march, out of Alban Berg's opera "Wozzeck"—still played by the same corny ensemble—and then, as a sort of letdown at the end, a slice of Johann Strauss, a commemorative march celebrating a military victory.

Just put it on and let it play, and you'll gulp when the Krenek and Berg items burst forth, hard after Schubert and Beethoven. Lots of fun!

As in the past, Boston's stereo recording is unusually good. This small company released some of the very first really high-quality stereo discs in this country, a match for anything from the big outfits.

Dvorak: Cello Concerto in B Minor. Ludwig Hoelscher; Hamburg State Philharmonic Orch., Keilberth.

Telefunken TCS 18022 stereo

Here's another one of those excellent new Telefunken low-priced stereos, a top bargain for my ear. This is a very sympathetic, leisurely but heartfelt performance of a piece that can be dreadfully unwieldy when it is pushed too hard. It just won't push; and yet a dull performance is heavy as lead.

The problem in Dvorak concerto music is tied in with his peculiar feeling about the concerto. Clearly, he took this form to be one requiring high-minded formality, complexity, bulk, length—even more so than the "king" of big forms, the symphony. He tried too hard in the concerto form; he is more relaxed, more lyric, more natural, in his symphonies. Thus the best possible treatment of the big Dvorak concerto is to play up its more relaxed aspects, its warmth and songfulness—always present—and let the heroics come forth without extra emphasis. That's what happens here, and there is an excellent cellist even if I don't know his name. He has the lyric gift in just the right manner for the warm, serious Czech style.

All of which adds up to the most effective, practical, enjoyable recording of this piece that I can remember, big names or no. Too many big-name conglomerations over-do the work, plug the heroics, heap on the high tension.

Close-up cello, apparently situated off to the left, though this could be a matter of channel balance.

* * *

Again—howcome London can promote this line at $2.98? I haven't asked (and I wouldn't get a very useful answer, I suspect). Trade secret. Yes, the performers aren't top-billed, but they are good enough for standard pricing, even here. The tonal quality is tops, my only reservation being a bit of very low rumble in the cutting that ought not to be there.

Don't ask questions; just buy.

Villa-Lobos: Music for the Spanish Guitar. Laurindo Almeida.

Capitol SP 8497 stereo

The enormously prolific Villa-Lobos, of Brazil, learned his music on the guitar because his mother wouldn't let him have a piano. He is, thus, a real master of its idiom and capabilities. These unpretentious little pieces are hardly modern, but their rich harmonies are ideal for the instrument and, indeed, seem born to it. Villa-Lobos greatly

widened guitar expression with these and many other characteristc works.

The pieces are mostly little etudes and preludes, the shadow of Bach pleasantly in view yet blended with the color of the luscious chord-clusters and sensuous melodies the composer loves. On any other instrument this stuff would be sheer glop, too sticky for listening. On the graceful guitar strings it seems almost chaste. A beautiful instrument, decidedly!

The player is a finished artist, wholly at ease and master of the quick, free guitar rhythms and colors. A good man, one of the best. Works in Hollywood, but doesn't sound that way.

Brahms: Symphony #3. Houston Symphony, Stokowski.
Everest SDBR 3030 stereo

It took the New York Hi-Fi Show for us here at AUDIO to catch up with Everest, which hadn't sent on any of its excellent wares since last January; I carried this one off under my arm, and I like it.

I guess it's a matter of putting in a good word for a maestro who hasn't stayed put, either with orchestras or record companies, since he left RCA many years ago. Don't forget that this man was virtually *the* conductor, in the early days of electrical recording in this country; the Philadelphia and Stokowski were automatic thoughts for most of us. He was a great man in his day and there is plenty of his style left in him still, though this orchestra isn't yet quite a match for the "Philly" of old.

Specifically, this is a warm, somewhat mannered and exaggerated treatment of the familiar Brahms, full of rubato (slowing-down), leisurely in all the melodic parts, even quite slow in the *allegretto* third movement. I feel charitable about the mild exaggerations because they are essentially true ones, if a bit overdone; these stylistic Romanticisms were the rule in an earlier day of great conducting—just try old Mengelberg, if you want to hear more of the same, as of thirty or forty or more years ago.

Better Stokowski's Brahms, like this, than many another hard, driving, unmellow version, too modern. A gentle and lovely recorded sound helps immensely and favors the fine detail work that Stokowski brings out.

Giambattista Viotti: String Quartets in B flat, G. Baker String Quartet.
Soc. for Forgotten Music M 1006

Michael Haydn: String Quintets in C, G. Roth Quartet.
Soc. for Forgotten Music M 1005

You may also have these in stereo—I was sent the mono version. Both now appear under the above label, and you can forget that for a while all of Contemporary Records' stereo offerings appeared on a label called STEREO. Proved confusing. (Contemporary also puts out Good Time Jazz, California, and the above Society.)

Viotti is familiar to all fiddlers as a violinist's concerto composer—the type of concerto that a violinist *would* play, and twenty nine of them at that, part of the standard violin literature. But in his day he also composed music for the rest of us, it seems, and herewith two out of three quartets published in 1818 near the end of his eventful life.

The Viotti music has that typically Italian virtue of fresh, lively expression even though the ideas are not of any great importance and the style—for the mid-Beethoven period—is old-fashioned. (Sounds like Mozart or Haydn in point of time.) I thoroughly enjoyed both quartets and so will you, without bothering as to their profundity. The Italians never did put much store in "heavy" music, anyhow. They aim to please.

As for that good Austrian Michael Haydn, overshadowed younger brother of the great Joseph Haydn, elder friend and colleague of young Mozart at Salzburg, these two sincere and well-meaning Quintets seem to contradict each other, one good and one inept, just as I've noticed to my puzzlement in other works by the man. Sometimes he's a capable workman at music if not a genius; at other times

he's pathetically inept (for a man with the Haydn name), or so my ears say.

Howcome? I haven't an idea. He was an odd musical duck, and maybe he had his better moments and his worser. Or maybe the good pieces are the ones where he was coached by Mozart, who often helped him out when deadlines came too fast. It was easy enough for Mozart and (I suspect) he didn't feel worried by any possible rivalry.

In a way, these Quintets are "deeper" than the light-hearted Viotti, or so intended in any case; but Viotti did better, with flimsier stuff.

Stravinsky: Agon; Firebird (1945 revision). N.Y. City Ballet Orch., Robert Irving.

Kapp KCL 9037 Mono
(Also in stereo)

This is one of the first batch of Kapp classical's I've heard, and I am decidedly impressed.

It is an excellent job and well-rounded, good in each aspect, from the choice of its content to the performance and the recording itself. Part of the credit should go, I suspect, to the intermediary producing firm that acted as a guiding "middleman" or over-all consultant and construction agent, so to speak—a new idea in recording that has already proved very useful (Bourée Productions is the firm and the operating agents for Kapp were Fred Gruenfeld and Alan Silver, the latter an audio engineer.) In these complex times, it takes a "pilot" with experience to steer a record company successfully into new areas; the idea of an independent firm specializing in this field is an interesting one.

Here we have an enterprising ballet orchestra, very much out in front at the moment in actual ballet production, and two notable Stravinsky scores out of its own repertory. "Agon" is the recent abstract ballet, celebrated for its novel 12-tone aspect but already a favorite on the ballet stage for its fundamental musical and dance appeal. I saw it myself in this production (after hearing two earlier recordings) and found it very enjoyable—especially since it turned out to be quite funny in places, thereby removing the threat of over-serious modern heaviness! Yes, it is dissonant, but this is utterly unimportant today. More interesting for you and me is that it has lots of quirky, typically Stravinsky instrumental color and rhythm, beautifully suited to recording, and very neatly recorded, too.

If you think you're familiar with that war horse, "Firebird," listen to this version and be astonished. Dollars-to-something, you won't even have heard some two thirds of the music. A good bit of it was composed in 1945 for this ballet company as an amplification of the original score, which dates back to before the first World War. Other parts were sharply revised in instrumentation—a quick ear will detect some surprising changes in the familiar sound.

The "new" "Firebird," as produced by this company, flows continuously without breaks, the well known excerpts of the familiar Suite being joined by varyingly long musical bridges, leading from one section to another; the complete score also includes numbers not heard in the Suite. I am somewhat unclear at the moment as to how much of this wealth of interesting new "Firebird" is actually from 1945, how much is the original score and how much from various other revisions—but so much the better. The "new" material gives the entire piece a more modern, more original slant that greatly enhances its value, and the performance, clearly an intelligent and beautifully worked-out one with the dance itself directly in mind, also updates the over-all effect no end. A very impressive, perhaps almost a definitive recording of this version of the music.

2. EXCELLENT, BUT . . .

Smetana: Ma Vlast (My Country), Symphonic Poem Cycle. Vienna Philharmonic, Raphael Kubelik.

London CSA 2202 (2) stereo

The Czechs play *Ma Vlast* for themselves as often as the British play "God Save the King" and "The British Grenadiers," but *Ma Vlast* is a lot longer.

So long, indeed, that I'm not waiting to

plough through to the very end before reporting to you upon the beginning. Six whole tone poems, designed to be played one right after the other, and of them all, only two are familiar to my ear, *Vltava* (*The Moldau*) and *From Bohemia's Meadows and Forests.*

Those two I'll admit, are lovely, especially the familiar sound of the Moldau river, burbling at its source, crashing over rapids (which, the notes say prosaically, have since been eliminated by a power project), idling onwards past Prague and away, beyond the Iron Curtain. The other pieces would take more listening, decidedly, in view of the almost fanatical streak of nationalism that is imbedded in their detailed story-lines, each a heroic tale of some vital Czechish import. It's big, loosely built, long-winded Romantic music of the high-1870 style, pretty tough for our chrome-plate ears today. Makes good hi-fi, in any case, and I suspect that maybe a number of playings would bring you to the point of being captivated by all six works. Especially if you have Czech blood.

Music from the Welsh Mines. Rhos Male Voice Choir, Edward Jones. John Tudor Davies, Organ. **Washington WR 416**

This title caught my curiosity: we are always hearing about the fabulous tradition of Welsh singing, but we practically never hear the actual music, nor those fabled Welsh "eisteddfods," ceremonial gatherings for musical and literary competition, that go back very nearly to Roman times. (I think Westminster has music from one of them.) So—here are the Welchmen come to sing for us. What are they like?

Well, the voices are as good as rumored; they are indeed quite fabulous for a bunch of unlettered miners out of the town of Rhosllannerchrugog. (Unlettered, indeed!) They have fine tenors, rich basses, their ears are good, they sing in tune, and in Welsh, too, as well as Latin and a bit of English. The Welsh itself might just as well be a somewhat adenoidal English—who can understand the words of a big male chorus, anyhow?

The ensemble reminds me a bit of the Don Cossacks—the Cossacks, perhaps, after they had settled down in some small British town, married respectable local girls and joined the church of England. Rather glee-clubby, on the whole, and the constant organ accompaniment gives a churchy atmosphere that at times is just plain saccharine.

The music? Welsh, of course, but mostly in name. These are largely a species of hymn-like tune very familiar in the British choral repertory, earnest, heavy, noble, a bit sentimental. The tastefully conventional arrangements are strictly the expected, each verse with the usual different setting. When the choir turns afield, to the sixteenth century Italian (Viadana) and to—of all composers—Schubert, the effect is scarcely any different. The Schubert drags along ever so seriously, like . . . well, like Welshmen dressed up for Sunday church.

Nope, I'm not really very impressed by the fabulous Welsh singing. Nor do I enjoy one of the sloppiest bits of tape editing I've bumped through for a good many months: each piece is cut off, echo and all, at the precise instant the last note stops, and more than one of them begins with a noticeable wow. Somebody's engineer is the mayhem-committing type and I hope it was a Welshman, for Washington's sake. (The tape is from Delysé Recordings.)

Ravel: Quartet in F.
Debussy: Quartet in G Minor, Op. 10. Paganini String Quartet.
Kapp KCL 9038

These two sensuous quartets seem always to be paired, like twins, though they are remarkably unlike in their very similarity. Both are French, both are often called "Impressionistic"—and sound it, both were early works, ten years apart, bridging the turn of the century. Both use the quartet medium with fantastic skill for effects that were then quite astonishingly new, yet wonderfully "idiomatic," i.e. suited to the instruments themselves.

Generally speaking, I've found that Debussy is the bigger musical craftsman, but Ravel is the most sensitive musician. For my ears, at

least, Ravel can "speak" music more penetratingly than Debussy, whose work to me often seems beautifully contrived. Heresy? Maybe . . . but as far as these two works are concerned, I'm struck again by the larger scope and originality of the Debussy, even though it seems to me not well performed, here. Debussy does more, puts more material, more ideas into his quartet; the Ravel is expertly written but musically unripe.

The Paganini group has four priceless instruments once owned by P. himself, but their Debussy is somewhat academic, precise, letter-perfect and minus its soul. Couldn't be proved, yet that's the way I felt it, beauteous tones or no. Oddly, the Ravel seems much more alive, as though the players really liked it. I have a sneaky feeling that this has to do with Ravel's more classic-minded structure, versus Debussy's somewhat arbitrary effects of color and light. These players aren't the impressionistic type.

Kapp has done a forthright job of good recording here, in a style too long neglected—no fancy liveness behind these string players, no big hall, no synthetic reverb; just the four instruments, exactly balanced in an intimate close-up "chamber." Though I do enjoy the "big" quartet sounds currently popular in many recordings, I prefer the close-up, non-live technique for quartet recording. It's better for the musical sense, even if sonically less spectacular.

Stereo Hi-Fi Test Record. Components Corp., Denville, N. J.

This is a helpful but rather clumsily presented test record with some good material on it and a very slow pace. The first side offers stereo tests, plus stereo sound effects, the second side is mono—or rather, it has tests that don't directly involve stereo performance.

On the stereo side there's first a channel identification, a long, faded-in 1000-cps tone on each channel, identified by a voice—in the middle. (Why? A pure tone, faded in, is particularly hard to locate directionally and, anyhow, the voice itself could have said "this is the right channel" in a quarter the time!) Then follows a metronome in the middle, for balancing. (I'd use it for phasing.) A speaker phase test didn't work for my ear; two low-pitched buzzes, one in and one out of phase, and with correct speaker set-up the first is supposed to sound louder, and vice versa. I can hear phasing quickly, but I didn't get this. Use the metronome—it should be right in that famous hole-in-the-middle with correct phasing.

The bands on this disc are locked at each separation, which means you must jump up from your observation point and run to the phonograph for every one.

The right-channel and left-channel glide sweeps are probably useful in making channel comparisons, if you run to unlike channels. (You shouldn't.) And as for the sound effects that end the side, they are mostly much too short, vary from good to inept—subways, jets sonic-booming, tree-chopping, the Queen Mary (good)—and each is ruthlessly cut off, without even the decency of a fade. Pretty rough. But I enjoyed the Queen and jumped at the thunderstorm.

The mono side is more enterprising. An interesting item is a supersonic glide, 35,000 cps down to a thousand. Yes, there's sound up there—I slowed the record to see. Another glide goes from 100 to 5 cps and via two AR-3's it set off some astonishing buzzes and rattles in my living room! At the bottom, I could feel the air pumping. These two glides will be worth the record's cost for most audio buyers. A rumble comparison test was good, too, a 30 cps tone, down 20, 30, and 40 db, plus a quiet band, presumably rumble-free. My pre-stereo turntable-of-the-moment rated about 35 db down—not too bad on vertical-lateral play. The first and last bands are 1000-cps tones, loud, for stylus wear comparisons. Just play 'em, one after the other.

A good side and the only trouble, again, is clumsiness. There are seven listed bands but the eye sees around 19 separations—and you can't for the life of you locate the band you want. (The rumble bands aren't even together with the quiet band.) For re-cutting, I suggest (a) unlocking all bands and (b) no visible separations except at the main band divisions.

Sviatoslav Richter, Piano (Liszt, Schubert). Columbia ML 5396

Recorded imports from beyond the Curtain have been released by many companies these last years, but a solo piano recital recorded in Bulgaria and released by Columbia is surely an unusual item—and ought to be worth it. It is, I'd say. The music was played at a concert in Sofia in February 1958—that is a Bulgarian State Radio tape, taken over by Columbia.

Richter is one of Russia's biggest pianists, one of the few in his class who has not yet played in person in the West, though he is well enough known via recording. In common with others of the Soviet school, he plays with a certain appealing old-fashioned musicianship, free from the hard, pile-driver technique so popular with younger Western artists. (That style can be effective enough in the top-quality music of our own contemporary composers in the West, of a sort that is not written in Russia.)

The Liszt items here are unusual and seldom-played, depending greatly on long, sparse passages of near-silence to set off the few pyrotechnical episodes. In concert these silences are magical, but even a recording of a concert loses much of the "spell" and the turning record seems to drag out the silences to inordinate lengths. Not Richter's fault, nor yet again, Liszt's.

Richter's fleet technique is excellent for extremely fast and light passage work, which abounds here, notably in the *Feux Follets*, one of the big Liszt piano études, a sort of Super-Flight of the Bumblebee. His singing tone is lovely, but not too lovely for Schubert, who gets a pleasingly expressive performance in three familiar piano pieces, two *Impromptus* and a *Moment Musical*.

An interesting problem, always, is the managing of applause in such concert-made recordings as this. Columbia (or the Bulgarian State Radio) has contrived to remove it all here, except for the final piece—at the expense of some rather too-sudden endings, with the concert-hall liveness switched off like a blown fuse. The overlapping applause in the ending piece is quickly faded away—I would have preferred a good, honest blast of it for some seconds, just to show for once that the undeniably present audience (coughs) did like the recital.

. . . And, Columbia, tell the Bulgarians to tune the piano next time.

The Romance of the Piano. Hans Richter-Haaser. Epic LC 3620

I wish this pianist had an easier name—for he is one of the greatest interpreters of Romantic music I've heard for many years. He reminds a bit (for those who remember) of the fabulous Rosita Renard, who gave one recital and made one record (of it) in New York and went back to South America to die. This man has something of the incredibly clear musical power that was hers, the power to play sheer music, *through* the piano rather than merely on it, a poetic sense for phrasing, harmony and style that is simply beyond understanding, as though fingers and steel wires were not even connected with the phenomenon.

Richter-Haaser (no relation of the Russian Richter) plays here an excellent selection of short Romantic works, ranging from the Liszt Liebestraum (the familiar one) through bits of Chopin, Brahms, Greig, Schumann, Beethoven, Schubert, Mendelssohn, to a superbly shaped Beethoven sonata, number 24 opus 78. Most of the music is unpretentious—even the Beethoven; this merely increases our joy at the marvelously sensitive playing. Every piece is a gem of musical purity, perfectly natural, perfectly styled . . . excuse my enthusiasm, but things like this don't often happen!

The trite title, suggesting a species of mood music, could have been "Romantic Music for Piano" with more dignity.

P.S. Only a day or so after I had written the above, I got a phone call from the German government, in New York, inviting me to the American debut concert of a celebrated German pianist—Hans Richter-Haaser; he wasn't well known in this country and had I perhaps heard of him? I had, and accepted with pleasure. It's a rare thing when I get to hear in person an artist I know on records.

(*Continued on page 89*)

CHARLES A. ROBERTSON*

STEREOPHONIC

Charles Mingus: Mingus Ah Um
Columbia Stereo CS8171

The current quest of young modernists for jazz roots is having an affect on musicians who happen to be amply endowed with such appendages. Besides causing a number of them to tap these resources more avidly than in recent years, it is prompting a few to pause and reexamine early influences in the light of later experience. With the same intrepidity that established him as one of the most forward-looking composers, Charles Mingus gives prominence to the trend, on this occasion, by harking all the way back to first memories of the gospel church and Duke Ellington. The attempt to describe the Times Square scene, which has held his attention lately, is left to Jack Kerouac, while Mingus leads an augmented group through some personal annals of jazz history.

When a student at Los Angeles City College in 1943, Mingus was attracted by the workshop idea, as a means of furthering his musical progress, and has organized one whenever possible since then. His last was a Composer's Workshop that included Teddy Charles, John La Porta and Teo Macero, the supervisor of the present album. Because of this experiment, Mingus is able to draw two conclusions. "First, a jazz composition as I hear it in my mind's ear—although set down in so many notes on score paper and precisely notated—cannot be played by a group of either jazz or classical musicians. A classical musician might read all the notes correctly but play them without the correct jazz feeling or interpretation, and a jazz musician, although he might read all the notes and play them with jazz feeling, inevitably introduces his own individual expression rather than the dynamics the composer intended.

"Secondly, jazz, by its very definition, cannot be held down to written parts to be played with a feeling that goes only with blowing free.

"My present working methods," he also states, "use very little written material. I 'write' compositions on mental score paper, then I lay out the composition part by part to the musicians. I play them the 'framework' on piano so that they are all familiar with my interpretation and feeling and with the scale and chord progressions to be used. Each man's particular style is taken into consideration. They are given different rows of notes to use against each chord but they choose their own notes and play them in their own style, from scales as well as chords, except where a particular mood is indicated. In this way I can keep my own compositional flavor in the pieces and yet allow the musicians more individual freedom in the creation of their group lines and solos."

If something about this last statement seems familiar, it is because Duke Ellington followed a like procedure when he brought his early band to the Cotton Club more than three decades ago. The first jazz Mingus heard as a boy, by coincidence, came from this source and he pays it just due on *Boogie Stop Shuffle*, and *Open Letter to Duke*, which includes a postscript for Johnny Hodges from the alto sax of John Handy. It was a creative period for the Duke, although he went on to compositions of greater sophistication and polish, and the impact on Mingus was lasting. It even extends to exotic jungle sounds on *Bird Calls*, which must be heard in stereo for complete effect.

What sets Mingus apart from previous Ellington imitators is his personalized approach and the originality of his ideas, as expressed on *Self-Portrait in Three Colors*, and *Goodbye Pork Pie Hat*, with a tribute to Lester Young from tenor-saxist Booker Erwin. Those Ellington devotees who feel their mentor became too refined in later years will find his early spirit surpassed on *Better Git it in Your Soul*, an invigorating gospel shout which drummer Dannie Richmond lifts to soaring heights. Soloing less than usual on bass, Mingus uses his instrument to deflate pomposity on *Fables of Faubus*; to depict the humorous antics of his household pets on *Pussy Cat Dues*; and to inject rhythmic surprises on *Jelly Roll*. The addition of Shafi Hadi and Willie Dennis, who joins Jimmy Knepper on trombone, swells the regular group to an octet. An excellent stereo recording represents Mingus in the fullest expression of his talent to date.

Big Miller: Did You Ever Hear The Blues?
United Artists Stereo UAS6047

Langston Hughes knows the blues. When he decides to put his information into a book, much that is still generally unkuown about the subject should be revealed. Until then, this set of lyrics to eleven songs will offer convincing proof of his understanding of the blues, just as the musical setting and Big Miller's performance demonstrate his ability to cope with the creative process involved after the words leave his hands. Hughes works in an urbanized dialect of the old anonymous folk blues, which live through interpretations perfected over the years. To ask a blues singer to assimilate this much new material quickly, somthing never attempted in a studio before, means a considerable shortening of the normal incubation period. Big Miller would never have managed the assignment without more aid than most record companies give a blues singer.

Hughes helped pick songs suited to the Kansas City blues shouter's style. David Martin, Sammy Heyward and Albert Hague composed melodies to underline the dramatic lines. Budd Johnson, conductor at the three sessions, collaborated with pianist Jimmy Jones on the arrangements. Zoot Sims, Al Cohn, Phil Woods, and Pat Brooks turn in stellar choruses throughout, and changes in the rhythm section add variety. Listening to the different accents supplied by drummers Jo Jones, Gus Johnson, and Elvin Jones is a rare treat. The same is true of the guitarists, especially in stereo, as two are used each time in a pairing of Barry Galbraith with Billy Bauer, Everett Barksdale with Kenny Burrell, and Chuck Wayne with Turk Van Lake. But success rests on Hughes' verses and Big Miller's confident mastery of them on *Good Old Guy*, *Cool Saturday Night*, and *Wee Small Hours*. Their intentions are well realized in stereo by engineer Ray Hall.

Jim Timmens: Showboat Revisited
Warner Bros. Stereo WS1324

This unfolding of the Jerome Kern musical follows the format originated for "Porgy and Bess Revisited," the first show to receive the revival treatment administered by Jim Timmens and an ample crew of studio musicians. The device of assigning starring vocal roles to solo horns packs fully as much entertainment as before. To the phrases of *Bill*, and *Can't Help Lovin' Dat Man*, Doc Severinson applies his trumpet with all the passion that Helen Morgan once expended in twisting her famous handkerchief. There is a fresh arrangement of *Old Man River*, designed for the trumpet of Ernie Royal, while added woodwinds and strings fill out the ballad backgrounds. *Make Believe*, with the brash, full sound of Lawrence Brown's trombone, serves as a contrast to *Why Do I Love You*, expressed in the liquid tones of Hilton Jefferson's alto sax. Usually slighted in other readings of the score are *Dandies on Parade*, from the dance sequence, and *Dance Away the Night*, which features clarinetist Walt Levinsky. Both the period and performance are summed up by *After the Ball*, the one non-Kern tune. The stereo version is fine as to spread and depth.

Ralph Hunter Choir: Songs of Battle
RCA Victor Stereo LSP1996
Felix Slatkin: Charge!
Capitol Stereo ST1270

The sounds of marching feet and the crash of drums fill these stereo visits to the parade ground. The Ralph Hunter Choir sings twenty-two war songs which figure in the fighting history of America from the Revolution to the present. The featured soloists are old campaigners and know just how to sing *I've Got Sixpence*, *Lili Marlene*, and *Wait Till the Sun Shines, Nellie*. An orchestra conducted by Sid Bass suits the prevailing mood, be it somber or rousing. Realistic interludes are supplied by the drill team of the Fort Monmouth Regimental Ceremonial Unit, recorded at the New Jersey outpost by Bernard Keville during the wind and rain of an autumn day.

Felix Slatkin conducts the Light Brigade, a bugle and drum corps that is augmented by fifes and bagpipes, on imaginative settings of traditional military themes. Some are reorganized into stirring vignettes of a pre-atomic era, when Grenadiers, Hussars and Dragoons rode into battle, while others pay tribute to hardy foot soldiers. Both recordings are spacious and offer a broad panorama.

The Thunderer Plays Carousel Marches
Columbia Stereo WS303

The Dutch street organ, a veteran of monophonic performances, is wheeled out again to make a stereo debut on a dozen marches, half bearing the stamp of John Philip Sousa. "The Thunderer" is billed as the greatest of the lot and boasts a mechanism of 75 keys, ten being for accompaniments, eight for basses and trombones, while the balance handle the melodies. The oddest sounds are generated by a violin register of string-toned flutes, and a special barrel-organ register of bright sounding sustained flutes. Like most mechanical contrivences, it carries a certain amount of inherent distortion, but no more than a majority

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of early LP's. Anyone wearing wooden shoes would hardly notice it. The interaction between three melody registers and four for the counter-melody contributes to a lively stereo effect, pitting a trombone choir against the trill of the curious string section. A spacious recording, and enough volume in reserve to run a merry-go-round.

Peggy Lee and George Shearing: Beauty and the Beat! **Capitol Stereo ST1219**
Count Basie: Breakfast Dance and Barbecue **Roulette Stereo RS52028**

Have a little pity for the disc jockey who hears performances like these at his annual convention and then has to return to playing rock and roll for the rest of the year. The event took place over last Decoration Day weekend in Miami, and two companies took down the highlights of the happenings at the ballroom of the Americana Hotel. From all reports, the recordings offer a better vantage point than actually being there. Peggy Lee and George Shearing account for the supper club portion of the program, offering tasteful stylings of *Blue Prelude, All Too Soon,* and *If Dreams Come True.* Instrumentals by the Quintet include *Mambo in Miami,* an original prepared for the occasion by conga drummer Armando Peraza. Stereo places the vocalist front and center, distributing the pianist and musicians to either side in the form of an effective backdrop.

Count Basie presides at the breakfast dance which followed, answering requests for such old favorites as *One O'Clock Jump,* and *Moten Swing,* besides uncorking a few new ones. Among them are Frank Foster's *Who Me,* Snooky Young's *Let's Have a Taste,* and Thad Jones' *Counter Block.* Joe Williams sings *5 O'Clock in the Morning* and *Hallelujah, I Love Her So.* The leader's piano kindles a good time feeling, his special guest is Harry Edison, and your price of admission is repaid by a fresh arrangement of Ellington's *In a Mellow Tone.* Bill Scripps and Tory Brainard engineered the date.

Esquivel: Strings Aflame **RCA Victor Stereo LSP1988**
Mighty Accordian Band: They Said It Couldn't Be Done **Capitol Stereo ST1212**

Unusual effects abound on these two novelty items and the stereo patterns create a lively mood. Esquivel employs a full string complement of eighteen violins, five violas, and five cellos to consort with his piano and harpsichord. Never letting his charges swoop or swoon in the pursuit of a dozen tunes, the leader sets out to bedazzle the listener with alert sound and bright arrangements. His full-bodied treatment gives a new zest to such exotic tidbits as *Scheherazade, Malaguena,* and *Misirlou.* His bouncy original, *Foolin' Around,* quickens the pulse with pizzicato passages. In keeping with his intentions, the recording focuses on the interplay between piano and strings, and the engineering of Ernest Oelrich makes it highly desirable for purposes of stereo demonstration.

Someone at Capitol came across statistics on the number of amateur accordionists, apparently, and decided that sales prospects of the Mighty Accordion band were mighty good. The twenty members are arranged across the stereo stage and toss the melodies back and forth before a large variety of percussion instruments. Their specialties are funmaking tunes like *Beer Barrel Polka, Syncopated Clock,* and *Holiday for Strings.* More ambitious projects find them capturing the sound of a big band on Count Basie's setting of *April in Paris,* and Tommy Dorsey's version of *Boogie Woogie.* All a home accordionist needs to do is pick up his instrument and join in from a place betweeen the loudspeakers. A wonderful idea for Music-Minus-One.

MONOPHONIC

Benny Carter: Swingin' The '20s **Contemporary M3561**

The two patriarchs of the alto sax and piano are united for the first time in jazz history on

this recording, making it an event of some note. Both Benny Carter and Earl Hines conducted revolutions of their own at one time and did much to establish the primacy of their instruments as jazz voices. To accomplish this, they achieved a high level of performance and founded styles which other musicians regard as a basis of much that happened later. There is no sadder commentary on the status of the music industry than the fact that it took thirty years to bring them together. No longer revolutionaries, they are still Titans, somewhat mellowed from waiting for the world to catch up with them, and both have grown and learned with the changing times.

The tunes are the ones they played during their formative years and include *Thou Swell, Mary Lou*, and *Someone to Watch Over Me*. Carter's singing alto tone is like velvet on the seldom heard *Just Imagine*, and the pianist's accompaniments are just right as always. Completing the quartet are Leroy Vinnegar, bass, and Shelly Manne, one of the few drummers who can match the tricky cross-rhythms set up by Hines. Carter plays trumpet on two numbers and is answered by choruses in the pianist's famous trumpet style. If further recommendation is needed, Roy DuNann's recording of the piano sound is splendid.

Don Ewell: Yellow Dog Blues
Audiophile AP66

The modern trend currently underway at Saukville, Wisconsin, continues apace and finds Ewing Nunn admitting to his studio that comparatively recent innovation—a drumless quartet. The liner notes fail to mention whether the idea came from the musicians themselves, or was adopted simply because Mr. Nunn wanted to test his skill at balancing a rhythm section without a drummer. Perhaps, due to the informality of these sessions, nobody missed him until too late. For this is a relaxed, unfrantic performance of the sort musicians play for their own enjoyment, and is practically never heard in a club. The tunes are all traditional blues, and the departure from norm is not great enough to offend any but the most hidebound traditionalist. The increased freedom is used to advantage, however, both rhythmically and in improvisations on phrases that will always be timeless in beauty of feeling and expression.

Don Elwell is in charge of Mr. Nunn's favorite Boesendorfer (one instrument not likely to be omitted from these sessions) and embarks on *Michigan Water*, a number which seems to be, in turn, his favorite. The superb piano tone creates a firm underpinning to Nappy Trottier's choruses on open and muted trumpet. Playing an unamplified guitar, Marty Grosz solos with taste and inventiveness on *Blues My Naughty Sweetie Gives to Me*, while his rhythm work blends effectively with Earl Murphy's bowed lines on bass viol. Even in these days of improved sound, the recording is exceptional.

Gil Evans: Great Jazz Standards
World Pacific 1270

Now that Gil Evans is turning his attention to the sound of a big working band, the concerto sketches which he wrote for Miles Davis and Cannonball Adderley are paying dividends. The close relationship established with those two artists is maintained in writing for the greater variety of soloists utilized here. Although two studio groups are employed, the arrangements were introduced during an engagement the leader filled at Birdland, where most of the personnel became acquainted with them. As before, the choice of theme combines the old and the new, permitting him to illuminate such diverse personalities as Monk, Beiderbecke, John Lewis, and Clifford Brown. More than a hint as to the basis of his orchestral style is disclosed on *Chant of the Weed*, the great Don Redman theme. Using it to clothe a gracious Budd Johnson clarinet solo, Evans demonstrates how much he has absorbed since the tune was written in 1931.

As Evans' finest achievement to date, the album must be regarded as essential to any representative jazz collection. The monophonic version is outstanding, so well are the solo voices balanced against the orchestral sections, but the stereo setting should be worth waiting for. When available, its virtues will be noted in this space, perhaps with more than

passing mention of the work of John Coles, Steve Lacey, Jimmy Cleveland, and Elvin Jones. This one is worth a second comment.

Ted Heath: Things To Come
London LL3047

After augmenting the sections by bringing together some of the fine jazz players who worked for him in the past, the British leader dedicates this session to allowing his band to play the way it wants. The avowed purpose is to avoid the restrictions of a commercial dance set, but the planning seems to have neglected a stereo version. The omission is regrettable in the case of Ronnie Roullier, whose arrangements might sound less top-heavy if distributed through two channels. His *Ringside Suite*, a piece of nearly eight minutes about the noblest art, provides a lovely theme for Ronnie Chamberlain's soprano sax, before the composer becomes overwrought in a desire to emulate Gillespie and Kenton.

Ken Moule remains at home for his inspiration and works with material at hand. His *Waterloo Bridge*, an impressionistic sketch fortified by a section of eight reeds featuring the baritone sax of Ronnie Ross, is full of local color and originality. His light, bright scoring is worthy of comparison with Fletcher Henderson's on *Sometimes I'm Happy*. If he continues to progress in this direction, his future is assured, commercial or otherwise. Eddie Blair solos on *Taboo*, Stan Tracey on *I'll Remember April*, and eight trombones enliven *Out of Nowhere*. After this demonstration, Heath can rest content that he has hired some of the best jazz men anywhere.

Red Garland: Red In Bluesville
Prestige 7157

A good blues pianist practices a great deal of deception, appearing relaxed yet remaining forceful, and assuming an apparent ease while alert to uncanny timing. Red Garland's former experience as a boxer may have trained him to a greater proficiency in these devices than many of his contemporaries. On this blues set, his softest phrases are firm and strong, while his left hand idles along unconcernedly before striking out with dramatic swiftness and power.

Garland mixes old and new themes to depict the endless variety of his subject, renovating *Trouble in Mind* and *See See Rider*. He swings lightly through *Real Gone Guy*, then makes an entertaining episode of *M-Squad*. Bassist Sam Jones solos on *That's Your Red Wagon*, and the drummer is Art Taylor. By understating it, Garland finds something new to say about *St. Louis Blues*.

Paul Horn Four: Impressions!
World Pacific WP1266
Mamoru Miyagi: Japan Revisited
Capitol T10195

Because good chamber jazz recordings are relatively scarce this season, adherents of the subject may be willing to journey further afield than usual. In addition to four light-textured jazz pieces, Paul Horn adapts works of 20th Century classical composers to suit the instrumentation of his quartet of conservatory trained musicians. The leader alternates on flute, clarinet, and alto sax, with John Pisano on guitar, Gene Estes on vibes, and bassist Lyle Ritz. The themes are picked for points of similarity rather than contrast, in each instance, and a pastel-tinted *Greensleeves*, or *Baltimore Oriole*, is matched with Debussey's *Girl with the Flaxen Hair*, and *Little Shepherd*. A more rhythmic bracketing is the Tadd Dameron-Count Basie *Good Bait*, with ballet interludes from Ravel and Stravinsky. *Mist*, the title of Horn's original, is descriptive of the blend achieved throughout, and the quartet is featured at Hollywood's Club Renaissance where the recording was made.

The modernists who comprise the group claim to be open to all musical ideas, whatever and wherever the source. Both they and their audience should be stimulated by Mamoru Miyagi, an artist on bamboo flute who is accompanied by graduates of Tokyo's University of Arts. Although a number of percussion instruments are employed on some numbers, the rhythms are as much at variance with a strict Occidental dance beat as those afforded by Horn's drumless quartet. All the melodies are ancient enough for the Japanese to regard as traditional, but unaccustomed ears are likely to find them fresh and appealing. Among the instruments heard are the koto, samisen, yokobue, and taiko drums. Produced in Tokyo, the album is excellently recorded.

Odetta: My Eyes Have Seen
Vanguard VRS9059
Ron and Nama: Donkey Debka!
Elektra 173

Although poles apart in other respects, the artists on these albums ply the folk music circuit as entertainers and defy the theory that, to retain the ring of authenticity, their art must remain static. Odetta Felious is gifted with a powerful voice and a natural feeling for spirituals, prison songs, and blues. Many other singers have these qualities, but take the same material and lesson the impact or smooth the edges in an effort to please their audience. Odetta's strength lies in her determination to get the most out of each song. To do so, she has no hesitation about dramatizing tempos, heightening tragic episodes, or altering lines. Her version of *Down on Me*, which she first heard in a recording collected for the Library of Congress by Alan Lomax, emerges from this treatment as a moving and lifelike experience of her own. Other aspects of her fullsome personality are set forth on *I Know Where I'm Going*, and *The Foggy Dew*. She accompanies herself on guitar, helped intermittently by Bill Lee, stringed bass, and a chorus under Milt Okun.

Ron and Nama, who first met while serving in entertainment units of the Israeli Army, go back no further in searching for material than the date when their country achieved statehood. On the evidence of other albums and the sixteen songs presented here, their range of choice seems to be wide and ever-growing. As veteran performers with pleasing voices, they are quite at home in this country and have appeared coast-to-coast.

Phineas Newborn: Piano Portraits
Roulette R52031

The Piano Scene of Ahmad Jamal
Epic LN3631

As an extra bonus, two practical lessons on the growth and cultivation of a piano trio are included on these albums. Phineas Newborn is again joined by bassist John Simmons and drummer Roy Haynes, continuing an association begun during a tussle with the blues for Prestige, and this time tests his evolving style on show tunes and ballads. Bent on catching the public ear before it lights on a new technical marvel, the pianist concentrates on selling each song for the melody or some distinctive quality he finds in it. When he wants to show his technique, he now avoids the cold and brittle, playing instead a striking blues theme with just his left hand. But the power behind the throne is Haynes, who drums with restraint and lets Newborn know when an idea has been pursued long enough. Like Israel Crosby in the current Ahmad Jamal trio, he makes an important contribution to the group's general concept and overall sound. He should not be overlooked on such portraits as *Star Eyes, Golden Earrings, It's Alright With Me,* and Strayhorn's *Chelsea Bridge.*

Ahmad Jamal is represented by a recording made while still working with a guitarist, the second from this period to be released by Epic. Among the dozen tunes are early exploration of *Poinciana,* and *Surrey with the Fringe on Top,* both of which may be compared to later versions by the trio he now heads. The insight gained into his methods during the process is likely to be useful in the future. The pianist is still examining these tunes and may come up with some new developments. Also heard are a blues and *Slaughter on 10th Avenue.*

Bikel Town Hall Concert: Bravo Bikel!
Elektra EKL175

If anyone missed the shouting for Theodore Bikel before, the live-audience response to his current effort should make itself heard far and wide. The best portions of two concerts, held last season at New York's Town Hall, are combined into a lively program which holds surprises even for those who know his seven previous albums. Who else would pick such a setting to introduce a newly acquired talent for the harmonica? And then play it to his own guitar accompaniment. His rich baritone voice wanders just as informally through songs from many countries, including one collected in Hollywood. When Bikel was making the film "Fraulein," the producers learned of his ability to sing in Russian and ordered that *Nitchevo,* an "authentic" folk song, be composed on the spot. His wit as a monologist comes to the fore in a reading of Robert Nathan's "Digging the Weans," a somewhat ominous look at the future which has yet to appear in book form. The engineering by Dave Hancock misses none of the detail.

Susan Reed: Songs for the Wee Folk
Elektra 163

The Happy Sound of the Bill Will Band
Audiophile AP62

Bud Shank: Slippery When Wet
World Pacific WP1265

Fiji: Isa Lei
Capitol T10216

60 Years of "Music America Loves Best"
RCA Victor LM6074

Arranged below is a suggested list of Christmas greetings for those who are unperturbed about not having everything.

For Children Everywhere: Susan Reed's collection of sixteen folk songs, each selected because of proven appeal to young audiences. Many will appeal to their elders as well, including *Sourwood Mountain, Waltzing Matilda,* and *Arkansas Traveler.* Also heard are game songs, a Pennsylvania Dutch lullaby, and songs about animals. They are sung sweetly and clearly, without any of the condescension or cuteness that children abhor.

The recording by David B. Jones is first class.

For a Rich Uncle: He should reside in a Middle Western State, or any other territory where the polka reigns supreme. Will Teuteberg, accordian, and Bill Peterson, banjo, who hail from the Milwaukee area, know the right tempos and when to mix in a waltz or leandler. Their little band is spirited and gay, the sound wonderful, and the right recipient will admire your good taste.

For an Athletic Cousin: Bud Shank's modern jazz background to "Slippery When Wet," a film about surfboarding on location in Hawaii, rather than crime or juvenile delinquency. With a rhythm section of Billy Bean, Chuck Flores, and Gary Peacock, the leader improvised many sequences while watching the film in the studio. He develops lithe, sinewy lines on flute and alto sax to capture the swift action. Even Eddie Condon will be offended only by the large amounts of undiluted water.

For an Armchair Traveler: A "Capitol of the World" expedition to Suava, located among the 322 Fiji Islands, to bring back the first LP from that part of the South Pacific to be released in this country. The Adi Cakabu Girls' School Choir sings traditional songs, but the Via Ni Tebara Choir, and all male group, recalls the time when the members served in World War II. Some of the tunes sound remarkably like West Indian calypsos, notably a tribute to Hellaby's canned meats by Alf Bentley and His Islanders. Another instrumental group, The Red Ringer Boys, specializes in bamboo percussion implements.

For a Record Collector: A cavalcade of performances from Caruso to Belafonte which represents a historical survey of the 60 recorded years contained in RCA Victor vaults. The two-record set allows room for one selection for every two years, and both popular and Red Seal artists are there. Benny Goodman rubs shoulders with Leopold Stokowski, and Perez Prado with Arturo Toscanini. Paul Ackerman summarizes the course of events in an informative essay, and the price tag symbolizes the Camden label.

Mitchell-Ruff Duo: Jazz For Juniors
Roulette R52025

Early in the summer, this Duo breached the Iron Curtain and gave an informal jazz concert to assembled Russians, an event our State Department has failed repeatedly to arrange. The resulting publicity was tremendous and news reports said the audience was charmed. Some idea of how it was accomplished may be gained by listening to this lecture-recital, prepared for the Young Audiences Concerts and recorded with high school students in attendance. Willie Ruff, who plays bass and French horn, serves as spokesman and indulges in a friendly give-and-take which holds the interest of the teenagers throughout. After his informative comments, each musical fragment serves a purpose, including one involving the sixteen-year-old class pianist. Both he and pianist Dwike Mitchell are most comfortable when dealing with their own field of progressive jazz and might devote more attention to it, leaving earlier forms to a program by another group. A filmed version is making the rounds of television stations.

Lambert, Hendricks & Ross: The Swingers
World Pacific WP1264

The fertile imagination of Jon Hendricks is responsible for putting another set of instrumental numbers to lyrics, departing this time from themes associated with the Count Basie band. The tunes were all developed by small groups and afford Dave Lambert and Annie Ross, his fellow vocalists, numerous improvised flights in pursuit of Sonny Rollins on *Airegin*, Miles Davis on *Four*, and Charlie Parker on *Now's the Time*. A knowledge of the original versions, though not essential to understanding, is a great help in appreciating their handiwork. Randy Weston contributes *Littles Niles*, and *Babe's Blues*. During Oscar Pettiford's bass solo on *Swingin' Till the Girls Come Home*, Hendricks finally runs out of words and adopts the exact timbres of the instrument in a startling exercise of vocal chords. Recorded while the group visited Hollywood, their accompanists are the Basie rhythm section, plus Jim Hall, Russ Freeman and Zoot Sims. Æ

AUDIOCLINIC

(*from page 4*)

position) with one of the positions blank. These switches create a pop in the loudspeaker when switched to the neutral positions. How can I eliminate this popping? J. H. Chaille, Brooklyn, N. Y.

A. Often this leakage results from capacitive coupling between switch contacts and between switch decks. It probably cannot be minimized by switching shields. There is an additional reason why switching shields is not recommended. Many grounds are "hot" with respect to their neighbors by virtue of the line-bypass capacitor incorporated in the unit. Switching these "hot" grounds could cause slight sparking which, in time, could corrode the switch contacts. Even more likely is the possibility that the sparking produced by switching the shields could be heard in the loudspeaker as additional popping to that which you have already encountered, (of which more will be said later). This is the reason preamplifiers use shorting decks to silence all inputs except that which is being fed at the time. It is also the reason broadcast engineers usually switch circuits in low-impedance lines; the capacitive reactance of the switch contacts is higher as compared to the circuit impedance. I suggest that you use low capacitance switches or that you confine one piece of equipment to each deck of a switch and have the decks placed as far apart on the shaft as possible. Switching can be accomplished by connecting decks in series. This will lower the capacitance. Insofar as is possible do all your switching by means of cathode followers; this will lower the impedance. If possible, reduce the levels of the signals which feed the switches. The telephone company does this in its circuits to prevent crosstalk between pairs in a cable.

Now to return to the popping. It results from an input grid being suddenly "unloaded" when the shorting switch to which you referred passes through neutral. To prevent this sudden unloading, place a 0.5-meg resistor between the neutral, unused contact of the switch and ground. The grid will then be loaded by the approximate impedance of the other two switch positions. You may have to juggle this resistance value somewhat, but the 0.5 megohm value is a good starting point. Æ

ATTENUATOR

(*from page 26*)

It might be well for anyone undertaking the design of an attenuator of this type to compute one or more of the resistors given with *Fig.* 3 in order to check the procedure.

Parabolic attenuators of this type which have been constructed and placed in service have proved to be operationally equal to well designed logarithmic attenuators. The differences appear to be purely academic. Æ

NEW PRODUCTS

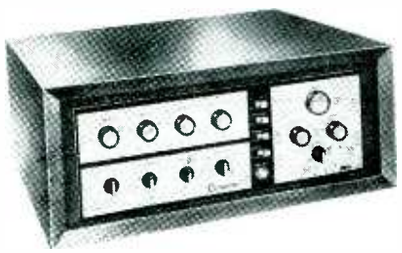
● **Stereo "Compentrol."** This is a stereo version of the popular Centralab Compentrol. It is designed to boost or reduce bass and treble frequencies automatically at various loudness levels in keeping with human hearing characteristics as interpreted by Fletcher-Munson curves. At full

output, the Compentrol operates with a flat response. The unit consists of two matched volume cnotrols, each with its own tone compensating circuit. Both controls are operated from the same shaft to assure equal compensation of the two stereo outputs. Two types are available for the replacement of 500k-ohm and 1-megohm volume controls. Centralab, 900 E. Keefe Ave., Milwaukee 1, Wis. **M-1**

Tiny Microphone. Aptly described as "Mighty Midge," this new microphone measures but 3-25/32 ins. in length. Formerly designated Model D-12, it combines light weight and miniaturized design with wide-range response and excellent sensitivity. A ruggedly-built dynamic element protects the unit against all normal hazards. Frequency response of the D-12 is

70 to 12,000 cps and impedance is 50 ohms (a similar high-impedance model is designated Model D-12T). Output level is −57 db. A plastic alloy diaphragm affords maximum protection against wind blast, temperature and pressure extremes and corrosive agents. A necktie clip and lavalier cord are standard equipment. For further information and literature write American Microphone Mfg. Co., 412 S. Wyman St., Rockford, Ill. **M-2**

Harmon-Kardon "Citation" Amplifier Kits. This new series of stereophonic instruments is of deluxe quality in every respect. Developed in line with the psychoacoustical fact that the characteristics

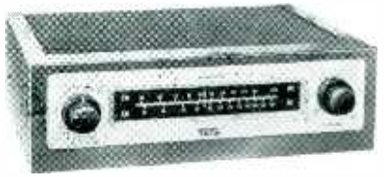


of an amplifier in the non-audible range strongly influence the quality of sound in the audible frequency range, the assembled Citation amplifier reproduces frequencies as low as 5.0 cps without phase shift, and is also able to deliver 100,000 cps without any type of instability. In the Citation II 120-watt (dual 60) basic amplifier, a multiple loop approach is used to increase the degree of feedback as the most logical method for lowering distortion without sacrificing stability. A unique silicon-rectifier voltage-doubler power supply assures stability necessary to support low-frequency response which cuts off below 2.0 cps. The Citation I preamplifier control center incorporates engineering techniques previously available only in professional equipment. Step-type tone controls are used. To facilitate home assembly, resistors and capacitors are filed individually on a special component card where they can be easily identified, and are mounted on a military-type phenolic terminal board when the unit is assembled. They are, therefore, rigidly located in the ideal position. A special template furnished with the Citation Kit enables the assembler to construct a professional-type cable harness, thus assuring proper lead dress and length for important wiring. The Citation kits, which can be assembled by an amateur with no previous experience, provide unique performance at a level available only in manufactured amplifiers which are far higher in price. For complete description and full technical specifications, write Harman-Kardon, Inc., 520 Main St., Westbury, N.Y. **M-3**

Stereo Analyzer. This is a new multipurpose instrument developed to provide the audio service man with all of the basic equipment necessary for service and test of high-fidelity music systems. Included in the Model 800 is an audio signal generator with ranges from 20 to 30,000 cps;

an a.c. vacuum-tube voltmeter with six scales from .01 to 300 volts rms full-scale deflection, and an audio wattmeter which measures .15 milliwatts to 150 watts full scale. Intermodulation and harmonic distortion measurements are made at 4, 8, 16 and 600 ohms with terminations rated at 32 watts. Db meter ranges are from −40 db to +52 db. Built-in switching provides complete flexibility. Winston Electronics, Division of Jetronic Industries, 4000 N.W. 28th St., Miami 42, Fla. **M-4**

Eico FM/AM Tuner Kit. Available in both kit and wired form, the new and economical EICO Model HFT92 combines on a single chassis the well-known HFT90 FM tuner with excellent AM tuning facilities. The unit provides monophonic FM

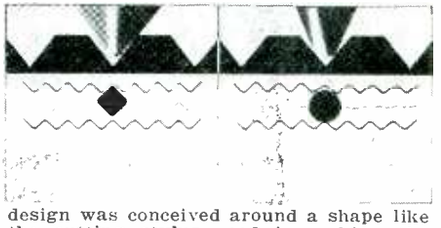


and AM reception and facility for FM-multiplex stereo reception. It is not a stereo FM/AM tuner since both types of reception cannot be obtained at the same time. The FM section includes an entirely pre-wired, pre-aligned "front end," housed and shielded in a solid aluminum-zinc casting. It is characterized by remarkable sensitivity (1.5 microvolts for 20 db quieting), complete stability, low-noise, and drift-free performance. No a.f.c. is used in the HFT92 because none is needed. All i.f. coils in both the FM and AM sections are supplied pre-aligned, eliminating any need for alignment instruments in building this tuner from the kit. Precision "Eye-Tronic" tuning is achieved for both the FM and AM sections with the pre-wired DM-70 traveling-eye indicator. The HFT92 also incorporates a stage of audio amplification and a cathode-follower output with low distortion and low impedance. A full-wave rectifier and heavy filtering provide a stable, dependable power supply. For full technical and price information, write Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N.Y. **M-5**

Ampex Stereo Tuner. Incorporating on a single chassis two entirely independent tuners, the Ampex Model 503 affords either AM or FM monophonic reception, or simultaneous reception of both AM and FM for stereo. Offering excellent selectivity and sensitivity, the tuner is designed throughout as a precision unit which provides optimum balance between the two parallel channels at all levels of operation. FM operation is drift-free, and

the FM section incorporates full automatic frequency control which may easily be switched in or out from the front panel. AM circuitry includes broad and sharp bandwidth positions. Engineering features include accurate visual tuning indicators, simple controls, and flywheel tuning mechanisms. The tuner also contains provisions for adaptation to FM/FM multiplex stereo reception. FM frequency response is 20 to 20,000 cps; AM response is 20 to 8500 cps. Total harmonic distortion is less than 0.5 per cent. Available uncased for built-ins, or with handsome hardwood cabinet for open or shelf mounting. Ampex Audio, Inc., 1020 Kifer Road, Sunnyvale, Calif. **M-6**

Pyramid-Point Stylus. Certain to create controversy among record and stylus manufacturers is the new "Pyramid-Point" diamond stylus recently introduced by Fidelitone, Inc., Chicago, Ill. Said by company officials to reduce sound distortion from records by as much as 85 per cent, the stylus tip has a pyramid shape with four sides instead of the conventional cone shape with a round point. The new



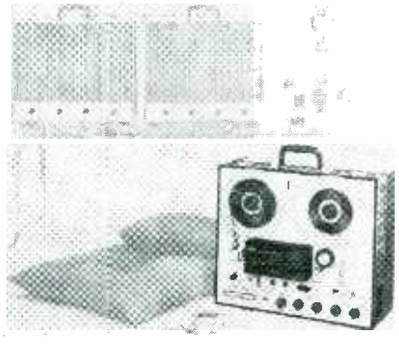
design was conceived around a shape like the cutting stylus used in making the sound impressions on all records. Other comments by Fidelitone engineers indicate that "phonograph needles shaped with hemispherical ball points cannot possibly fit into some of the wave shapes found on records." "A ball point stylus tends to ride up in the groove at the narrow points which are created by the tri-

angular shape of the cutting stylus. This is what is known as the 'pinch effect.' The Pyramid Point greatly reduces pinch effect because it is designed to fit all gyrations and surfaces." The illustration, drawn and supplied by Fidelitone for this item, shows graphically the purported difference in the two types of styli as they rest in a record groove. **M-7**

Home Recordist Tape. A new line of Scotch brand recording tape, attractively priced for home recordists, has recently been introduced by Minnesota Mining and Manufacturing Company, St. Paul, Minn. Called the Tartan Series, the new tape is available at retail dealers. Developed especially for home use, tapes in the new

series meet demands ranging from the wide frequency range and excellent tone quality required by the serious music lover, to the maximum versatility and simplicity required by those who simply want a quality tape that gives best results under the widest variety of recording situations. As with all Scotch brand magnetic tapes, the Tartan Series tapes have built-in silicone lubrication for protection against recording head wear. **M-8**

Concertone Stereo Recorder. Capable of virtually any tape recorder function, the Concertone 505 incorporates many features found only in machines costing as much as twice its modest price. Basically a stereo recorder-reproducer, the 505 can be used for monophonic half-track recording as well as for playback of both 2- and 4-track tapes. Also it is a sound-on-sound recorder due to use of a unique erase head and associated circuitry. Separate record



and playback heads permit instant monitoring of the taped signal. Among outstanding features of the 505 are push-button relay operation; three motors, including hysteresis drive; automatic cut-off switch; automatic tape lifter, and tape location indicator. The two operating speeds are 3.75 and 7.5 ips. Frequency response is 40 to 12,000 cps, ±3.0 db, at the latter speed, while flutter and wow content is less than 0.25 per cent. Start-stop time is 0.5 sec. Separate microphone and line inputs are provided for each channel. For additional information, write American Electronics, Inc., 1025 W. Seventh St., Los Angeles 17, Calif. **M-9**

TAPE GUIDE

(from page 38)

Other Qualities

Playing time, type of base material, output level, and print-through characteristics are far from a complete description of tape properties. Additional properties of importance to the user are:

1. *Uniformity of Magnetic Coating.* An uneven magnetic coating—in terms of thickness or distribution of magnetic particles—produces what is called modulation noise. When an audio signal is recorded on the tape, the amplitude of the signal varies in accordance with the irregularity of the coating. This variation is in effect a noise signal added to the

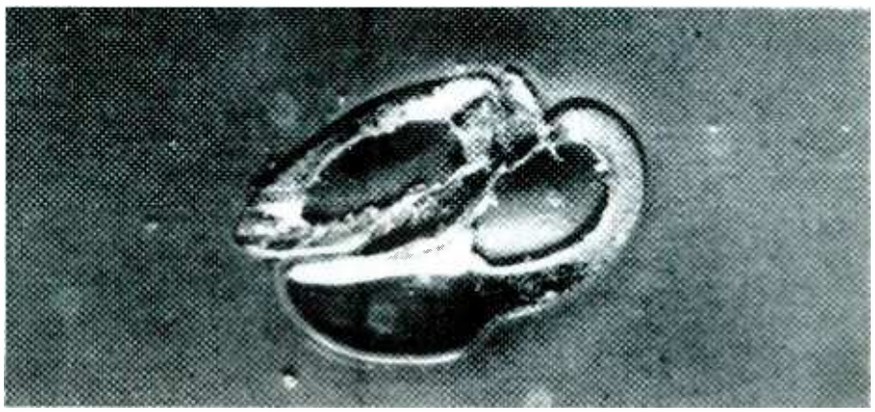


Fig. 8. Photomicrograph of an irregularity in the backing of magnetic tape. Minnesota Mining & Mfg. Co.

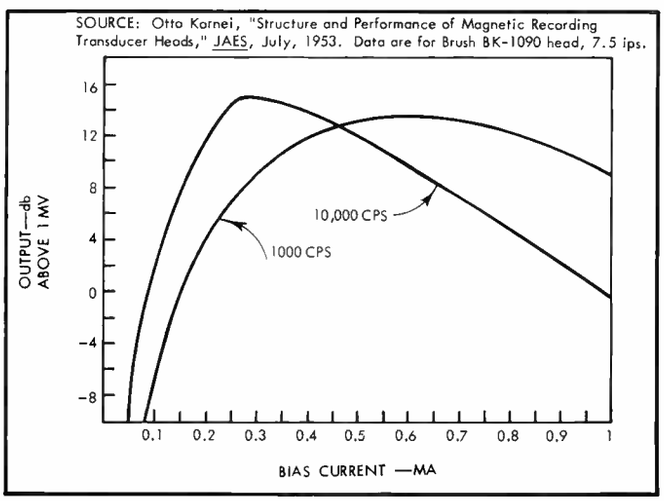


Fig. 9. Variation of output with bias current.

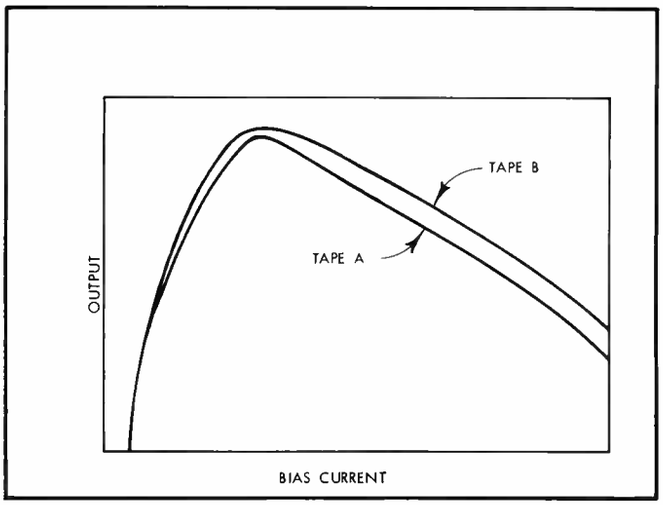


Fig. 10. Output vs. bias current for different tapes; 10,000 cps recorded at 7.5 cps.

audio signal. The louder the audio signal, the greater the modulation noise.

2. *Uniformity of Base Thickness.* If the base varies in thickness, the oxide deposited on the base tends to vary correspondingly, resulting in modulation noise.

3. *Absence of Foreign Materials.* Foreign matter impregnated in the tape coating causes the magnetic coating (tape oxide) to be separated from the head, resulting in signal attenuation (dropouts). *Figure* 7 portrays the nature of such tape flaws. The higher the frequency, the more severe is the dropout. *Figure* 8 shows an irregularity in the tape backing, which has similar consequences.

4. *Smoothness of the Magnetic Coating.* Tapes of good quality are polished and impregnated with a lubricant in order to minimize friction between the tape and the heads, guides, and so on. Excessive friction between the tape and the heads can produce audible squeal. Even though squeal is not heard, friction can cause excessively rapid head wear and a high order of flutter and frequency-modulation noise, evident as a grainy quality in the reproduced sound.

5. *Limpness.* The nature of the materials used in the coating and the base must be such as to impart a limp quality to the tape, permitting it to conform intimately to the contour of the heads and thereby maximize high-frequency response; as previously stated, treble response is severely reduced by extremely slight separation of the tape from the head.

6. *Good Frequency-Response Characteristics.* In part this refers to the output that can be obtained at high frequencies relative to low frequencies. It also refers to the variation of frequency response with bias current. At any given frequency, response rises at first with an increase in bias, but eventually falls as bias is further increased; this is shown in *Fig.* 9. The higher the frequency, the earlier and the sharper the drop in response with increasing bias, as may be seen in *Fig.* 9, which presents data for 1000 and 10,000 cps recorded at 7.5 ips. However, for some tapes the shape of the curve is not as sharp as for other tapes, as may be seen in *Fig.* 10, which compares the output *vs.* bias curve at 10,000 cps for two brands of tape. Curve B in *Fig.* 10 has a broader plateau; the significance of this is that the value of bias current becomes less critical. A slight departure from correct bias current—because of changes in line voltage, insufficient warmup time, aging of components, and so on—will have less effect upon output and frequency response in the case of curve B, which represents the tape with the broader plateau.

7. *Stability.* It is desirable that tape characteristics remain, as nearly as possible, the same within the reel and from reel to reel. Thus it is often important, as in professional recording for the purpose of making commercial tapes or phonograph records, that for a given signal level *applied* to the tape the amount of signal *recorded* on the tape remain virtually constant throughout the reel and from one reel to the next one. Similarly, it is desirable that the tape's frequency response, distortion, and noise characteristics remain as stable as possible.

The degree to which the above tape characteristics concern the recordist—whether it is worthwhile paying something extra for the very best in tapes—depends upon his standards of performance and upon the particular tape machine he is using. The higher his standards and/or the quality of the machine, the more apt one is to find a difference among brands or among grades of tape within the same brand.

The recordist whose requirements are critical should experiment with various brands of tape. Depending upon what factors are of particular importance to him, he may find that one brand suits his needs better than another. The brand best suited for one recordist may not necessarily be so for another. In the case of the less critical recordist, the differences among brands may be minor or completely non-apparent. Æ

ABOUT MUSIC

HAROLD LAWRENCE*

In Defense of Percussion

Long before U. S. marshals and private eyes dominated television program schedules, a comedian performed a skit involving an orchestral musician who was drafted as a last-minute replacement for not one, but *two* ill percussion players. The percussion section, for some unaccountable reason, was split into two parts, one on the left and the other on the right. The orchestra was deployed on a series of rising platforms, the last of which supported the brass and percussion. Because of the restrictions of space, there was only one way for the percussionist to reach his instruments at the other end of the orchestra, and that was down the terraced steps, across the stage in front of the conductor's podium, and up the other steps. As might have been expected the music on the program was heavily scored for percussion, with the result that the unfortunate player's excursions from one end of the stage to the other turned the concert into a potato race.

Although this satire of the percussionist was of the slapstick variety, it nevertheless pointed up an interesting fact about audience attitudes toward what Howard Hanson called, "the salt and pepper of the orchestra." It is no secret that the percussion section often comes close to monopolizing the public's attention even when its part is of secondary importance. Several factors are responsible for this unusual interest. First, located as it is on a riser above the other instruments, it has a visual advantage over the lowly scrapers or blowers. Second, the instruments at the disposal of the percussionist are all unique; he is not a member of a multitudinous group of strings or winds. This gives him the feeling of being an unofficial soloist. Third, in terms of carrying power, he has no trouble making himself heard above the orchestral texture, even when tapping the triangle *pianissimo*. Finally, the percussion is in the spotlight at the high point of most musical scores since composers generally call for percussion when they wish to underline an important motive or rhythm, or reinforce a tutti climax.

For the general public, there is a certain fascination in watching the percussion section go through its paces: the timpanist with his ear nearly touching the drum head as he speedily manipulates the tuning screws in preparation for a key change; the cymbal player stretching wide his arms as he waits for the cue to bring the metal plates together in a smashing impact; the triangle player delicately holding his tiny instrument aloft as he executes a silvery trill with an even tinier metal rod; the snare and bass drum producing a rattle and thud in quick succession; and myriad other effects slapped, jogged, rubbed, shuffled, shaken, jangled, pounded, brushed, blown, and coaxed from exotic-looking instruments ranging from the miniature antique cymbals to the huge bent rail used to produce the anvil's ring for the *Entry of the Gods into Valhalla*.

For all the notice it receives at concerts, the percussion is too often regarded as a mere noise-maker whose function is to punctuate rhythmic figures, strengthen tutti chords, and add color and atmosphere. Conductors, orchestral managers, and even the percussionist's own colleagues tend to think of him as a second-class citizen of the orchestra.

Roughly speaking, composers employ percussion either as a wholly decorative element, or as a legitimate instrumental choir on an equal footing with all other segments of the orchestra. Both approaches are valid, of course, although recognition of the full potential of the percussion seems to be given by a limited number of composer rather than by composers as a whole. 'Full potential,' however, does not mean volume alone; if anything, the tendency is to over-orchestrate for the percussion, to throw in everything including the kitchen sink. But, as Gardner Read observed in his *Thesaurus of Orchestral Devices* (Pitman Publishing Corp.), "The more restrained and sensitive employment of percussion instruments now at the composer's disposal . . . can quite immeasurably enhance the coloration and over-all effectiveness of a score." A stunning example of the subtle use of percussion in a modern orchestral work may be found in Hindemith's *Symphonic Metamorphosis on Themes by Weber*. The second movement, *Turandot* Scherzo, is based on a Chinese melody and is scored for an exotic battery of percussion instruments, all of which perform thematic as well as rhythmic and coloristic functions. Through a delicate handling of such instruments as the kettledrum, chimes, triangle, tom-tom, wood-block, small cymbal, and the small gong, Hindemith achieves a striking transparency that conjures up the senstive line drawings of classical Chinese artists.

Bartók was another composer who lavished affection and profound thought on the use of percussion. In his *Music for Strings, Percussion and Celesta,* he replaced conventional alignments of orchestral parts; the strings were split into two groups, and the percussion, including piano, celesta, xylophone, harp, tam tam, and cymbals, was placed in the center. Among the imaginative effects he employed were pedal glissandi on the kettledrums, a technique he also used in his Violin Concerto and Concerto for Orchestra.

Over the years, such composers as Villa-Lobos, Prokofiev, Cowell, Stravinsky, and Honegger have given the percussion an increasingly important role in the orchestral realm. It is an unfortunate fact that the performing musician still lags behind these technical advances. As any conscientious percussion player will tell you, performance standards in his field hardly approach those of other instrumental families. In this respect, the European musical scene is a great deal more percussion-poor than its American counterpart. A flagrant example of the sublime indifference with which some European orchestral managers regard the percussionist involves a timpani player in a central European musical organization. While on tour, the timpanist discovered that two of his drum heads were defective. When he asked the manager to obtain replacements, the latter informed the player that he would have to struggle along without them for the rest of the tour; after all, only a few notes would be missed here and there, and with rapid tuning, perhaps the timpanist might succeed in hitting most of them anyway.

Incredible as it may seem, this incident actually took place less than two years ago. Fortunately, such colossal stupidity is hardly typical of orchestral managers anywhere else. However, the condescending attitude prevailing toward the percussion group creates equally harmful effects on the standards of orchestral playing in the final analysis. Weak percussion is a characteristic of too many orchestras today. For this, music educators who refuse to grant the percussion its deserved place in the curriculum are as much to blame as conductors who assign percussionists' posts without subjecting the candidates to the same rigorous tests devised for violinists or horn players. Æ

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RECORD REVUE

(*from page 75*)

Brahms: Piano Concerto #2. Richter-Haaser; Berlin Philharmonic, Von Karajan. **Angel S 35796 stereo**

First-off, there is an interesting point here concerning stereo sound. The solo piano is here miked at stage-distance—i.e. it is apparently picked up by the same over-all mikes that do the job on the orchestra. (If there was a solo mike, it surely was cracked open barely enough to register at all.)

Now it is significant, I think, that *in direct stereo listening* this arrangement is convincing and good; but if you will listen to the record *from another room*, around a corner, you will find that the piano then seems unfocussed, 'off-mike." This is exactly as it should be in a well-considered stereo solo job.

The original intention of close-up solo miking was to compensate, via sharper highs, louder volume, more detail, for the monophonic lack of definition, as compared to the live-concert situation—in which two ears, two eyes and the presence of the soloist in person combine to give drama to his playing even at some hundreds of feet distance. Habit and custom have now made the close-up soloist an accepted convention on records; the habit has carried over into stereo recording. It's the expected thing.

However, each new increment of realism in sound-reproduction reduces the necessity for compensation, for exaggerated, close-up miking of all music. Ideally, we could, indeed, move out to "the best seat in the concert hall" with our mike stands, if we could achieve ideal and literally exact reproduction acoustics.

Stereo miking can get away with less close-up accentuation than mono, and for this very reason. Yes—you can use all sorts of special effects. But *if* you move your mikes back a bit on the solo, reduce his volume nearer to the literal balance, you can still get good results, where a mono pickup at the same point would be on the edge of the off-mike area, unfocussed, ineffective, too distant. Not much difference, but it is there.

This Brahms Concerto perhaps was miked via the M-S set-up. In any case, stand directly in front of your speakers and the pianist is real enough, right on the stage and fully effective. Walk away and around a couple of corners and then listen awhile—he's too distant, not loud enough, slightly off-mike. (Note that much solo-and-orchestra stereo is still done with maximum close-up exaggeration of the solo—too much. The wise engineers are moving away, back a bit.)

Now—the music. The New York critics didn't too much like Richter-Haaser at his debut, say that he was too loud, took liberties with some passages, made finger mistakes and impatiently rushed by them as if they were mere annoyances.

Well, I was there, at his "live" concert, and I was thrilled—with only minor reservations, on these same lines. Matter of emphasis. Give me any day a splendid musical mind that makes a few mistakes but gets over the big picture—as well as the shape of the details—better that, any day, than the more typical pianist who gets all the notes right but doesn't really know what the music can say.

Yes, Richter-Haaser likes to play Brahms as some sort of titan; he thunders no end. It is an aspect of Brahms that isn't often heard to full effect and as such it's novel—but I do feel an impatience here, an overthunderous nervousness, that contrasts with the smooth power-punch of old pros like, say, Rubinstein or Horowitz. Those boys make no mistakes; their show is 100 per cent perfect.

And the famed Berlin Philharmonic seems to be curiously uneven here. The strings sound sloppy, as though not well rehearsed. The details are minutely messy—they shouldn't be.

Just the same—Richter-Haaser is a big There's a curiously diffuse sound to it all. I can't explain it, but *I* can't avoid it either. musician and an impressive pianist. We'll hear more from him, especially his fabulous Beethoven.

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AUDIO ETC

(*from page 58*)

along with the wide-range highs. And so I recommend these Weathers midgets for your inspection as standard-type auxiliary stereo aids.

The TrioPhonic system, however, also includes a woofer, designed to produce only the very bottom and to be stuck behind or under something out of the way. The speaker is unusual in two respects, one being itself and the other the method of providing its signal.

The Hideaway woofer itself is flat, in a low, plain black box with larger overlapping top half that leaves a four-sided slot at the bottom for the emerging sound. The speaker, I can say definitely, is very low in efficiency, taking more wallop by a good deal than the AR-type woofer with which I compared it.

The Weathers system, as above-mentioned, makes use of a small matrix arrangement that feeds from the 16-ohm speaker taps of the two main amplifiers and combines the bass end (removing the highs) for re-feeding in A+B to a third power amplifier. I am not up to investigating this tricky circuitry nor can I comment on its electrical properties, but I do feel, somehow, that this is a relatively complicated way to go about getting a good center signal. Weathers has improved its idea by designing its own bass amplifier, a small transistor unit, to follow the summing circuit and feed the woofer. Good idea. I just used whatever I had around, and found the connecting-up rather a chore.

We tried the system out with on AR-2 woofer section (the tweeter disconnected) and the results were interesting. No question about it, the "One-Woof" principle works. Standing off at a proper listening distance, I found that the bass was definitely present, definitely blended with the highs from the book-speakers, and definitely not directional. The AR could be put over on its back facing up, for an equally good blend of bass and treble.

I did find, though, that if the center woofer were moved forward too close to the listening spot, *or* if I jacked up the volume on the center speaker too high, things began to go wrong with the stereo illusion. The low bass is misleadingly faint to the ear and your first impulse is to turn it up much too far. Rightly balanced, it is scarcely audible by itself.

The complete TrioPhonic system was working overtime at last fall's Hi Fi Show and I must say it seemed to do a convincing job, on display there. The woofer in that show installation was on its side, rather than flat down on the floor. Maybe that lead weight works best sidewise.

FISHER STEREO

Two essential units in my home-style radio program set-up—along with my standard Ampex 350—are items of incongruous home hi-fi equipment that have no business being there, so to speak, because they aren't supposed to be professional. But the temporary "emergencies" that led to my plugging them into my circuit have now been extended into semi-permanency, since I really couldn't find a good reason for taking the units out again. Both are Fisher units. One is the original Master Audio Control, the 80-C; it is my equalizer, for tailoring old and erratic tapes to present standards. The other supplies another useful link, a variable cut-off filter, top and bottom: the Fisher Hi-Lo. It removes rumble and the like from the bottom up and is extremely useful in cutting down noise and distortion from the top downwards in the old 78 records I still occasionally broadcast. (I also can fuss with their "curves" via the Master Audio Control's tone controls.) The little Hi-Lo unit was altered in only one important respect—we took out the main guts in its low-end filter and now they dangle safely out of hum's way, on the end of an extension cable, for virtual silence in respect to induced noise.

I mention these simply as a prelude to stating that my latest batch of Fisher material, as of 'way back last June, shows every sign of being the same sort of orderly, good-looking, intelligently patterned and reliable equipment. Let me tell you, the ultimate test in my home endurance race is staying-power. Any piece of hi-fi that I'm still using regularly after three or four years is good.

Stereo is here, now, and so I have the enlarged (but still compact) Fisher 400-C Stereophonic Master Audio Control (the lineal descendant of the 80-C) plus the SA-300 basic stereo amplifier, the big fellow in the line (30-30 watts). The 400-CA, newer master control, is modified only in that it offers provision for separate tone control of each channel—which I do not need—plus some new facilities for remote control.

Well—Fisher is expecting soon to take back the Master Audio Control, et al, since I have the stuff on memo; but they're going to have a tough time getting it from me. I'm going to stall. With all due respect to many another excellent product (and I can't try 'em all) I can only state for the record that I continue to find Fisher's equipment reliable, easy to use, unusually good looking and good feeling; in fact the only immediate complaint I can dig up is petty—the little green signal lights on the pushbuttons on my units have blown, but this has been fixed on later production.

Basic Amplifier

The stereo amplifier, SA-300, really needs no detailed accounting here. It just sits and works. No hum whatsoever—neither electical nor mechanical (from the transformers). Neat brushed-gold cage, a sensible, legible, simple arrangement of inputs and outputs with a handy level-set for each of the former. There's a special output with filter, to match electrostatic speakers to their woofers—an excellent way of being sure and definite, over and above the tone controls, as to a proper hook-up for this tricky type of tweeter. The output balance-adjusting facilities are set up so that accidental confusion is unlikely; d.c. and hum balances for each channel are out of the way, under removable caps on the front panel. No more to be said except, again, the thing works and keeps working. I can't make a higher recommendation—and every day this report is delayed makes it better.

Master Control

The 400-C Master Audio Control is basically like the original 80-C in outward set-up, but stereo has dictated important functional changes. There is considerable simplification in non-essentials—only four pushbuttons, two auxiliary inputs, one with and one without level-set, where the old model had legions of level-sets right on the front panel. OK by me—there's plenty of versatility left, and more room for the fingers. Two other switch positions—all of them dual, of course—cover phono-mike-tape and a tuner, one being "high-level" and the others involving the pair of pre-amplifiers.

Six neatly spaced knobs with thin gold bands at the edges take care of main functions, including tone. The left switch gives you two RIAA inputs (both via the "phono" pushbutton) plus an "LP" equalization, presumably for old-type high-rise LP curves, and a 78 position—these being more or less standard. Next in line are the outwardly standard balance control and two tone controls, with "flat" at the center position. (It was 11 years ago, wasn't it, that I was taking much space in AUDIO recommending this then-novel arrangement as desirable?) Volume and on-off come next, with loudness contour on a lever just above, and at the right end is the mode selector.

It's really gratifying, I should remark at this point, to see how quickly these basic stereo controls have settled down to more or less a standard outward format. It took many years longer for the equivalent in mono controls to reach a form as recognizeable, say, as the controls of the pre-automatic automobile. This is all to the good, as far as a widening market for stereo is concerned, for the biggest "occupational hazard" in stereo component selling is complexity.

Honestly (I say to my friends), the most recent crop of stereo control paneling displays hardly anything more complicated than the old mono controls—indeed, many are simpler. (For one thing, we no longer have 792½ phono equalization positions).

Take courage! Stereo isn't really so complex, once common sense and ingenuity get to work on the problem.

Well-Bred Moderation

It is in the details of the Fisher control unit that I find a few things to bring to your notice. Take 'em right to left. I haven't mentioned the left vertical lever switch (aesthetically matching the loudness lever on the right), which is none other than the "lo" half of my old friend, the Fisher Hi-Lo, a rumble filter from the bottom up at 20 (none), 50 and 100 cps cut-off, values that I feel are well chosen for practical use.

I like, too, the balance control (second knob from the left) which has values similar to those in the two tone controls involving a sort of well-bred moderation, with a relatively expanded "scale." This balance conrtol doesn't fade one channel entirely out at each end, but merely reduces it, building up the other, in a wide, slow taper. Good and sensible. Why go to extremes when the proper function of a balance control is to adjust, to modify? The wildest imaginable degree of unbalance isn't likely to be anywhere near the one-channel all-out vanishing point! Your balance control will never succeed in forcing a 90 per cent week-kneed channel to match an 85 per cent overloaded partner; so why bother. The best balance control merely goes a little way, with a lot of knob-turn for free, flexible, easy operation and precise settings for exact future reference. That's Fisher—and probably other reputable makes too, though definitely not all.

Similarly, the Fisher tone controls have always struck me as admirably effective. I haven't even considered circuitry—I just use 'em. But again, they are noticeably moderate in extent, the extreme positions being well within a really usable, low-distortion range. Well-designed controls should always be that way, but I've tried many a hi-fi tone control with such exaggerated boost and rolloff that I hardly dared use more than a few degrees of knob-turn for fear of violent distortion.

It is this very feature, back in the old 80-C control unit, that allows me to use it for tape equalization in the copying. At the extreme high-end rolloff position, the old Fisher neatly equalizes an unintentional high boost that somehow managed to get into a large batch of my older Magnecorder tapes, in an effort we once made to match them to the then-different Ampex playback curve for broadcast. On the air, these tapes squealed unmercifully and I winced, but could do nothing. (Eventually I bought an Ampex and that was that.) Now, after a run through this elderly home control unit and subsequent copying on the Ampex, the old tapes come out virtually flat and remarkably free from distortion. Only an occasional overblown *sss* sibilant indicates what was once that unwanted boost in the top highs—and so I have modernized and saved for further use some hundreds of hours of the hardest work I ever did on tape. You can understand why I appreciate the simple virtues of a well-designed audio control unit.

Words of One Letter

One final point. The right end of the Fisher stereo control is the more or less standard mode selector knob, with stereo, reverse stereo, channel A, channel B, and so on. But one unusual item on this Fisher knob had me quite bemused. Two positions are marked with admirably cockeyed mathemetical logic, "A + B" and "B + A."

Now that hit me at once as the acme of nonsense, for didn't we all learn in grade-school geometry or something, that when A equals B, then B equals A, AB is the same as BA, A added to B is the counterpart of B added to A. . . . What? Was Avery Fisher defying the axioms of mathematical self-evidency?

Well, I set out (without, of course, looking in the instruction book) to find what in heck those two positions might signify.

The intent is useful, if anticlimactic. All that happens is that one position feeds input A into both amplfiers, the other feeds input B into the same. Thus my FM radio zoomed out through both speakers on one position but there was silence on the other —no signal from that input.

It's a matter of nomenclature. After all, how are you going to say I love you in less

than three words, not counting shorthand and Latin (te amo)? "Mmmmm!" maybe?

Short of something like "CHANNEL A INPUT INTO BOTH AMPLIFIERS, I suppose "A + B" is as good as anything, though it still says nothing at all to me, next to "B + A." Just another example of an increasingly familiar problem often mentioned hereabouts—how to label complex audio functions in words of one letter, or maybe two.

AR-3

Whoops—I planned to talk about the AR-3 and I haven't left myself room. Everybody's had his say on that Acoustic Research speaker but me, and I've had a pair of them on hand since last June, thanks to the kindness of the company.

Well, I've said reams about AR in the past, having been one of the very earliest AR enthusiasts. There really isn't much left for me to write now and, anyway, I'm scared to open my mouth; somebody might think I'm prejudiced, or hired by a Consumer Organization or something.

I'll only state then, that I have been using the two AR-3 units since last June for most of my listening and intend to continue using them indefinitely. That's for the record and it's enough. Also for the record, I might add that I am still using my pair of KLH Six speakers, which I've had for almost two years, I guess.

If I think of anything else to say, I'll wait until there's more space. Nope—I haven't tried *three* AR-3s yet and don't intend to. See above! *Æ*

SMALL SPEAKERS

(*from page 23*)

is with larger single speakers.

Efficiency

Another interesting situation is the matter of efficiency. Efficiency is a term used loosely in audio to describe the amount of power required to drive a loudspeaker to any given output. As a general rule,, the lighter the voice coil. the more efficient is the speaker. Also this efficiency depends on how well the speaker is coupled to the air, as in horn or bass-reflex systems. Since our system is coupled to the air by the movement of 32 cones moving in unison we can expect a high degree of efficiency. Further. the voice coils and cones of each speaker are very light in weight. Most high-quality speakers are generally about 10 per cent efficient. Some systems claim as high as 30 per cent. Others are down to only 1 per cent. If we calculate what this means in terms of power necessary to obtain any given output, we arrive at some rather interesting figures.

The symphony orchestra has an average loudness level of about 100 db. To reproduce this level of loudness in a room of about 2000 cu. ft. requires amplifier power output of approximately one watt into a speaker only 1 per cent efficient. However, if the speaker is 30 per cent efficient, we need only about .08 watts of amplifier power for 100 db of loudness

level. These figures represent an average room with the average amount of carpets, draperies, glass, and so on. The higher the sound absorption power of the room the higher the amount of power required to achieve a given amount of loudness. Of course, instantaneous peaks of music may increase the power required by a factor of four or more. The average speaker system which is about 10 per cent efficient will require amplifier power of about 0.5 watt for the same loudness level. Again this is average power. When we increase this by a factor of four to obtain the peak power necessary we find that the 10 per cent efficient speaker now requires about 2 watts. The 1-per-cent system requires 4 watts of power and the system which was 30-per-cent efficient only requires 0.32 watts.

The 32 speakers mounted in our cabinet, which we will describe later, had an efficiency of about 15 per cent. Most important, however, was the amazing efficiency below 100 cps. We know that lots of air must be moved before we can hear these desirable low frequencies. Even though each speaker by itself is moving only a fraction of air mass, the total air mass moved by all 32 six-inch speakers is quite impressive. A rough idea of how much air we are moving might be obtained by calculating the piston surface of the whole moving system. The diameter of a six-inch speaker is about 5¾ inches. The area of a circle is found by the formula $A = \pi r^2$, so $A = 3.14 \times 8.21$ or 25.87 square inches. Multiply this by the number of speakers and you get a total of 827.84 inches or about 5¾ square feet. The radius of a fifteen-inch speaker is about 7¼ inches. So the area would then be 162.6 square inches for a single 15 in. speaker. It would take five 15 in. speakers to equal the piston area of our thirty-two six-inch speakers.

It is important to remember that all the speakers must be working in phase. Figure 2 shows how each speaker is marked for polarity. If all the speakers are from one manufacturer then the terminals on the speakers will be easy to mark plus or minus. However, if you have a mixture of manufactures, it will be necessary to test the speakers to determine the polarity of the terminals for marking purposes. This can be accomplished by taking a flashlight battery and applying the voltage across the speaker terminals. If the cone moves away from the magnet, mark the speaker terminal which is connected to the positive battery electrode with a postive sign. If the cone moves in towards the magnet, mark the terminal with a negative sign. When you have all your speakers marked in this manner then it will be easy to wire the system as shown in the diagram.

Performance

At the beginning of this article we made some statements concerning performance specifications necessary to qualify our system as high fidelity. The distortion of our system is easily within the 5-per-cent requirement. As shown in *Fig.* 3, the frequency response turns out to be down only 1½ db at 20 cps and down only about 1 db at 10 cps. The higher frequencies are good out to about 17,000 cps but down about 22 db. At 15,000 cps we are down about 17 db. High frequency drop off begins at about 11 kc. So our frequency response curve does not look as good as we would like it to be. The transient response of the system at all frequencies is superb. This is something which has to be heard to be appreciated. The speaker resonance is not even measurable. This is due to the extreme small movement of the cone. The cone excursions are so fractional that we do not encounter the outer rim suspension limitations. Speaker resonance is only a problem when you operate the speaker at a level which approximates the design level. Since we are operating these speakers at a fraction of the design level we do not find the cone resonance of the system an objectionable factor.

Since we have coupled to the air in the room a very large air movement, we are not concerned with elaborate cabinet design. The only limitation on cabinet design is to eliminate to as great a degree as possible the rear wave of the speaker. If the rear wave of the system is allowed to leak through to the front wave of the system, you will have bass cancellation at certain or all frequencies, depending on the length of return path. If the cabinet is completely enclosed on all sides and the inside packed with sound absorbant material, you will not experience this difficulty. The cabinet may be very shallow from front to back if so desired, as shown in *Fig.* 4. Since the six inch speaker is shallow in depth it is possible to have a cabinet only about six inches deep. However, the width and height will depend on how you arrange the speakers on the front mounting panel. Too many holes too close together may weaken the mounting board. Considerable vibration is encountered when reproducing 10 cycles tones at high volume levels. It is a good idea to brace the front of the cabinet as much as possible. Also the back of the cabinet should be rigid. Cabinet reasonances and standing waves behind the speakers should be avoided.

If a tweeter is not used to bring up the high frequency response of the system, it will be possible to assemble this remarkable performer for less than one hundred dollars. The system could be split into two systems of sixteen speakers each for stereo. Æ

STEREO RECORDING TECHNIQUES

(*from page 46*)

V. MISCELLANEOUS

(1) *Carillon Bells at Niagara Falls, Ontario, Canada.* 55 bells of all sizes up to ten tons are hung in the top three stories of a nine-floor tower overlooking the cascading waters of the Niagara. Carillon recitals are heard twice daily between Easter and Labor day, but to minimize traffic sounds a special mid-winter recital was arranged.

The bells are arrayed over almost 40 ft. of vertical space, so it seemed more practical to re-orient the listener "sideways" than to suspend microphones in a horizontal plane outside of the tower. This seemed a safe deception because few persons have heard carillon music from the interior of a tower.

The playing cabin was in the center of the bell cluster at the eighth floor level. From this level one microphone was pointed upward from a corner toward the small bells and, in the diagonally opposite corner, the other microphone was directed downward to pickup the larger bells. The tower was 15-ft. square, the mikes about 20 ft. apart.

The roar of the Falls punctuated the time between selections, and "voice over" was added later to these portions to identify selections and explain the carillon using the noise as an authentic background.

A few months afterwards the 47-year old carillonneur, Dr. Robert B. Kleinschmidt passed away. A memorial radio program featured a mono copy of this, his last recording.

Summary

The foregoing examples are intended to share with the reader some of the writer's recording experiences. Formulas described here must not be considered infallable, however, because local conditions may render some of these ideas unworkable and/or require other techniques.

Personal experience is often the best teacher and most recordists will credit their own experience as a large factor. Happily, tape allows us to "keep the best—erase the rest." Try as many experimental recordings as you feel necessary, making no promises as to outcome. Do not be pressured into any commitments for delivery of material for future use. Make as many "test" recordings as possible before each session.

Listen, as you record, on "monitor" position (from the tape) if your recorder embodies this feature. Results may be audited best on speakers in an adjacent room if this is possible. Otherwise use a high-quality stereo headphone set with comfortable and tight ear cushions. The one-fifth second delay heard in most cases on "monitor" will be an aid if you are within earshot of the "live" music because it permits recognition of

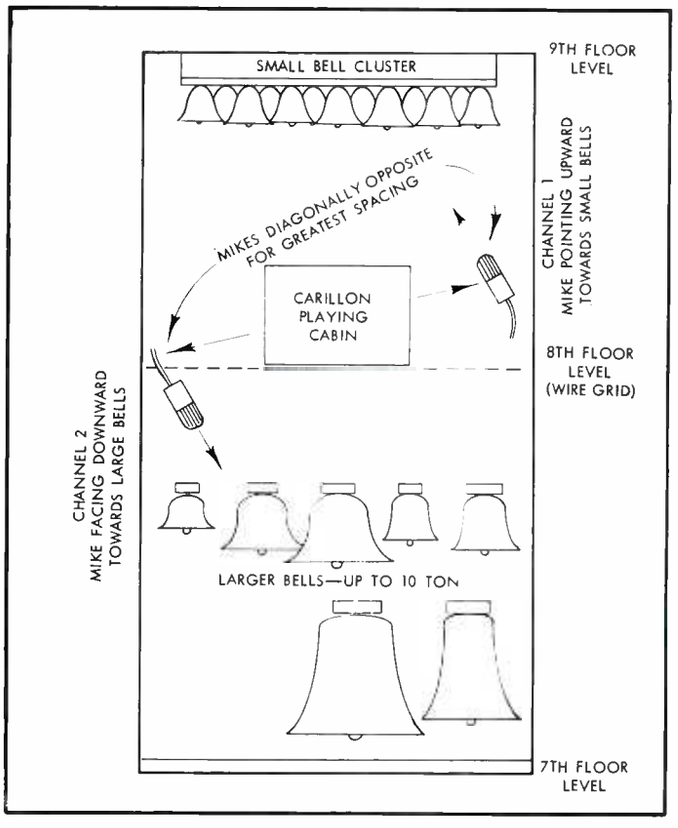


Fig. 9. Elevation, carillon tower with stereo microphone placement and direction.

good or bad attributes in the recording.

Ask the conductor and any available musicians to evaluate an immediate playback—preferably with speakers placed as close as possible to the mikes and with the same spacing in any case. If this is not convenient use one or more sets of good stereo headphones (like mono phones except that each ear is connected separately to the output of its own—right or left—channel). Musicians are invariably quick to recognize defects in musical reproduction.

Take things in slow, easy steps. Few experienced recordists can dash in to an involved job, set up in minutes and capture a truly realistic stereo likeness that will be "a thing of beauty and a joy forever." Spend time to learn and understand the fundamentals and to discover any mistakes you may make.

Getting your feet wet may take a little courage. But don't hesitate to get into the swim. You'll enjoy it and your pride in the ultimate results will be immeasurable.

Acknowledgements

The author gratefully acknowledges the assistance and courtesies of the following persons, each of whom was connected with one or more of the stereo recording projects outlined:

Amherst Symphony President Victor Einach; Buffalo Philharmonic Associate Conductor Joseph Wincenc; Violinist Rivka Mandelkern.

School principals James Mancuso and Rebecca Shepard; Professors Irving F. Cheyette and the late Robert B. Kleinschmidt of the University of Buffalo. Mrs. Sachiko Hashimoto, Tokyo Chapter, International Red Cross.

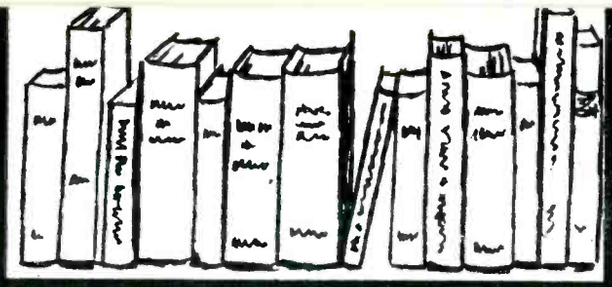
Organists Hans Viegeland, Edward Bebko, Jane Davidson, and Vic D'Ana.

Fellow stereo-enthusiasts Frank Fosbury (*Human Relations for Industry*), Alfred A. Greenberg (*Audio-Visual Aids*), Harry Radloff (*Sylvania Labs*) and designer Richard H. Dorf (*Schober Organ Corp.*). Æ

TAPE CONTROL

(*from page 30*)

Briefly, the operation of the controls is as follows. The first control has six positions which provide for: reverse two-channel record, normal two-channel record, record of input #1 to both channels, record of input #2 to both channels, record of input #1 on Channel 1 and simultaneous record of Channel 1 on Channel 2, and last, record of input #2 on Channel 2 and simultaneous record of Channel 2 on Channel 1. The last two operations, along with the two input mixers of the record amplifiers, makes it possible to record sound on sound. For hints on sound on sound



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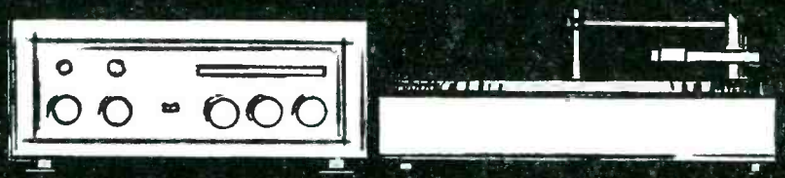

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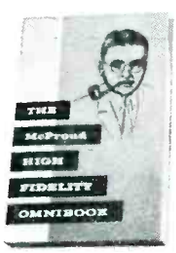

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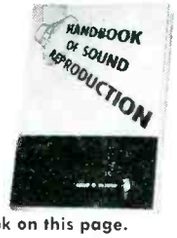

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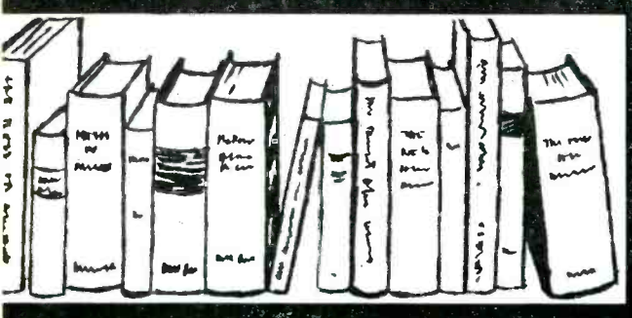

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recording see J. E. Freda, AUDIO, December 1957, p. 19. The second control selects the playback mode of operation for the two main speaker channels. There are five positions which select reverse channel playback, normal channel playback, third or mixed channel playback to both speakers, Channel 1 to both speakers and Channel 2 to both speakers.

The third control selects the monitor mode for binaural earphones. This control is almost essential for stereophonic recording. It allows one to hear the full stereo channels in either normal or reversed perspective. Switching back and forth between these two arrangements helps one evaluate microphone placement quickly. In addition, one can listen to either channel in both phones and thus essentially hear from one microphone position in an optimum way. Finally, over-all balance can be checked by listening to the mixed channels in both phones. This gives one a good idea about the way a monophonic dubbing of the tape will sound. The ease of operation and speed of operation which this control alone affords should not be underestimated.

There is a gain control for the third-channel speaker and a dual control for the monitor channel.

Circuitry

Looking at the electronic part of the schematic, we see a mixer stage in which the two stereo channels are added together. The first stage of the mixer is a high-gain triode amplifier. Each channel feeds to the input grid through a resistor, as does the feedback. The feedback is returned via the cathode-follower output section. This mixing amplifier effectively isolates the channels and thus prevents channel interaction. The operation of the mixer may be described approximately as follows. If the gain of the first stage is high, the input grid is a virtual ground. The currents at this grid node must add to zero and are thus given by $E_1/R_1 + E_2/R_2 + E_3/R_3 = 0$. Then, if $R_1 = R_2 = R_3$ we have $E_1 + E_2 = E_3$ which corresponds to an addition and phase inversion of the signals. The ratio of the two channels and over-all gain may be controlled by adjusting the values of R_1, R_2, and R_3. The most useful arrangement is to have the gain equal to unity and the two channels mixed equally. The cathode follower output of the mixer serves to isolate the remainder of the control system and prevents switch clicks from interfering with the recording or playback while using the monitoring channels.

The headphone amplifiers are simply a pair of cathode followers used to isolate and drive the low-impedance headphones. A dual-concentric control is

used to control the gain. The two shafts were cemented together and a single knob attached. The cathode follower is necessary to prevent reaction on the playback channel to the main speaker system or to a remote location while monitoring.

The third-channel line amplifier isolates the mixer from the line. A very low impedance output is obtained from an amplifier and cathode follower combination. Unity feedback is used to obtain unity gain. A gain control is provided in case the third channel amplifier does not have such a control.

The amplifiers are carefully designed for low distortion and long term reliability. The switching operations are arranged for minimum complexity and freedom from switching transients. It is suggested that the recording enthusiast will find the control center described above a very useful luxury. Æ

FM MULTIPLEX ADAPTOR

(*from page 56*)

R_{12}, R_{13}	250 k ohms, potentiometer, audio taper
R_{14}	1 megohm, ½ watt
R_{16}, R_{17}, R_{23}	10 k ohms, ½ watt
R_{18}, R_{19}, R_{20}, R_{24}	120 k ohms, ½ watt
R_{22}	15 k ohms, ½ watt
R_{26}	47 k ohms, ½ watt
R_{29}	4700 ohms, 1 watt
S_1	DPDT slide switch
SR_1	50-ma 130-v selenium rectifier
T_1	455-kc full-wave detector transformer, Miller 512-C3 or equivalent
T_2, T_3, T_4, T_5	455-kc 4-terminal interstage K-Transformer
T_6	Power transformer, 125 v at 50 ma and 6.3 v at 1.5 A. Stancor PA-8421 or equivalent
V_1	12AT7 tube
V_2, V_3	6AU6 tube
V_4	6CG7 tube

Æ

GRID DISSIPATION

(*from page 24*)

The screen grid dissipation P may then be determined by substitution of the values for E, I, e, and i in Eq. (1), or directly from the following equation:

$$P = E\,I - \frac{N_s}{2\,N_p}\sqrt{R_L\,P_o}\quad\sqrt{I_t^2 - I^2}$$

It is essential that M_2 and M_3 be calibrated accurately against each other (in a series circuit) because any differences in their indications will be magnified by the squaring operation in Eq. (3).

The method described can be used to determine the screen-grid dissipation of any beam power tube or power pentode in a screen-grid grid No. 2 feedback circuit. Æ

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EQUIPMENT PROFILE

(*from page 66*)

chose a particularly suitable unit since the instructions are extremely clear, the diagrams eminently readable, and most parts easily recognizable, even to us tyros. The only snag was that, in a few instances, the instructions indicated wire lengths which were hardly long enough for us, in our inexperience, to place as indicated in the diagrams. However, the kit is comparatively easy to build."

Inexperienced or not, the fact remains that the preamp worked from the first time it was turned on—after resoldering a couple of insecure connections. Furthermore, it came up to the published specifications. Signals of 1 mv on phono and microphone and of 0.5 mv on the tape-head inputs will give a 2-volt output, and distortion measured less than 0.2 per cent at 5 volts out, less than 0.1 per cent at 3 volts. The tone control ranges are approximately 15 db boost and cut at 50 and 10,000 cps, and tracking was within ±4 db throughout the range. Volume control tracking varied no more than 3 db down to 40 db of attenuation, and between 40 and 60 db loss the variation increased to 7 db. Signal-to-noise ratio measured 63 db on phono and microphone inputs with controls set for a 10-mv input and a 2-volt output; on the tape-head input it measured 54 db, and on the high-level positions, with controls set for a 0.5-volt input and a 2-volt output the figure was 76 db. M-30

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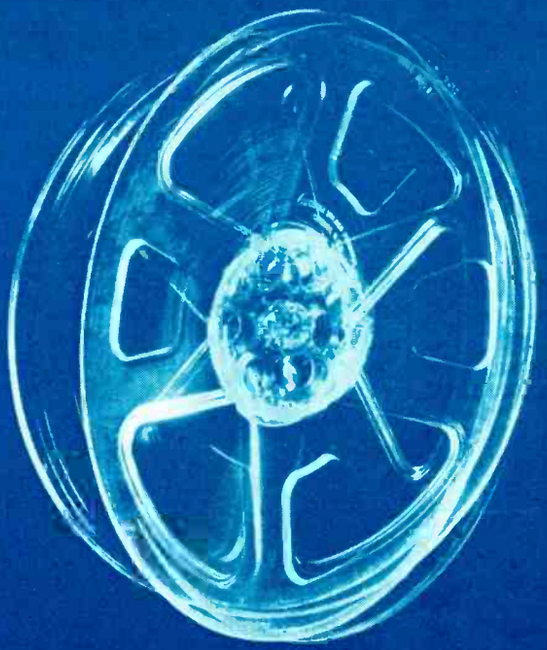

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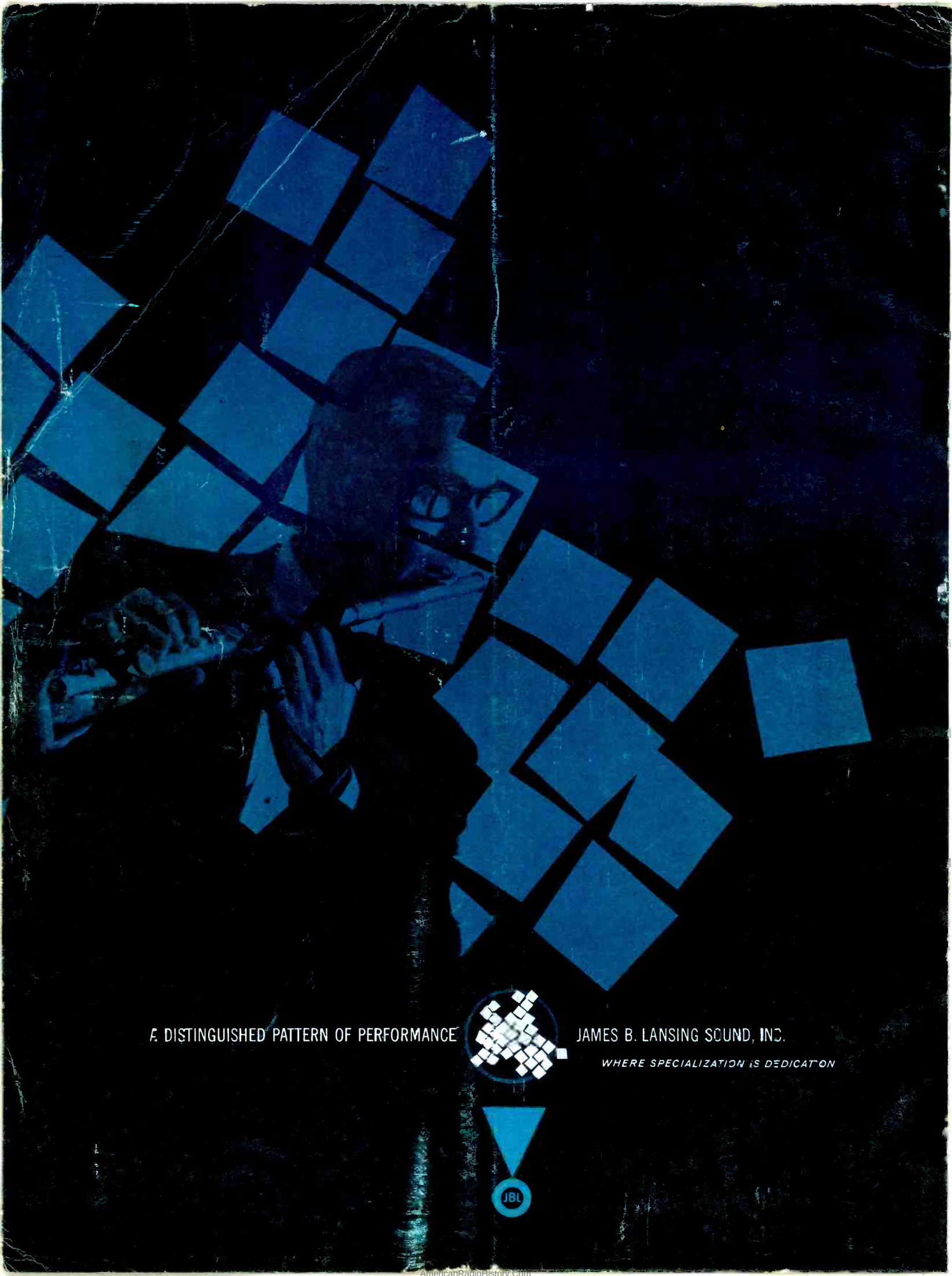

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