# AUDIO

APRIL, 1959
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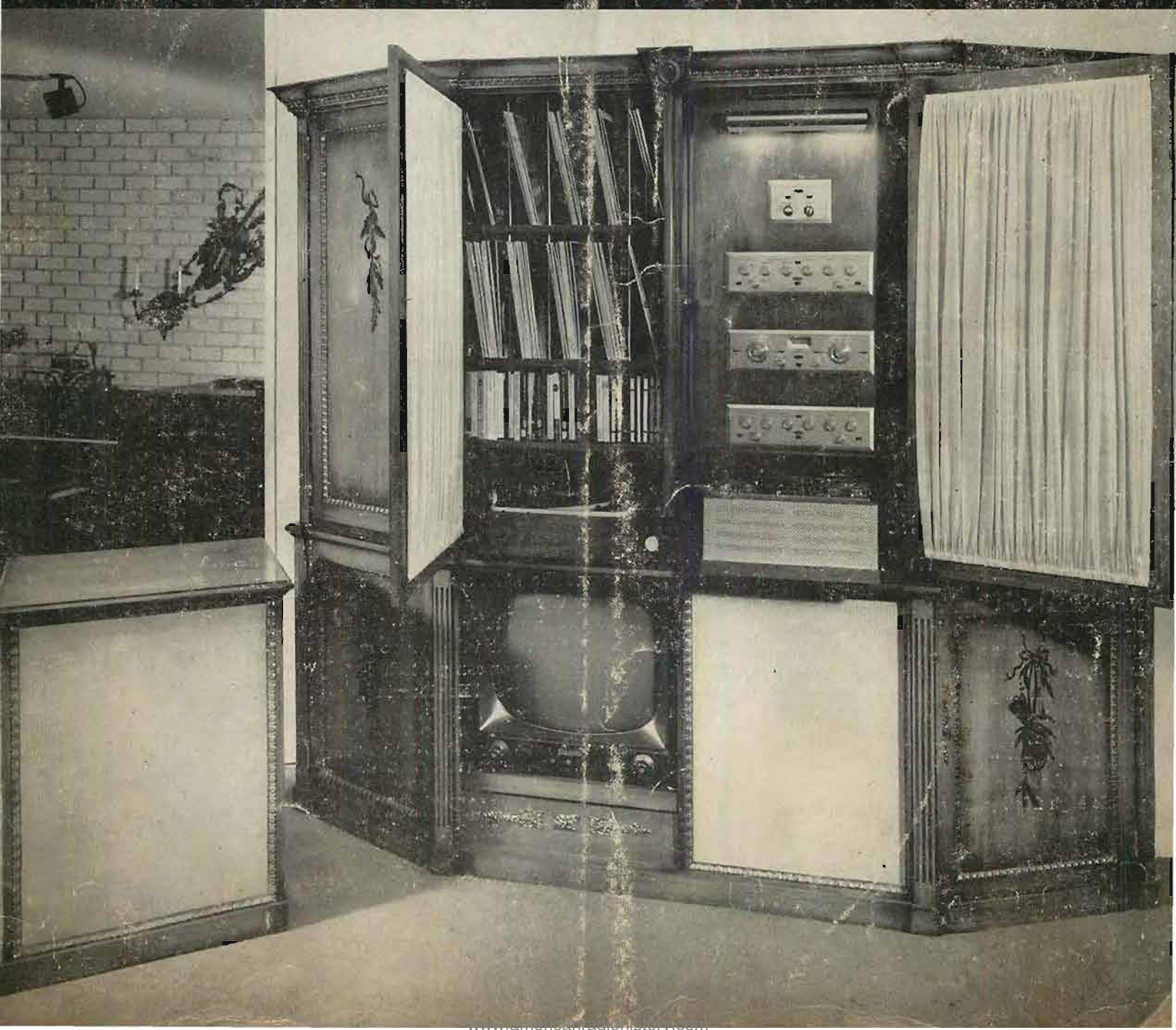


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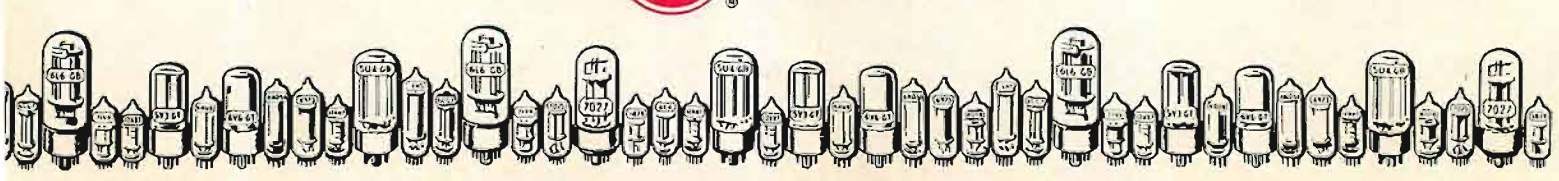

APRIL, 1959 VOL. 43, No. 4

Successor to RADIO, Est. 1917.

# AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION



CONTENTS



COVER PHOTO—Complete home entertainment center in the home of Mr. Mike Green, in New York City, houses a Scott 135 Stereo-Daptor Control, two Scott 210-F dynaural 36-watt amplifiers, a Scott 330-C Basic FM-AM stereo tuner, Garrard RC-88 record changer, Ampex A-122 tape recorder, with one Bozak speaker in the main cabinet and another in the separate housing which may be moved around for optimum placement. —Photo by Bill Aller.

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# AUDIOCLINIC??

JOSEPH GIOVANELLI*

### Amplifiers and FM Interference

*Q. I live about three city blocks from a fairly strong FM station which does commercial broadcast music via multiplex. This FM signal has been coming through my music system for about two years. By juggling the various a.c. power leads, audio cables, and all concerned, I have been able to keep the amount of signal picked at a minimum.*

*I have just completed a stereo installation. The FM station is coming in much more strongly, and curiously enough, it is more pronounced in the "left" channel than in the other. In the right channel, I get an overdose of hum, which doesn't worry me. I have been fighting the hum war for years, and I am confident I can lick that. My question is, How can I prevent this annoying interference? Cameron Magnon, Tampa, Fla.*

A. The first thing to ascertain is just where the signal is entering the equipment. To do this, first short the pickup leads. If the signal ceases, you have obviously located the source of entry, the pickup and/or associated leads. If the interference still persists, short the grid of the second stage of the preamplifier and so on down the line until you have found the point of entry of the signal.

You will then have to experiment with bypass capacitors. You probably can find one whose value is sufficiently large to shunt out the interfering signal and yet small enough so as not to limit the high-frequency response of the equipment.

If this method fails, place a choke in series with the offending lead. This choke can be made by winding 20 turns of No. 24 enameled wire around a 1-megohm 2-watt resistor. You may have to provide shielding for this filter arrangement. The filter can be rendered even more effective through the use of a second capacitor, arranged in the circuit in such manner that the circuit is a capacitor-input pi-type filter.

Should the interference still continue, you will have to resort to a wavetrap rather than to the filter system just described. This is made of a series-resonant circuit placed across the offending input circuit, and a parallel resonant circuit placed in series with the hot lead. *This unit must be shielded* and the shield returned to a good ground. Capacitors here should be variable, and their values are 10 μμf maximum to 1 μμf with their rotors open. Inductances are wound of No. 14 enameled wire on a ⅜-inch form. Each inductance should contain 3 or 4 turns. The inductance should not be closewound, but rather, should be spaced. After the coils are wound the forms are slipped out, leaving a self-supporting structure. After the wiring of the wavetrap has been completed, set the amplifier to the phono position or whichever position produces the interference, and adjust the tuned circuit for minimun signal.

If no such dip can be found, the coils in the network contain too much or too little inductance. You can determine which of these conditions prevails by compressing the turns. Compression increases inductance, expansion decreases it. If this procedure does not produce a null in the signal, you must then add or subtract turns.

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

### Speaker-Microphone

*Q. Is there any reason why a speaker could not be adapted for use as a microphone? It would seem to me that a speaker system should yield results at least as good as a comparable quality microphone in this regard. I have no idea what output can be expected from a speaker working in reverse, but I would guess that well over 1 mv could be obtained under working conditions. If the output would be inordinately high, is there any simple way to reduce the strength of the signal to a workable value? Also, would there be any difficulty with impedance mismatch, and how can this be rectified? John Graner, Great Neck, N. Y.*

A. The experiments I have performed suggest that a speaker can serve very well as a microphone. Unfortunately, a speaker which gives a good account of itself at the bass end, doesn't always perform the same at the high end and *vice versa*. I found that one needs a highly compliant speaker for use as a mike, just as one needs such a speaker if it is to be used in an infinite baffle enclosure.

Impedance matching is not much of a problem. You are likely to get enough drive from the loudspeaker so that you can connect it directly to the grid of the mike input of the preamplifier. If you need more gain than that provided by the unaided speaker, you can use a line-to-grid transformer to make up the difference. Unless you load the secondary of the matching transformer in some manner, you cannot achieve a match of impedances since the grid is virtually an open circuit and, therefore, performs no loading action. If you wish to try matching impedances, use a 30-ohm to grid transformer and load the secondary with a resistor whose value is half of the secondary's nominal impedance. (The foregoing assumes that the impedance of the speaker being used is 16-ohms.) If this combination overloads the front end, you will have to use the ordinary potentiometer circuit, with the full resistance of the pot serving as the transformer's load.

If you are going to use transformers, you must use good ones. If you do not do so, you will lose any advantages of the microphone. You will never know whether the transformer is causing a given effect or whether the microphone is causing it.

A microphone of the type in which you are interested has some other advantages, notably that, because of its large pickup area, more sound can be captured. This can mean that the diaphragm need not be driven far at all in order to obtain a good output level. As is well known, the less a diaphragm can be moved, the better will be the results obtained since the motion is more nearly linear when the excursions are kept small. This is merely a hypothesis I'm throwing out for those interested in experimentation. I have not tested its validity.

### Amplifier Instability and Remote Lines

*Q. This past weekend I was asked to connect a remote speaker system for a friend.*

*The system consists of an amplifier feeding a 500-ohm line, thence to a 500-ohm*

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*speaker and an 8-ohm speaker fed through a matching transformer, each speaker controlled by "T" pads on the speaker side of the transformer. The distribution line was an unknown (but very long) length of No. 18 lamp cord.*

*At moderately loud volume levels, the system was unstable and would motorboat badly. Reduction of bass would stave off the motorboating some but not much. In connecting an outboard jack to the line I noticed that holding one lead of the line while standing on wet ground encouraged the instability; touching the other lead had no effect. Also, this effect was not noticeable when standing on a dry board.*

*The amplifier was connected to the speaker through a short lead and full gain could be used with no instability.*

*From the above I assume the instability is due to line capacitance. If so, could this be eliminated without replacing the line, since replacement would be almost impossible? H. S. Newins, Red Bluff, Calif.*

A. I agree with you that the instability is caused by an alteration of the feedback characteristics of the amplifier resulting from the long line. It will be hard to say whether this trouble is the result of capacitive effects or inductive effects because a long line will contain significant amounts of both.

Before adding reactances and capacitances in an attempt to tune this difficulty, ground the amplifier to a good ground, and ground the common side of the far end of the 500-ohm line and one side of each speaker voice coil. Sometimes this kind of grounding will shunt out this kind of instability. If it works, it will save you much trial and error fiddling with inductances and capacitances which will otherwise be your fate.

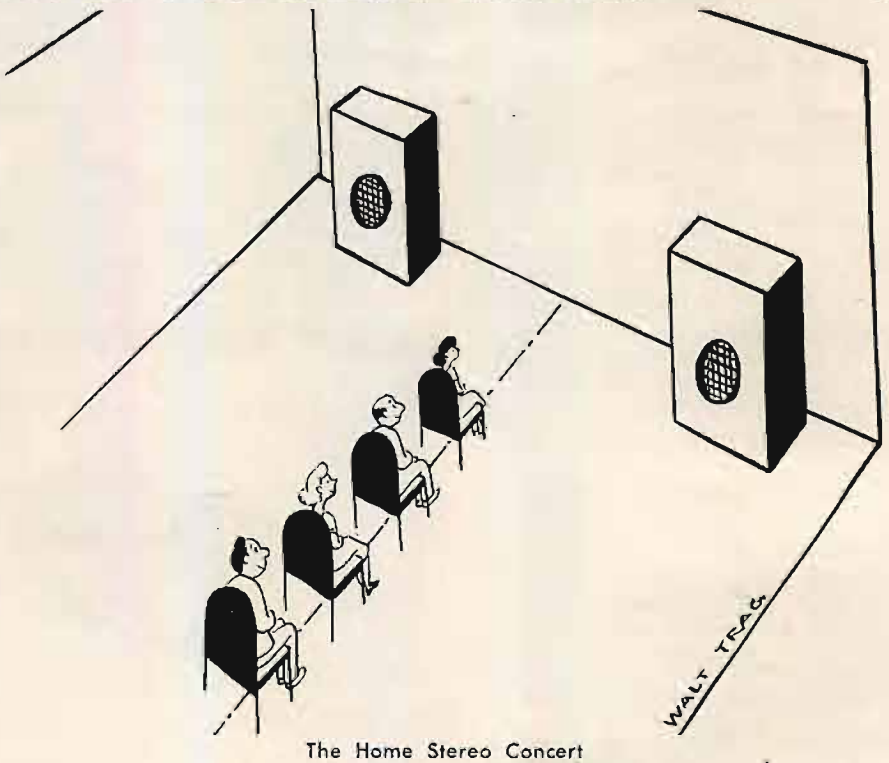
### Stereophonic or Monophonic Sound

*Q. I have many monophonic discs and tapes. Now, with the advent of stereo, is my monophonic collection worthless? Arthur Darrow, Albany, N. Y.*

A. I have met many people who lament the fact that stereo has made their fine record collections obsolete and miserable. While it is unquestionably true that the addition of spaciousness to music adds much to our emotional reactions to it, it does not and should not mean that we can no longer enjoy our otherwise fine discs. When you stop and think about it many people began collecting records in the 20's and before, and the sound on those early discs was poor indeed compared to those of today. Those people have not discarded them. I guess this is partly related to sentiment and is the symbol of a past which many of them considered to be better than the present. Probably, though, in the vast majority of instances, people hold onto these discs simply because of the artistry of those appearing on them. Stereo, wonderful though it is, cannot give us those oldtimers who have flashed across the concert and popular stages. This is not simply true of the 20's. It holds even for comparatively recent monophonic releases. What about those releases of old 78's or the immortal performances of Toscanini? True, stereo could have enhanced all of these performances, but they are still fine, valid ones, even without stereo. Of course, a record need not be world-acclaimed in order for it to be enjoyable to you. The main thing is that you liked it when you bought it and probably did right up until the time you heard your first stereo broadcast. Listen to that monophonic disc or tape again and you will probably enjoy it as much as always. I have such discs and tapes in my own collection, and I have stereo as well.

If possible, you should have equipment capable of playing both types of material. After all, there will be new music and new performances of old music. All of this will be recorded for our enjoyment. It will be captured in stereophonic sound.

You should not feel that the stereo system is just a flash in the pan, since material is coming at us with extreme rapidity, and this material and the equipment with which to play it, is being sold at a tremendous rate. It is hard to believe, but in the short time that the stereo disc and tapes have been with us, over 1,000 titles have been released. Æ




The Home Stereo Concert

# NEW LITERATURE

• **Alpha Wire Corporation,** 200 Varick St., New York 14, N. Y. is now offering free a wire-stranding chart, designated ZK-4, which makes it possible to determine rapidly the available stranding combinations for various sizes of conductor wire. This information is shown on a one-page reference chart which also tells the number of smaller gauge wires necessary to make up the cross-sectional area of a conductor. The chart is free, and will be furnished on request to Alpha Wire Corporation, or in response to the Reader Service Card. **D-16**

• **Astron Corporation,** 255 Grant Avenue, East Newark, New Jersey, announces the availability of Service Replacement Catalog AC-7 which covers technical data on the company's full line of capacitors and filters for radio, TV, and electronic applications. The illustrated 16-page booklet features a photographic "guided tour" of the Astron plant and explains product production from researching and engineering to testing and quality control. Complete product listings are also shown. **D-17**

• **Electron Tube Division of Radio Corporation of America** has just announced the latest edition of the well known RCA Receiving Tube Manual, RC-19. This manual, which is claimed to have sold more than two million copies since 1947 in earlier editions (and we wonder how many more were sold before then, for we remember them much further back than 1947), is the most comprehensive and authoritative book of its type in the industry. The new edition has been revised, expanded, and brought up to date. It contains technical data for more than 625 receiving tubes, including types for black-and-white and color television, series-string applications, 12-volt automobile radio receivers, and high fidelity audio, and more than 95 picture tubes including color types. A veritable education in vacuum tubes and their applications, this new manual also covers basic tube theory in the same easy-to-understand style used in previous editions. The section on Electron Tube Applications has been expanded to include a description of tone-control circuits for hi-fi audio amplifiers and high-voltage regulator circuits for TV use. Other sections include information on generic tube types, interpretation of tube data, and electron-tube installation.

The Receiving-Tube Classification Chart has been revised to show the latest tube data, and types designed for series-string applications are specially marked for easy selection.

The popular Circuits section at the back of the book shows a new intercom for three or more stations and several new high-fidelity audio amplifier circuits including preamps for magnetic and ceramic pickups, an audio control unit incorporating both volume and tone controls, and two complete hi-fi amplifiers having outputs of 10 and 35 watts, respectively, and suitable for both monophonic and stereo applications.

Copies of the RC-19 RCA Receiving Tube Manual can be obtained from RCA Tube distributors, or by sending 75 cents to Commercial Engineering, Electron Tube Division, Radio Corporation of America, Harrison, New Jersey.

• **Astron Corporation,** East Newark, N. J., is making available to design engineers a series of publications called "Techniques," covering a variety of subjects in the capacitor field. The current issue deals with "Application Notes on the Solid Electrolytic Tantalum Capacitor," in an article by Matthew Katz, Engineer in Charge of the Tantalum Department of Astron Corporation. Other Astron components will receive similar treatment in subsequent issues to provide ready visualization for the design engineer seeking characteristics for special problems.

Requests for copies should be addressed to Astron Corporation, 255 Grant Ave., East Newark, N. J.

# LETTERS

### Galactic Noise

SIR:

Harman-Kardon has created a mild furor in the industry by introducing a new term in the published specifications of its new Model ST350 AM-FM stereo simulcast and FM multiplex tuner.

The paragraph describing the FM section reads "remarkable sensitivity permits distant station reception—limited only by galactic noise."

The company has been busy answering consumer correspondence and telephone calls on the meaning of "galactic noise" and its influence on tuner design. We frankly never realized the subject would appeal to so many audio enthusiasts. For those consumers who may not have seen our ad or published specifications and who are interested in tuner design, I would like to explain the meaning of the term.

Galactic noise can be termed as noise or interference from outer space. Every star and galaxy emits electromagnetic radiation over a wide frequency spectrum. Part of this spectrum is light and can be seen. Another part is radiation in the VHF portion of the band and can be picked up by any FM or TV receiver of sufficient sensitivity. The characteristic of the noise is quite similar to thermal resistor noise and to "shot" noise in vacuum tubes.

Although galactic noise is not present in a receiver when connected to a signal generator for measurement, the noise will enter the tuner as soon as it is connected to an antenna. For a tuner to receive an FM signal, the signal must exceed both the internally generated noise and the galactic noise in intensity. The galactic noise, therefore, becomes a practical limit to the possible sensitivity of an FM receiver. A poorly designed tuner will not be affected by this type of noise because the noise created within the tuner is sufficiently high to mask the galactic noise. Our new ST350 offers a front-end design whose noise figure is so low that this noise from outer space is its only limit.

LEON KUBY, Sales Promotion Manager,
HARMAN-KARDON, INC.,
520 Main St.,
Westbury, L. I., N. Y.

### Corrections

SIR:

Three corrections should be entered on the schematic of "The Purple Cow" amplifier on page 31 of the January issue.

The resistor between the arm of the 50-k potentiometer and the junctioned plates 2 and 5 of the 6SN7 is 18,000 ohms, instead of 1200 as shown. Additionally, the cathode pin 8 of the 6U8 should be marked as having a 140-volt potential. The next item is my error and I apologize for it, but the voltage at plates 2 and 5 of the 6SN7 should have been shown as 895 volts instead of 795.

J. C. WITHERSPOON,
95 Keller Ave.,
Kenmore 17, N.Y.

*(And we apologize for the first two errors.* ED.)

SIR:

I have noted two errors in our article on the Regal speaker systems. The "rear view" photograph of the system as shown on page 25 of the March issue is actually a phantom view. In *Fig.* 6 on page 26, (A) is drawn incorrectly. The voice coil is shown just the same length as that of (B), but it should be just as long as the gap and no longer.

ROBERT C. AVEDON, Engineer,
ELECTRO-VOICE, INC.,
Buchanan, Michigan

### The Bi-Ortho Circuit

SIR:

Lately you have been printing a lot of interesting and informative articles on stereo reproduction, and as a reader I am certainly pleased. However, every now and then an article appears that makes me wonder. Such an article is "For Stereo, the Bi-Ortho Output Circuit," by C. Nicholas Pryor, in your November issue.

The idea of providing more power reserve (except under unusual signal conditions) for each stereo channel than is available from two separate amplifiers using the same output tubes is a good one. However, contrary to popular opinion, a cathode follower will deliver the maximum output to a load equal to the plate resistance $r_p$ of the tube, and not to a load of $r_p/(\mu+1)$. The secret lies in being able to drive the grid with larger signal swings in the case of the higher-resistance load. So Mr. Pryor's channel providing the $BE_2$ output is working under very unfortunate loading conditions and the power output from this channel will be limited compared to that of the $AE_1$ channel. Any hoped-for power reserve over a two-amplifier system is thereby prevented. In addition, a great differential in power output exists between the two channels—an undesirable condition indeed. Mr. Pryor has ended up with a system of lesser quality than he needed to.

If Mr. Pryor would use the same transformer in the cathode channel ($BE_2$) as he used in the plate channel, he would cure these ills; both channels would have the same output power, he would have his reserve power, and he would avoid the necessity of winding an output transformer.

One further point. A re-evaluation of the magnitude of various output-tube-grid driving voltages is in order. It seems probable that simple sums and differences of $E_1$ and $E_2$ will not do the trick; however, this needs further investigation.

WILLIAM C. HOLM,
917A Birch Road,
East Lansing, Michigan

### Speaker Cabinet Controversy

SIR:

The interests of clarity might be better served if Messrs. Williams and Novak, in their rebuttal (LETTERS, January) to Mr. Villchur (LETTERS, December), would plead to the issue.

As Mr. Villchur points out, their statement that "A large box always allows more and cleaner bass than does a small box," is patently either incorrect or incomplete. Williams and Novak tacitly concede this by basing their explanation on the assumption that the same speaker is used in each case.

This particular assumption apparently binds them to the conventional viewpoint: having chosen a speaker, system resonance is a function of box size. Although valid, this viewpoint is no more so than what I take to be Mr. Villchur's: having chosen a system resonance, box size is a function of speaker compliance. Once this chosen resonance is attained by a proper combination of box and speaker compliance, an increase in box size is pointless.

For given sound output and frequency, the cone must move a certain distance.

*(Continued on page 81)*

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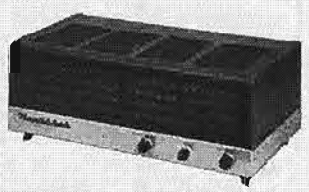

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# AUDIO ETC.

## Edward Tatnall Canby

### 1. RCA and STEREO

THIS IS PUTTING the cart before the horse—but the three large, identical press envelopes I received in one mail from RCA Victor that will be discussed below enclosed some pointers on stereo that were so unexpectedly to the point (even though in triplicate)—that I am prefixing them to my somewhat satirical discussion on mailing pieces in general, which you'll get to after you read this. The three RCA packages constituted one of those bulky press collections, inspirational multigraphed articles by famous personalities, glossy eight-by-tens of record stars and the like, that tend to clutter up our mails these days. I'd like to dare to throw them all out unopened but I never do. For inevitably, every so often, there is a nugget of pure gold on foolscap to be found in them. Right in the middle of this package was a clip entitled "Some Frequently Asked Questions—and Their Answers—About Stereo Records." Oh-oh, says I and almost threw it aside. The usual stuff, I thought, and probably I know the answers anyhow.

But not a bit. These RCA questions were reasonable, sensible, genuinely of the sort that people do ask. And the answers were intelligent ones. Somebody at RCA is on the ball, as the old phrase goes.

Out of the ten or so questions and answers typed over three pages, I red-penciled a couple for your information and interest.

*"How should I place the loud speakers to get the best results from stereo records and tapes?"*

Is *that* a cogent question! RCA suggests that since every room has its own acoustical properties, the best results, first, will be achieved by trial and error. That is a viewpoint that I heartily endorse. The thing not to do, as anybody ought to be able to understand, is to buy your stereo fixed and ready-mounted, then plop it into whatever small space the prevailing decor allows. RCA is so right and this common sense is pleasant to read.

The rest of the answer, though, is even better. RCA goes on to a rule of thumb for speaker separation that is the simplest and best I've yet seen for the general stereo user. Rather devastating, too, if you'll keep in your mind's eye some of the fancier stereo consoles now on the market.

*"As a rule of thumb, the most effect can be achieved by sitting the same distance from the speakers as the speakers are from each other. . . . It is not recommended placing speakers closer than six feet together, as the true stereo effect will most likely be lost."*

Take *that* from RCA and ponder it well. Sometimes the truth can be so simple that it's hard to believe. And note a further implication in RCA's answer, that a good and likely optimum separation for the average smallish living room is around eight feet. Better saw that new stereo console of yours in half and fill in the space between with a nice, uncluttered table or something.

Another clincher of a question posed by RCA's stereo man, is *"Will I be able to hear the stereo effect at any other place in the room?"* (That is, any other place than midway between speakers, as far back as they are spaced apart).

Now as we all know, there has been more hot air, more confusion—and more hard thinking—on this aspect of stereo than almost anywhere else; the ingenious solutions to the problem have ranged all over the lot from Stereodots to Klipsch systems with center speaker and pair of corners. I've been experimenting sporadically on this subject myself, but with results not yet worth detailed publication. And so I like RCA's good answer, as to what you can expect to hear in some other part of the room than the optimum stereo listening spot.

*"Of course* (you will hear stereo effect), *but the effect will not be as great. There is a marked difference in sound quality between a standard and a stereo disk even tho they are listened to outside of the room in which they are played. Stereo sound gives the effect of more solidity and depth than monaural sound, no matter where the listener is in respect to the loud speaker placement."*

Now that is a very shrewd observation and, as far as my experience is concerned, a true one. RCA has scooped me and I'm glad to hand them the palm. I've been noticing this very thing for a long time—and wondering why. How can it be? But it is.

I have a small kitchenette off the main living room in my New York apartment and, come breakfast or snack time, I often sit there sipping coffee, listening to the music coming in from the main room. Now that stereo has arrived, I listen to stereo in there, too. At first, of course, I said to myself—well, I'll just have to hear my stereo mono for a few minutes while I finish my coffee break. Comfort before listening pleasure. And so I listened around the corner, through an open door—and discovered to my utter surprise that stereo music *sounded stereo, through* that door, off in a straight line directly to one side of the speakers.

Stereo side-to-side separation? No; it could not of course do that. Separation was obviously impossible. Then what?

Well, I never have been able to put it into words, nor really explain it to myself in technological terms. And yet it is there and very definitely there. Even without a trace of side-to-side separation, with a through-the-door sound transmission that would seem to be entirely "mono," I still can sense a stereo effect, and it is a worthwhile effect, an improvement over the literal mono.

So RCA has a real point here and this is the first time I have seen it suggested in print.

It's interesting, isn't it, how much better a publicity handout can be when the material is obviously direct, first-hand, and not the usual watered-down re-hash by somebody who has no direct and personal understanding of the matter. Practically everything we read these days is second hand. And yet the reader—any reader—can spot real stuff instantly when he finally gets to see it. The difference between a write-up that is direct from experience and one that isn't cannot be very well concealed. It's just that we get so used to the second-hand stuff that we forget what it's like to have it first hand.

(Maybe RCA's writer didn't do the listening himself, in person. But if not, then he obviously got his dope straight from somebody who did.)

More, please, RCA, and let's hope others do likewise. We could use a bit of first-hand stereo clarification these days.

* * *

Has RCA been recording in stereo, as have other companies? Why of course! They probably do the biggest and fanciest job of anybody. Have they been at it for long? Natch! RCA practically started large-company stereo in this country, if I am right. Tapes came out from RCA 'way back. RCA discs were announced about as quickly as anybody's, roughly speaking. Does RCA have lots and lots of stereo material on hand, then? Obviously. RCA Victor remains one of the industry's record-producing giants.

OK, then. If my blue cards are right (I make cards for all review recordings, blue for stereo, white for mono), then I have received the following totals in stereo discs, give or take a few, allowing for likely stray items.

RCA stereo discs (classical): 9
London ffss stereo discs (classical): 117
Columbia stereo discs (classical): abt 16

Does look funny, doesn't it? At first I thought maybe RCA was trying to pull back with one stereo hand while pushing forward with the other. But I have just had the explanation from RCA itself.

Review copies. Seems the company decided, 'way back, that we reviewers were conservatives; they would send just a few stereo samples and all other discs in mono form, automatically, unless we asked for stereo all on our own.

As for me, *I* figured RCA would send us stereo as fast as it could—unless we posi-

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**HF86: Stereo Dual Power Amplifier** for use with HF85 above or any good self-powered stereo preamp. Identical Williamson-type push-pull EL84 power amplifiers, conservatively rated at 14W, may be operated in parallel to deliver 28W for non-stereo use. Either input can be made common for both amplifiers by Service Selector switch. Voltage amplifier & split-load phase inverter circuitry feature EICO-developed 12DW7 audio tube for significantly better performance. Kit **$43.95**. Wired **$74.95**.

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**MONO PREAMPLIFIERS (stack 2 for Stereo) HF-65:** superb new design. Inputs for tape head, microphone, magphono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. **HF65A** Kit **$29.95**. Wired **$44.95**. **HF65** (with power supply) Kit **$33.95**. Wired **$49.95**.

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tively objected. I'm that much of a hardened convert. Genial misunderstanding all around and I would have noticed it sooner, via RCA's publicity, if I weren't so buried these days in mountains of paper (see below).

Lots of RCA stereo discs on the market, then, if not on reviewers' shelves. But I still have a feeling in my bones that RCA has stereo of another sort up its sleeve. What about that little time bomb with the fuse pulled out, the RCA Victor Stereo Tape Cartridge? Not a word for months—but I can't believe RCA has given it up. Just regrouping forces. I suspect that the fuse will soon be lit again.

I shouldn't wonder. And if so, remember, I'm still in favor of the magazine, as a useful supplement to the disc market and the tape recorder market. (*So are we if it has adequate quality—doubtful at 3¾ ips—and if the flutter is adequately low—not yet demonstrated by any cartridge/magazine device.* ED.)

## 2 PRESS STUFF

Darn it, publicity sometimes gets me down. And it's not always in the ways you are imagining—though I'm always ready to proliferate objections to my favorite grammatical falsehood, the Dangling Comparison—the hi-fi that has the fi which is hi-er, the bread that is richer, the chocolate that is choclatier, the car that has 20 per cent more (proved by famous research laboratory, of course). To all of these fine claims you need merely add the question—THAN WHAT?—to show up the dangle. The answer may be semi-legitimate, say, last year's model, which naturally can't be described as inferior, even though this year's model CAN be described as superior! If you want to have your superiority without any inferiority, then just use the Dangling Comparative, and at least you may be speaking the truth after a fashion, granting that the newest model actually *is* better.

No—I'm not even thinking about another pet peeve of mine, that superbly meaningless term *"the only."* Sure, Colgate's is the only toothpaste with Gardol. So is General Electric the only company that makes the GE stereo cartridge. (Last I heard, anyhow.)

I can't remember at the moment the name of Pepsodent's "only" ingredient, but I do know that my mouth is the only mouth with Superteath. I just named my teeth that two minutes ago.

What I had in mind, actually, is the business of super-redundancy in the mailings that go out to folks like me, to inform and impress. As a practitioner and writer on hi fi, records, music, and related subjects, I am now on Everybody's mailing list. And, it seems, Everybody and his brother are trading lists. The mailing lists have got so big that nobody bothers to check any more who gets what or how many times. The volume is too "mass"; the individual is so microscopic a factor in this immense operation that a petty matter like duplication can't be allowed to gum up the works. That's the way it looks to me.

Thus, for example, I made the mistake of subscribing to *Life* some years back, I don't remember just when. No complaints—I read the mag and like it. But what gets me down is that *Life* doesn't yet know I'm a subscriber and obviously never will.

Practically every week, now, I get a new bid to subscribe to *Life* via some special, last-minute offer, for new readers. New readers, my eye! What d'they think I've been reading all these years? Every week, the postman goes right on jamming *Life* itself into my apartment house mailbox, as he always has, then rolling up the rest of my mail around a pencil and squashing the letters up the folds of the magazine, evidently with a blunt instrument; when he's got it all in quite solid and immovable he locks the outer lock, incorporating sections of several envelopes one of which always includes a monthly pay check. It takes me a good ten minutes to extricate the remains, with the check torn and *Life* minus half the front cover.

And just as sure as fate, two of the squashed letters invite me to subscribe to that marvelous special-bargain sheet, *Life*. Maybe three. For one of the worst aspects of the mail glut is its duplication. I never get any publicity just once; it comes in multiples. Yesterday I received three large identical packages from RCA Victor, all of them about the marvels of stereo, all three addressed identically but with (I note) different reference symbols. Different aspects, I suppose, of my own public character, as RCA sizes me up. Cryptic, too. One is called RS-F, "Reviewers Service, grade F"? The next is marked PA-PUB. Obviously that must be my capacity as a PAtient PUBlicist. Or maybe its Public Address. . . . I dunno. I seem to have lost the third envelope . . . . it must have got mixed up with a piece of *Life*. Each of these had 28 cents in first class postage on it, seven ounces' worth. They were identical in contents.

The triplication is only the final and most drastic annoyance. What really gets me down is the deliberate repetition of the same material in different forms, as though to drive us recipients to the wall by sheer reiteration. Why send a press release, another press release, then forty-five excerpts from a dozen magazines and newspapers promoting the same material, plus a booklet done up on slick paper, all repeating the same words? The ultimate futility is the appearance of one's own name in these persuasive duplications! People keep sending me my own reviews or criticisms to persuade me that what an expert like myself says just *must* be right. This, I suppose, is a form of feedback.

Capitol Records and *Billboard*—to name merely two names—are on my list right now. *Billboard* thinks I'm a record dealer (I'm on somebody's mailing list) and keeps dunning me, in duplicate of course, about the Profit$ I'm just bound to make in my store via $tereo, if I'll just send in the enclosed special subscription offer card, available for a very limited time. (It's always very limited, month after month. . . .)

I've given *Billboard* some fairly peppery publicity in this column, as readers may just possibly recollect, but do you think

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tively objected. I'm that much of a hardened convert. Genial misunderstanding all around and I would have noticed it sooner, via RCA's publicity, if I weren't so buried these days in mountains of paper (see below).

Lots of RCA stereo discs on the market, then, if not on reviewers' shelves. But I still have a feeling in my bones that RCA has stereo of another sort up its sleeve. What about that little time bomb with the fuse pulled out, the RCA Victor Stereo Tape Cartridge? Not a word for months—but I can't believe RCA has given it up. Just regrouping forces. I suspect that the fuse will soon be lit again.

I shouldn't wonder. And if so, remember, I'm still in favor of the magazine, as a useful supplement to the disc market and the tape recorder market. (*So are we if it has adequate quality—doubtful at 3¾ ips—and if the flutter is adequately low—not yet demonstrated by any cartridge/magazine device.* Ed.)

## 2 PRESS STUFF

Darn it, publicity sometimes gets me down. And it's not always in the ways you are imagining—though I'm always ready to proliferate objections to my favorite grammatical falsehood, the Dangling Comparison—the hi-fi that has the fi which is hi-er, the bread that is richer, the chocolate that is choclatier, the car that has 20 per cent more (proved by famous research laboratory, of course). To all of these fine claims you need merely add the question—THAN WHAT?—to show up the dangle. The answer may be semi-legitimate, say, last year's model, which naturally can't be described as inferior, even though this year's model CAN be described as superior! If you want to have your superiority without any inferiority, then just use the Dangling Comparative, and at least you may be speaking the truth after a fashion, granting that the newest model actually *is* better.

No—I'm not even thinking about another pet peeve of mine, that superbly meaningless term *"the only."* Sure, Colgate's is the only toothpaste with Gardol. So is General Electric the only company that makes the GE stereo cartridge. (Last I heard, anyhow.)

I can't remember at the moment the name of Pepsodent's "only" ingredient, but I do know that my mouth is the only mouth with Superteath. I just named my teeth that two minutes ago.

What I had in mind, actually, is the business of super-redundancy in the mailings that go out to folks like me, to inform and impress. As a practitioner and writer on hi fi, records, music, and related subjects, I am now on Everybody's mailing list. And, it seems, Everybody and his brother are trading lists. The mailing lists have got so big that nobody bothers to check any more who gets what or how many times. The volume is too "mass"; the individual is so microscopic a factor in this immense operation that a petty matter like duplication can't be allowed to gum up the works. That's the way it looks to me.

Thus, for example, I made the mistake of subscribing to *Life* some years back, I don't remember just when. No complaints—I read the mag and like it. But what gets me down is that *Life* doesn't yet know I'm a subscriber and obviously never will.

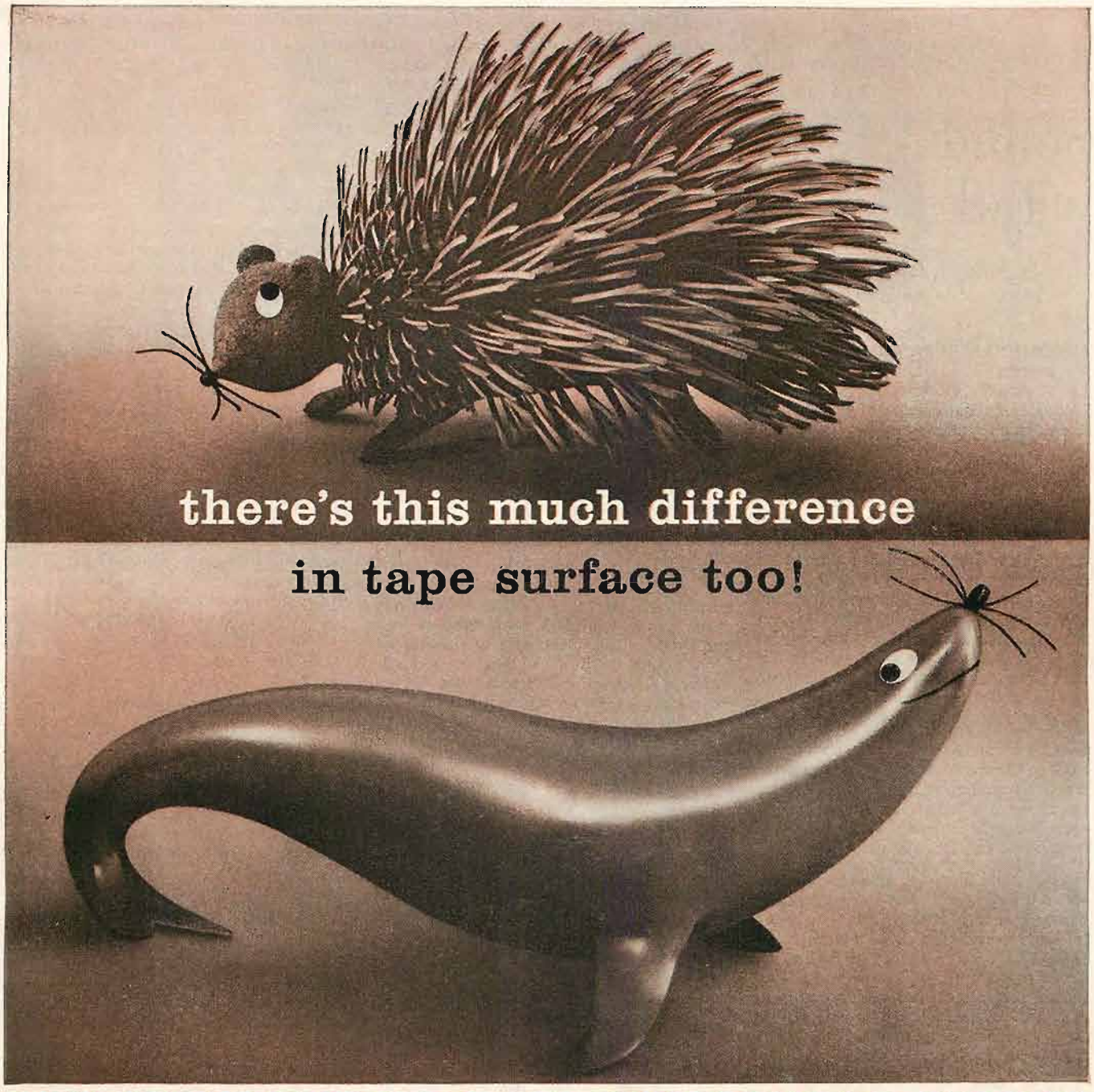
Practically every week, now, I get a new bid to subscribe to *Life* via some special, last-minute offer, for new readers. New readers, my eye! What d'they think I've been reading all these years? Every week, the postman goes right on jamming *Life* itself into my apartment house mailbox, as he always has, then rolling up the rest of my mail around a pencil and squashing the letters up the folds of the magazine, evidently with a blunt instrument; when he's got it all in quite solid and immovable he locks the outer lock, incorporating sections of several envelopes one of which always includes a monthly pay check. It takes me a good ten minutes to extricate the remains, with the check torn and *Life* minus half the front cover.

And just as sure as fate, two of the squashed letters invite me to subscribe to that marvelous special-bargain sheet, *Life*. Maybe three. For one of the worst aspects of the mail glut is its duplication. I never get any publicity just once; it comes in multiples. Yesterday I received three large identical packages from RCA Victor, all of them about the marvels of stereo, all three addressed identically but with (I note) different reference symbols. Different aspects, I suppose, of my own public character, as RCA sizes me up. Cryptic, too. One is called RS-F, "Reviewers Service, grade F"? The next is marked PA-PUB. Obviously that must be my capacity as a PAtient PUBlicist. Or maybe its Public Address. . . . I dunno. I seem to have lost the third envelope . . . . it must have got mixed up with a piece of *Life*. Each of these had 28 cents in first class postage on it, seven ounces' worth. They were identical in contents.

The triplication is only the final and most drastic annoyance. What really gets me down is the deliberate repetition of the same material in different forms, as though to drive us recipients to the wall by sheer reiteration. Why send a press release, another press release, then forty-five excerpts from a dozen magazines and newspapers promoting the same material, plus a booklet done up on slick paper, all repeating the same words? The ultimate futility is the appearance of one's own name in these persuasive duplications! People keep sending me my own reviews or criticisms to persuade me that what an expert like myself says just *must* be right. This, I suppose, is a form of feedback.

Capitol Records and *Billboard*—to name merely two names—are on my list right now. *Billboard* thinks I'm a record dealer (I'm on somebody's mailing list) and keeps dunning me, in duplicate of course, about the Profit$ I'm just bound to make in my store via $tereo, if I'll just send in the enclosed special subscription offer card, available for a very limited time. (It's always very limited, month after month. . . .)

I've given *Billboard* some fairly peppery publicity in this column, as readers may just possibly recollect, but do you think

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# Sound Talk

*by John K. Hilliard*
Director of Advanced Engineering

**PLACEMENT OF LOUDSPEAKERS FOR STEREO**

This much-discussed subject has been confused through attempts at oversimplification. There are a few clear-cut principles that should be followed for good stereo.

Two separate channels, from source through amplification to the speakers, provide the time and intensity difference that develops the spatial quality of stereo. If the speakers are too closely spaced, as in a single enclosure which houses two speakers only a few feet apart, the time and intensity difference is so small that spatial quality is severely limited. Eight feet is considered minimum spacing between speakers for good stereo and they should be placed in a common plane.

Good listening begins the same distance in front of the speakers that they are spaced apart, and continues for twice this distance. For example, if the speakers are placed 8' apart, the good listening area begins 8' in front of the speakers and continues to 16'.

Greater spread between speakers is desirable but the listening area must be moved back proportionately. Listening too close to widely separated speakers creates a "hole in the center" which gives the impression of two distinctly separate sound sources rather than the desired broad front of sound. When speakers have to be too widely spaced or placed in corners, a slightly converging angle will improve the stereo.

The effective dispersion angle at high frequencies is usually limited to 90°. To obtain the benefit of the entire audible frequency range, the listener should remain within this angle.

Both reflected and direct sound is required. However, staccato or transient tones are localized for the stereo effect only through direct sound. Because of this, the speakers should be directed at the listener and not first bounced off side walls or other reflectors.



*Billboard* will ever find out? Maybe its right hand will, but not the left, that insensate, unreasoning, juggernautish colossus that is the *Billboard* mailing list! I'll surely be opening *Billboard* subscription blanks, three letters in each mail, at least until Doomsday unless *Billboard* gives up the corporate ghost. That would be too bad—it's a useful mag. I just don't like its mailing-list department.

Even good old *Harper's*, the staid, elderly magazine for which I also write record reviews, has got into its head that I ought to subscribe and keeps sending me enthusiastic bids, reminding me about how intellectual I am and how I really ought to read this great magazine. The crowning insult, entirely ignored by the mailing list people, is that they don't even mention my column as one of the lovely things any intellectual like me ought to be reading in *Harper's!* But then they probably don't know I write for them.

As for Capitol—that is, Capitol, Capitol-EMI and Angel—this entirely worthy concern, whose products I frequently endorse with pleasure, has three mailing arms, two informational and one quite utilitarian. They all tell us the same things, practically word for word, but in different sizes and type faces. You can't split them up—it's all or nothing. Not even as to classical *vs.* rock'n'roll; it all comes together, and the volume is enormous. So if I want to find out what's cooking at Capitol I have to plough through the complete road itineraries of every rock'n' roll and pops artist in the Capitol catalogue and read all about the latest whamdizzy of a hit by young Pseudo Jones the hottest teenage number since the last one, day before yesterday, until finally I reach the info concerning my field. Pages and pages of stuff, all promptly deposited in the waste basket—and everything I need to know is *also* sent out via the reviewers' service department. *Or is it?* I'm never quite satisfied and so I usually open everything and read.

Just to be sure we get the point, Capitol also provides a little vest pocket magazine called Music Views (or is that Columbia?). This is in case you need reading matter on the train or plane or maybe in a crowded restaurant where publicity on big paper wouldn't be convenient. Anyhow, it tells the same story once again—with pictures.

All these mailings—reviewers' service, press releases, and pocket sheets—are merely the weekly routine. There's also a frequent air-mail first-class letter that tells you all about the best sellers of the week or something; I always think it's a real letter. That's four routine lines of stuff. In addition, anything special that goes on at Capitol is likely to call forth a big SPECIAL AIR MAIL RUSH EMERGENCY package, too big for my mail box, which invariably arrives at my door at seven thirty in the morning—and boy, are those special delivery boys sadistic. They don't just ring the bell, they stand on it. They know they aren't going to get any rise from me and so they take out a few of their own mailing frustrations in a nice, harmless way . . . That's for special occasions, but there is also my regular business correspondence with Capitol, which gets quite voluminous on its own, sometimes.

As far as I can see, I'd better set up a Capitol mail-opening division within my office and assign a full-time staff to the boiling-down process. They'd brief me on the essential meat and the excess stuff would be carted away in huge barrels. It is now, but I do it myself.

Don't think I'm permanently down on Capitol. Lots of other firms do about the same thing. I could take any one of them with the greatest good nature but when you add up all the mailing lists, all the deliberate duplications and repetitions, the mass of sheer paper that is thrown at any press man or writer via the mail is really incredible. It's just more than I, for one, can take. I suggest that my mailing beefs and their close relatives, the telegram beefs, (below) apply just as much to the hi-fi promotion departments as they do to records and to the rest of the great American economy in all its wastefulness of paper-power. Remember—I'm speaking here not of advertising in general but of publicity aimed at writers, publicists, editors, the makers of further publicity. How can we write when we have to spend half of each day just wading through mail in duplicate, triplicate, quintuplicate. I'm not exaggerating a bit. I've had as many as five copies of some releases.

Well, this has taken almost as long to write as I took to open this morning's crop of information.

**Rules for Publicizing the Publicists**

1. Please, fellahs, give us a chance to breathe (and maybe to think). Don't depend entirely on sheer paper-volume and package size. It looks impressive but it curdles our blood. (And it won't fit in the mail box.) Try being succinct and economical, maybe. Give us your message fairly, precisely and JUST ONCE. We can read. We like to read.

2. If you must send everything first class air mail, then how about removing those big, bold letters, RUSH, IMPORTANT INFORMATION, THIS IS FOR *YOU* that somehow get on every mailing piece? Didn't you know that the bloom is long since off that peach?

Didn't you know that when people like us see RUSH, IMPORTANT INFORMATION, THIS IS FOR *YOU* we just can't help reaching for the waste paper basket and, maybe, missing a useful message? I *want* to know what you have to say, remember. I need to know, I have to know.

3. An opposite sort of peach is that nice, friendly, personal letter—"Dear Edward" —that turns out upon close inspection to be a form letter, more or less disguised as the case may be.

Perhaps you didn't know it, but etiquette and fairmindedness says that a personal letter should be answered personally. I believe in this etiquette and do my best to live up to it, at great expense of time. I resent faked personal letters, then, as a breach of taste and as an unfair taking-advantage of my time and interest. Don't you do it. Make it really personal, if you must. I'll be pleased to hear from you, and glad to have your information. So will most of the rest of the "press," as we are sometimes called.

4. If you are planning a cocktail party

*(Continued on page 80)*


FLUXVALVE AND T-GUARD ARE TRADEMARKS USED TO DENOTE THE QUALITY OF PICKERING & COMPANY INVENTIONS. 2371 A

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**F**or instance...only the STANTON Stereo FLUXVALVE has the "T-GUARD" stylus assembly—so safe and easy to handle...so obedient and responsive to every musical nuance in the stereo groove.

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*Excluding wear and tear of the diamond stylus tip and parts of the related moving system in the "T-GUARD" assembly.

**A**nd...because of this the STANTON Stereo FLUXVALVE reproduces music with magnificent sound quality...from both stereophonic and monophonic records...with negligible wear on record and stylus.

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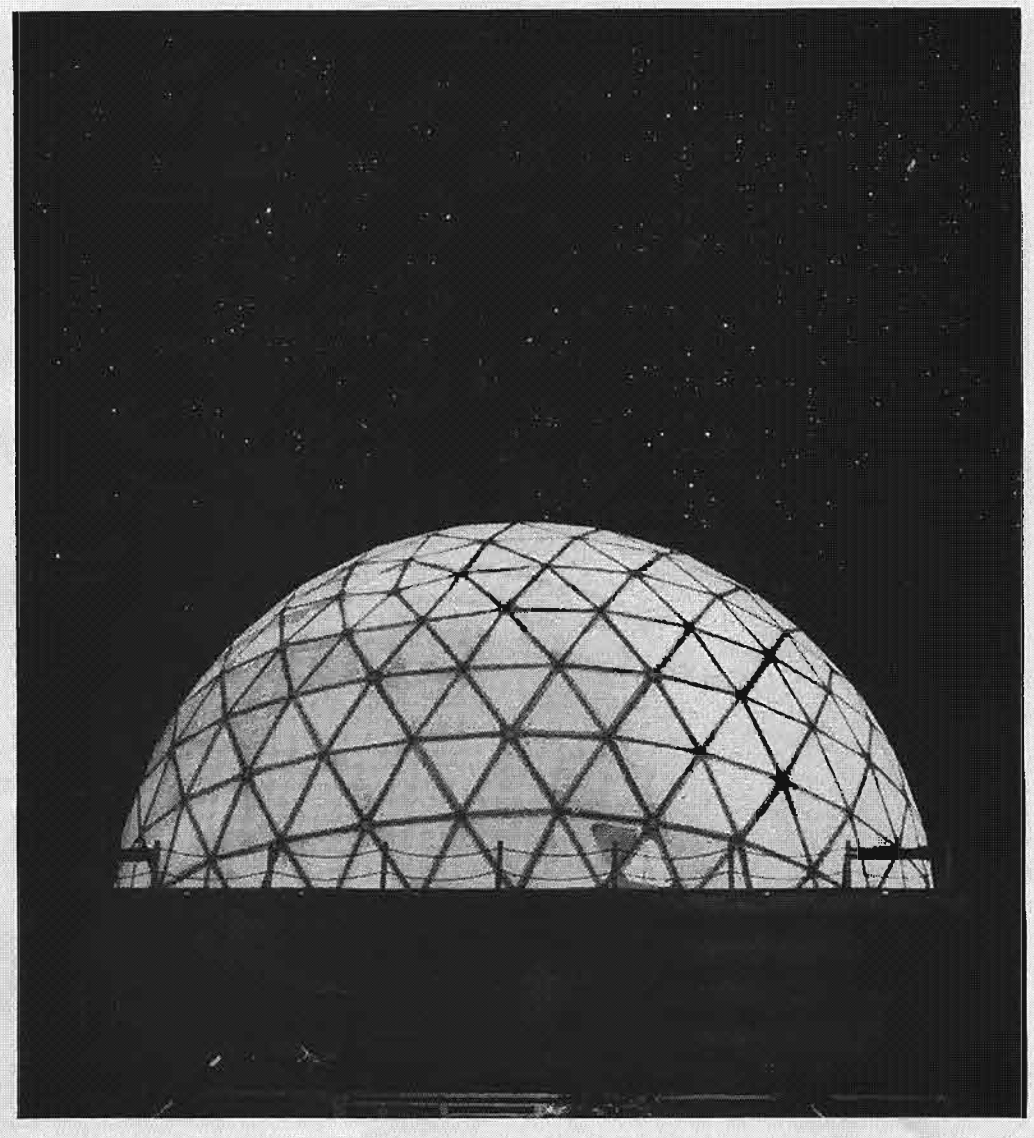

This plastic radome houses a radar antenna constantly scanning the skies to detect the presence of aircraft. A line of these radars provides early warning of any threatening approach to the North American continent.

The Distant Early Warning Line is now on perpetual guard duty. Spanning the Arctic from Baffin Island to Alaska, this great system was conceived at the Lincoln Laboratory of M.I.T. and produced under the leadership of Western Electric.

But first the DEW Line had to be engineered into a workable system. This was done at Bell Telephone Laboratories.

The obstacles were formidable. Conventional means of communication—telephone poles, cables and even line-of-sight microwave radio—weren't feasible. A complicated system had to be made to operate reliably in a climate so cold that outdoor maintenance is impracticable farther than a few hundred feet from heated habitation.

Whenever possible, Bell Laboratories engineers utilized well-proven art. But as it became necessary, they innovated. For example, they designed and directed the development of a new and superior radar which automatically scans the skies, pinpoints a plane and alerts the operator.

To reach around the horizon from one radar station to another, they applied on a massive scale a development which they pioneered—transmission by tropospheric scatter. Result: at a DEW Line Station you can dial directly a station more than a thousand miles away and converse as clearly as with your home telephone.

Bell Laboratories' contribution to the DEW Line demonstrates again how telephone science works for the defense of America.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

# Push Pull in Hi Fi

MANNIE HOROWITZ*

**The push-pull amplifier has become standardized as the optimum circuit arrangement for providing adequate power output with a minimum of distortion—so long as the tubes are used under proper conditions. The author makes the performance of this type of amplifier thoroughly understandable.**

THE PUSH-PULL POWER OUTPUT STAGE can be studied from many angles. A theoretical discussion on composite tube characteristics is interesting and informative. A survey of the practical applications of different push-pull or driver circuits is an important asset to any audiofan's library.

In this article, several refinements in push-pull circuits will be discussed. These refinements are frequently designed into the amplifier on an intuitive basis rather than a scientific one. The importance of a scientific analysis rather than instinctive motivation can be well appreciated by the serious hi-fi enthusiast.

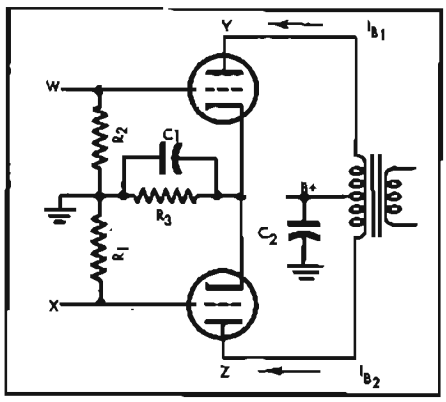


Fig. 1. Typical push-pull amplifier.

### Graphical Analysis

A typical self-biased triode push-pull output amplifier is drawn in *Fig.* 1. Everything discussed about this triode refers to the pentode as well—but to an even larger degree due to the greater curvature of the tube characteristics.

It is a well known fact that there is a phase shift of 180 deg. between the grid and the plate of any tube. When the signal at the grid reaches a crest, the signal at the plate is at a trough. The reverse is also true. The phase relationship of a sine wave signal at the grid and plate of a tube is shown in *Fig.* 2. Note the crest and trough reversal indicating a 180 deg. phase shift.

This is true in the case of both tubes in the circuit shown in *Fig.* 1. When W

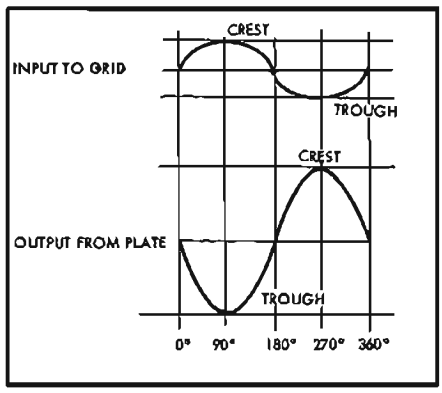


Fig. 2. Grid-plate phase reversal—180-deg. phase shift.

is at a crest, Y is at the trough; when X is at a trough, Z is at a crest—and *vice versa*.

It is equally well known that the voltage at W and X must be exactly 180 deg. out of phase and exactly equal in amplitude in order that the push-pull amplifier operate properly. These voltages at W and X will appear as shown at (A) in *Fig.* 3. In class A operation, the voltages at the respective plates, Y and Z will appear as shown at (B) in *Fig.* 3, each equally shifted in phase due to the grid-plate phase relationship of the tube. The signal voltages at the plates will be greater than that at the grids due to tube amplification.

The signal-voltage amplitude appearing between the plate of each tube and signal ground (B+ since $C_2$ in *Fig.* 1 is a short circuit to ground for signals) appears across one half of the output transformer. The signal voltage between Y and B+ due to tube I appears across the upper half of the transformer, while the signal voltage between Z and B+ due to tube II appears across the lower half of the transformer.

When the voltages at Z and Y are equal, there is no difference of potential between the ends of the transformer. The signals will then cancel out and no voltage will appear at the output.

If the voltages are unequal, or equal and 180 deg. out of phase, the difference of the instantaneous voltages at the plates will appear across the transformer. This will be the output signal.

In (B) of *Fig.* 3, let us assume a peak signal voltage of 30 volts between the plates of each tube and ground. At the beginning of the cycle, at the midpoint

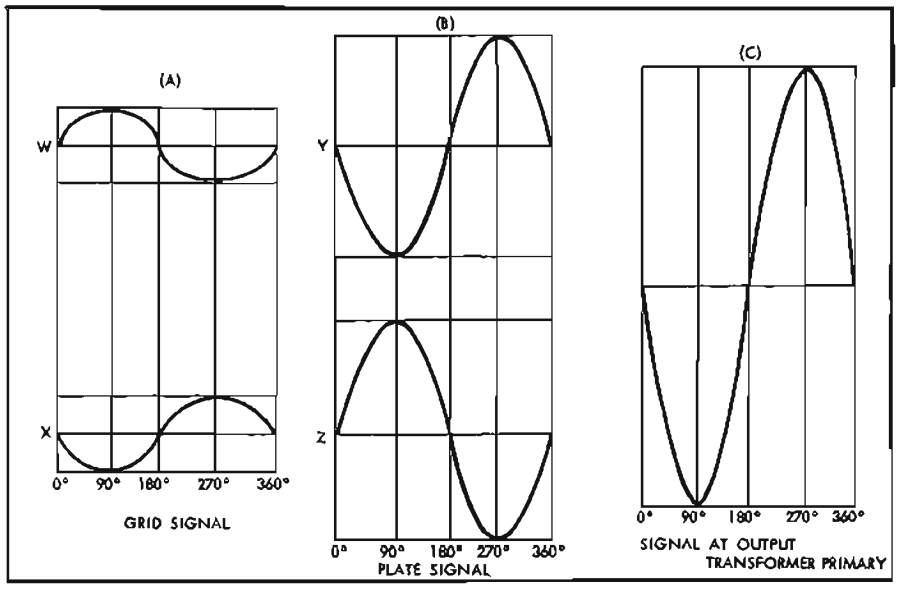


Fig. 3. Push pull signal under normal operation. Note phase relationship of grids W and X and phaes relationship of plates Y and Z. Output is double the output from each plate individually.

* *945 E. 26th St., Brooklyn 10, N. Y.*

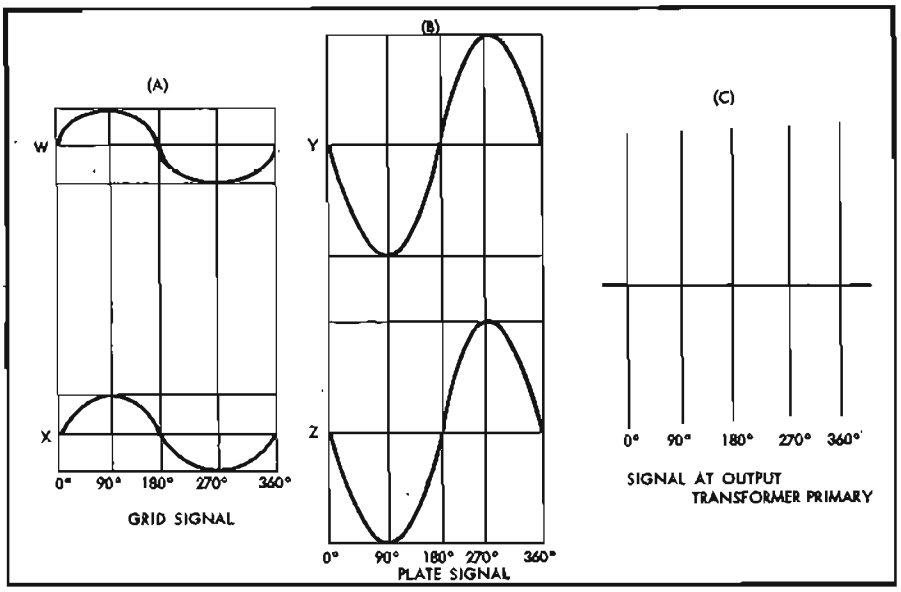


Fig. 4. Phase relationship when signals are fed in phase to the two grids. Note the zero output across the output transformer.

(180 deg.) and at the end of the cycle (360 deg.), there is zero signal voltage. Thus there is no signal difference of potential between the two plates and there is no signal voltage across the output transformer.

At the 90-deg. point, the Y plate has a trough of – 30 volts and the Z plate has a crest of + 30 volts. Thus there is a difference of potential of 60 volts between these two points. Assuming the Z plate as the "0"-voltage reference level, the voltage between plates, or at the Y plate (across the output transformer) is – 60 volts.

At the 270-deg. point in the cycle, the reverse is true. The Y plate has a crest of + 30 volts and the Z plate a trough of – 30 volts. Again assuming the Z plate as the "0"-voltage reference level, the voltage between plates, or at the Y plate is + 60 volts.

When plotting this information, the voltage between plates of the tube (across the output transformer) is a sine wave of double the amplitude of either plate output voltage alone.

It should then become obvious that if the grid signals were of equal amplitude and in phase (*Fig.* 4), the voltages between plates Y and Z would be in phase. Being in phase, there would be no difference of potential, during any point of the cycle, between plate Y and Z. This would result in a zero signal output.

From this graphical analysis, two things governing push-pull operation become obvious.

1. A signal applied 180 deg. out of phase to each grid, results in double the usual output from each tube individually.

2. A signal applied in phase to each grid, results in zero output from the push-pull arrangement.

Rule 2 applies to all cases, while rule 1 applies only to Class A operation of the output tubes. In Class $AB_1$, usually used in hi fi amplifiers, the output is greater than indicated due to increased efficiency.

### Class $AB_1$

In class A, we may assume operation of the tube along a linear portion of its characteristic curve, as shown in *Fig.* 5.

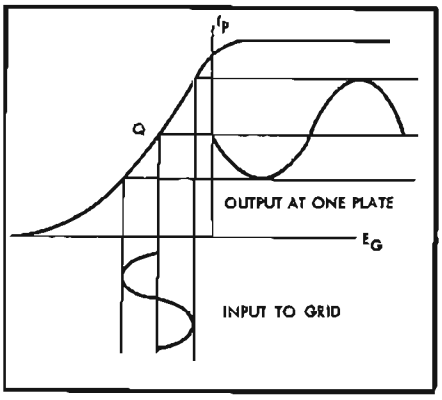


Fig. 5. Class A Operation. Q is operating point (bias voltage). Undistorted sine wave at input and output.

*Figure* 6 shows the same tube operating in class $AB_1$. The signal reaches cutoff (or at least a non-linear portion of the curve) resulting in a distorted output from each tube. Since the output from each tube is of identical waveshape, but 180 deg. out of phase, the distortion partially cancels itself out, resulting in a "pure" sine wave at the outpnt.

The distortion from a tube can be studied most beneficially by a Fourier analysis. This is covered in many texts[1,2] and will not be derived here. The results of this analysis are simple and can be stated briefly.

[1] Hugh Hildreth Skilling, *"Electrical Engineering Circuits."* John Wiley & Sons, New York, 1957, pp 403–410.

[2] MIT, *"Applied Electronics."* John Wiley & Sons, New York, 1943, pp 438–439.

Represent the plate current to Y in *Fig.* 1 as $i_{b_1}$. This plate current consists of three factors.

First, there is a d.c. component due to the plate power supply or B+. Let us call this d.c. current $B_0$.

The second is the fundamental signal component. When a sine wave is fed to the grid of a tube, a large signal component at the original sine-wave frequency appears at the output. The amplitude of this component can be labeled $B_1$. Designating the fundamental frequency as $f_1$, the $B_1$ component varies sinusoidally with this frequency. Thus the complete fundamental signal component of the current is $B_1 \cos \omega t$, where $\omega = 2\pi f$.

The output being somewhat distorted, must of necessity also consist of some harmonic components. Following the procedure for finding the fundamental, the amplitude of the second harmonic component is $B_2$, the third is $B_3$, the fourth is $B_4$, and so on. Similarly, the sinusoidal variations at these frequencies are respectively $\cos 2\omega t$, $\cos 3\omega t$, $\cos 4\omega t$, and so on. The complete harmonic content of $i_{b_1}$ is then $B_2 \cos 2\omega t + B_3 \cos 3\omega t + B_4 \cos 4\omega t \ldots$ etc.

The plate current, $i_{b_1}$, is the sum of all of these factors. Approximating the result only as far as the third harmonic—disregarding the fourth and higher order distortion components, the plate current is

$$i_{b_1} = B_0 + B_1 \cos \omega t + B_2 \cos 2\omega t + B_3 \cos 3\omega t \quad (1)$$

Assuming first that $i_{b_2}$, the current of tube II is in phase with $i_{b_1}$, then

$$i_{b_2} = B_0 + B_1 \cos \omega t + B_2 \cos 2\omega t + B_3 \cos 3\omega t \quad (2)$$

It can be taken for granted that the impedances of each of the two halves of the output transformer are equal. The voltage drops across each half are proportional to the plate currents ($E = Z\, i_b$).

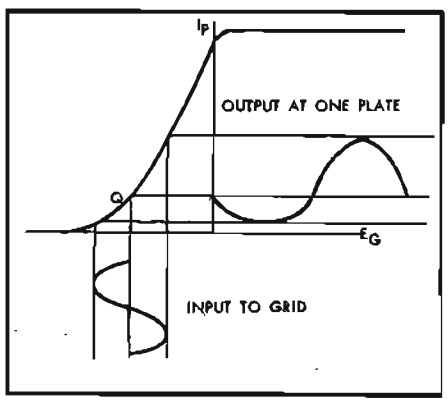


Fig. 6. Class $AB_1$ operation of the same tube. The quiescent point is moved down so that less current flows when no signal is applied—which means less power dissipated, resulting in greater tube efficiency.

The total plate voltage appearing across the transformer is then proportional to $i_{b_1} - i_{b_2}$, which is proportional to the difference of potential between the two tubes, as explained above graphically. Subtracting Eq. (*2*) from Eq. (*1*) shows a resultant zero output. This is the same result previously deduced graphically in *Fig.* 4.

Assume next that $i_{b_1}$ and $i_{b_2}$ are 180 deg. out of phase—the case for normal push-pull operation illustrated in *Fig.* 3. Since 180 deg. is equivalent to $\pi$ in radian measure, adding $\pi$ to each of the angles in Eq. (*1*) will be the equivalent of an 180-deg. phase shift.

$$i_{b_2} = B_0 + B_1 \cos(\omega t + \pi) + B_2 \cos 2(\omega t + \pi) + B_3 \cos 3(\omega t + \pi) \ldots =$$

$$B_0 - B_1 \cos \omega t + B_2 \cos 2\omega t - B_3 \cos 3\omega t \ldots \quad (3)$$

Equation (*3*) follows from the trigonometry which indicates the following identities:

$$\text{Cos}(\omega t + \pi) = -\cos \omega t$$

$$\text{Cos}(2\omega t + 2\pi) = +\cos 2\omega t$$

$$\text{Cos}(3\omega t + 3\pi) = -\cos 3\omega t.$$

Subtracting Eq. (*3*) from Eq. (*1*) results in an expression which is proportional to the voltage across the output transformer,

$$i = i_{b_1} - i_{b_2} = 2(B_1 \cos \omega t + B_3 \cos 3\omega t) \ldots \quad (4)$$

This indicates that all even harmonics are cancelled out in the push pull output. Only the third and higher *odd* harmonics remain. The "2" in the Eq. (*4*) indicates what we already found graphically. The amplitude is double the output of a single tube.

### Implications

This long-winded discussion may be considered to be a lot of trouble to prove some factors which are common knowledge. Everyone knows that even harmonics are cancelled in push-pull. Everyone also knows that the signal applied to the two grids, W and X, must be of equal amplitude and 180 deg. out of phase. So why this dissertation?

Amplifiers are made out of tubes, resistors, transformers, capacitors—not out of tube manuals, theoretical text books or magazine articles.

### Bypass the Cathode Resistor?

Assume for one moment that the two output tubes are dissimilarly non-linear. In that case, the plate currents in *Eq.* (*1*) are and equal to the plate currents in *Eq.* (*2*). The fundamental amplitudes $B_1$, and the harmonic amplitudes, $B_2$ and $B_3$, in the two equations are then unequal. Subtraction of (*2*) from (*1*), in the case of in-phase signals, or (*3*) from (*1*) in the case of out-of-phase

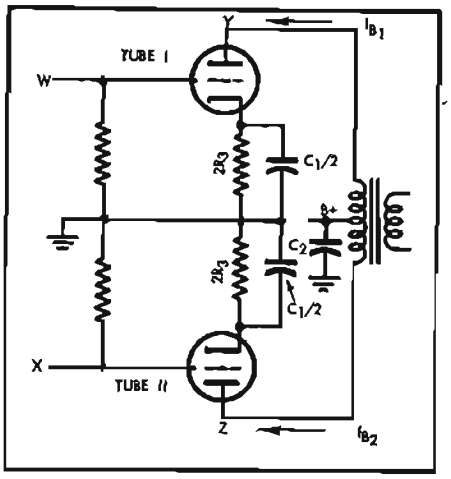


Fig. 7. Same circuit as Fig. 1, but with separate bias resistors for each tube. Resistor value is twice that of Fig. 1, for only half of total current goes through it. Bypass capacitor need be only half that of Fig. 1 to keep the circuits identical.

$$R_3 C_1 = (2R_3)(C_1/2).$$

signals, will result in no cancellation of the high-amplitude second harmonics.

The total plate current $i$, which is equal to $i_{b_1} - i_{b_2}$, appears across the common cathode resistor, $R_3$ in *Fig.* 1, as a voltage $(i_{b_1} - i_{b_2})R_3$.

Due to circuitry configuration, the voltage across this resistor appears between the cathode and grid of each tube (between B and W, and A and X). Being an amplifier, the tubes amplify this signal as well as the desired signal appearing at the grids.

Assume that the resistor $R_3$ is bypassed by a large capacitor, $C_1$, as is the case in *Fig.* 1. All the harmonics are then bypassed to ground and not amplified. This may be the most desirable case.

In many amplifiers on the market, the cathode resistor is not bypassed to ground[3]. What happens then?

In class A operation, there is very little effect on the harmonic distortion. The signal across the cathode resistor causes the harmonics to appear at the two grids, W and X in phase. These harmonic components will cancel out, resulting in no or little additional harmonic distortion.

In class A, and more so in class $AB_1$ due to nonlinearity, the harmonics between the cathode and ground will modulate the fundamental input signal appearing between the grid and ground. These resultant signals are not in phase and will not cancel. The final outcome are additional factors of intermodulation distortion.

Experiments of this type are interesting and should be tried by the reader who possesses harmonic and IM distortion measuring instruments. First make the measurements without a bypass capacitor across the cathode resistor and then with the bypass capacitor connected. The results are predictable. The record of the magnitudes is interesting.

Results will indicate the desirability of a bypass capacitor in Class A operation and the necessity of this component in class $AB_1$.

### Separate Cathode Resistor

*Figure* 1 shows one common resistor in both cathodes to develop bias voltage. Is this the most desirable arrangement? *Figure* 7 shows the same circuit, but with two resistors, one in each cathode and separately bypassed. Is this better or worse?

Output tubes vary by as much as 40 per cent from each other. The plate currents can be quite different—especially when operated class $AB_1$ or more so in Class $AB_2$.

Assume that tube I has a lower plate current than tube II when operating at the same bias conditions. Let us also suppose that at 8 volts bias, tube I has a plate current of 30 ma and tube II has a plate current of 50 ma. The total d.c. plate current through the common cathode resistor of *Fig.* 1 would then be

(*Continued on page 72*)

[3] Robert M. Mitchell, "Effect of the cathode capacitor on P-P output stage," Audio, Nov. 1955, pp. 21–23, 75.

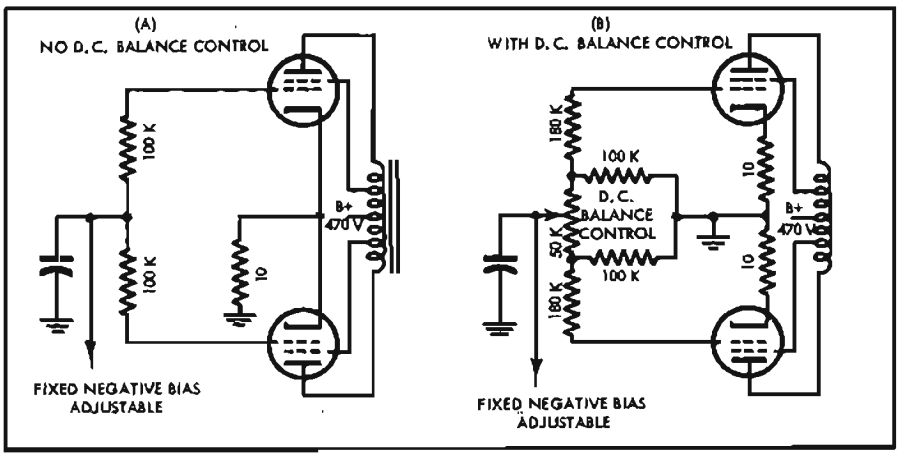


Fig. 8. EL34 or KT88 may be used with adjustable bias of about 50 volts. Two arrangements are shown to measure bias and balance voltages.

# Choice of a Crossover Frequency

JAMES MOIR*

**When two- or three-way speaker systems are used, somewhere in the design procedure a decision must be made as to the crossover frequency. This important consideration is thoroughly discussed by the author.**

FOR MANY GOOD REASONS the vast majority of high-quality wide-frequency-range loudspeakers are of dual-unit construction, with separate units handling the low- and high-frequency regions of the audio spectrum. This contribution is intended to deal with these factors that influence the choice of crossover[1] frequency, the point in the range at which equal amounts of power are being handled by both units.

When two or more units are used to cover the audio band it is necessary to prevent the relatively large low-frequency signals being applied to the high-frequency speaker, for units intended to have good performance in the region of 3000–12,000 cps are necessarily of such light construction that they are incapable of handling high powers in the low-frequency range. In addition it is advisable to prevent the available high-frequency power being dissipated in the low-frequency speaker and to confine it to the units which are best able to convert it into sound. The filters that divide the power between the two sets of speakers are known as dividing networks or crossover filters and have several possible configurations.

However, it is worth pointing out that typical speaker dividing networks may leave the high-frequency unit handling an appreciable amount of power at frequencies below the nominal crossover frequency. The simplest dividing network, that shown in *Fig.* 1, has an attenuation rate above and below the crossover frequency of only 6 db per octave, a point that must be borne in mind when considering the design of both the high-frequency unit and its horn.

**TABLE I**

**Values of Components in Crossover Filter of Fig. 1**

| Crossover Freq → | 500 cps | 5000 cps |
|---|---|---|
| $L_1$ | 4.77 mh | 0.477 mh |
| $C_1$ | 21.2 μf | 2.12 μf |

$$L_1 = \frac{R_o}{\omega_c} \text{ Hy.} = \frac{15}{3140} = 4.77 \text{ mh at 500 cps}$$

$$C_1 = \frac{1}{\omega_c R_o} \text{ F.} = \frac{10^6}{3.40 \times 15} = 21.2 \text{ μf at 500 cps}$$

Two-way systems have been commercially produced with crossover frequencies as low as 200 cps and as high as 5000 cps, this wide variation rather suggesting that the "best" crossover frequency is not subject to precise determination. The factors controlling the choice differ somewhat as between professional and domestic installations and so the problems will be discussed in that order.

The difficulties involved in designing any loudspeaker with a flat response are roughly proportional to the number of octaves that the speaker is intended to cover, though the "difficulties per octave" are perhaps a little higher at the top end of the audio range than they are at the bottom end. The materials currently available for manufacturing diaphragms have densities that are much too high in comparison to the density of air. This is one of the prime causes of the low electro-acoustical efficiency of loudspeakers, the penalty being particularly severe at the top end of the frequency range. A division of the frequency range into two equal four-octave bands would place the crossover frequency at 800 cps, but the problem of designing an efficient high-frequency speaker would be eased by shifting the crossover frequency up by one octave leaving the low-frequency units to handle five octaves and the high-frequency unit three octaves. The good performance over the band between 500 and 12,000 cps of several of the commercial units shows that the problem, though difficult, can be solved if a low price is not a primary requisite.

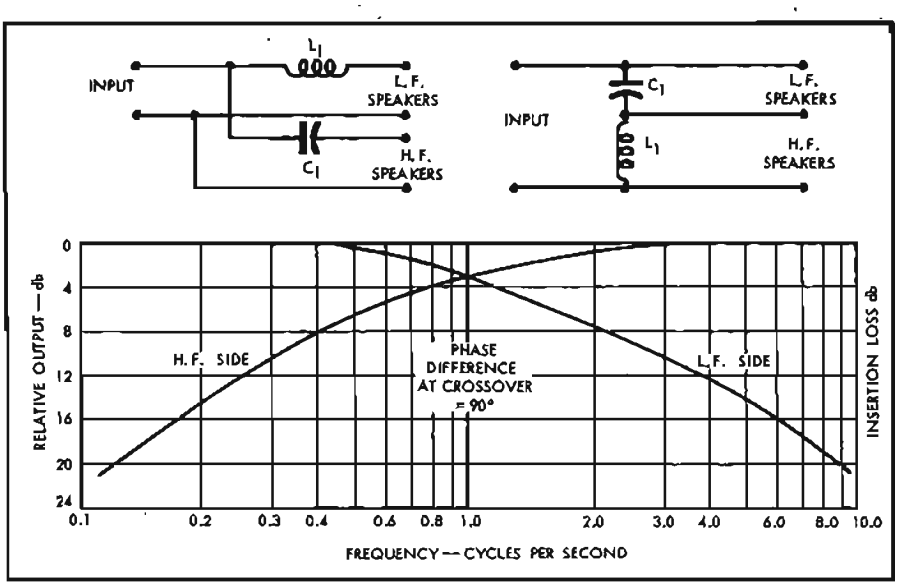


Fig. 1. Performance of a simple filter-type dividing network.

### Power Division

An alternative and probably more reasonable approach is to divide the

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[1] The author's term, *ohangeover,* was converted to the more familiar (in U.S.A.) *crossover* by the editors.

total audio power equally between the H.F. and L.F. units but as the audio power in a typical orchestral composition is not uniformly distributed throughout the audio range this does not mean that the total *frequency* range is divided equally between H.F. and L.F. units. The peak power spectrum of a typical orchestral composition is indicated by (A) in *Fig.* 2, from which it will be seen that the major peaks are concentrated in the low-frequency end of the spectrum below 500 cps. Graphical integration of the peak power spectrum indicates that a crossover in the region of 330 cps results in equal division of the total peak power between H.F. and L.F. units. The distribution of peak power throughout the audio spectrum is an important factor, for it is the peak powers that determine the peak excursion of the speaker diaphragm and its liability to mechanical failure. Heating of the voice coil may also set the limit but this is proportional to the distribution of rms power throughout the audio spectrum, the data on this being presented at (B) in *Fig.* 2. While the rms power distribution differs radically from the peak power distribution, it will be seen that the maximum rms power—and therefore the maximum heating of the speaker voice coil—also occur at the low-frequency end of the range.

Consideration of either peak or rms power spectra suggests that the crossover frequency should not be below 500–600 cps in view of the desirability of minimizing both the diaphragm excursion and the power that must be dissipated as heat by the H.F. speaker voice coil.

Most professional loudspeaker systems employ horn type speakers for both high- and low-frequency reproduction but it has been shown that horns used with high power systems may introduce distortion due to the non-linearity of the air in the throat. Among other factors, this distortion is proportional to the number of octaves handled by the horn,

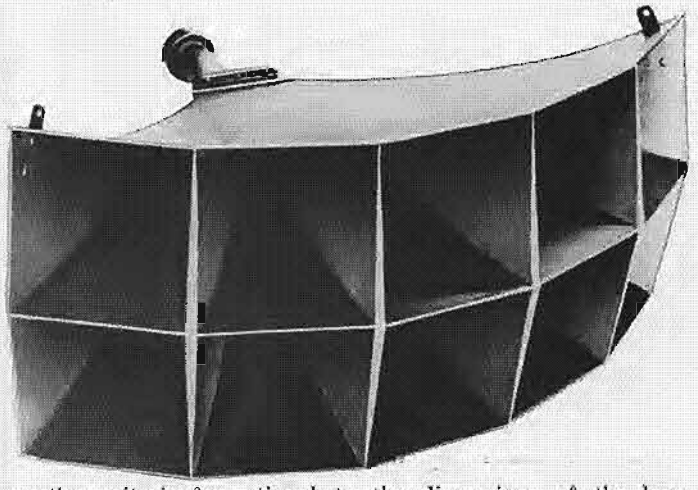

Fig. 3. Typical multicellular horn intended to give a uniform polar diagram over a wide frequency range.

thus suggesting yet another criteria for choice of crossover frequency. The product of (*power*) × (*bandwidth in octaves*) should be equal for both H.F. and L.F. units. On this basis the crossover should occur somewhere between 330 and 800 cps, 500 cps being the geometrical mean of these two limits.

### Distribution Pattern

In a monophonic reproducer system intended for use in a large hall, one of the most important factors in obtaining good performance and particularly good presence or good intimacy, is a speaker system having a polar diagram tailored to fit the auditorium. A monophonic reproducing system prevents the hearing system using its facility of discriminating against the generally reverberant sound and in these circumstances it is always advantageous to minimize the amount of sound falling on the side walls of the auditorium. This may be achieved by designing the speaker system to have a distribution just sufficiently wide to cover the seating area and uniform in angular distribution down to somewhere in the region of 400–500 cps. It is particularly important to obtain uniform angular coverage in the range between 400 and 2000 cps. The beam width of a horn loudspeaker is to a first approximation inversely proportional to the dimensions of the horn mouth, with a useful measure of control being secured only above the frequency at which the horn mouth is one wavelength wide. If a mouth much in excess of two wavelengths wide is used, highly undesirable side lobes appear, though this is a difficulty that can be largely obviated by multicellular construction such as shown in *Fig.* 3. Practical difficulties in building a horn make it necessary to limit the dimensions of the mouth of a multicellular horn but a horn mouth 2 feet across is quite feasible. This gives adequate control of the polar diagram at frequencies of 300 cps and over.

There are practical advantages in limiting the depth (length) of a cinema horn as it must be accommodated behind the screen and thus from this point of view it is advantageous to place the lower cutoff frequency of the horn as high in the frequency range as possible for this results in a short horn. However 40 inches is usually available in the average theatre and within the limits of these dimensions a crossover frequency of 500 cps appears to be a good compromise for it enables the cutoff frequency of the horn (due to the finite mouth area and rate of taper) to be placed at about 250 cps, a desirable value for the ratio of crossover frequency to horn-cutoff frequency.

In the crossover region, approximately one octave above and below the crossover frequency, the over-all response is due to the outputs from both loudspeakers. A smooth combined performance is only obtained when the two units are as close together as possible with their diaphragms in the same plane. This will be clear from *Fig.* 4 showing the effect of having two loudspeakers radiate the same sound power. A listener seated on the axis of the lower loudspeaker will receive sound from the two loudspeakers over paths of slightly different lengths and thus the sounds will arrive at the listener's ears at slightly different times. Looked at in the conventional manner they will arrive with slightly differing phases. At those frequencies at which the

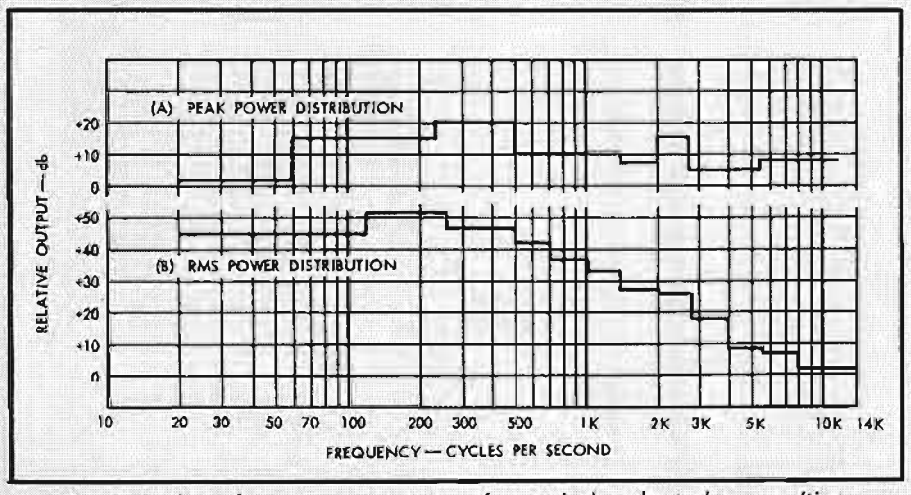


Fig. 2. Peak and rms power spectra of a typical orchestral composition.

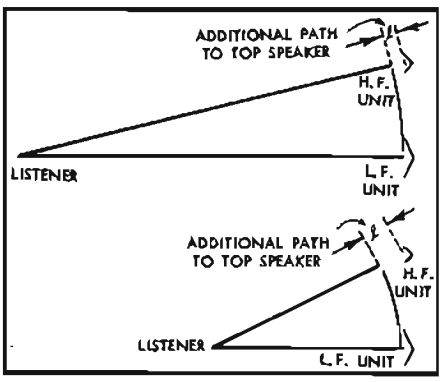


Fig. 4. Effect of spatial displacement of two loudspeakers.

path length *difference* is exactly one half the wavelength the two sounds will be in phase opposition and there will be complete cancellation at the listener's ears.

This is a wavelength effect and therefore the path-length difference that results in complete cancellation will be inversely proportional to frequency. Thus if the crossover frequency is 500 cps the wavelength is 24 in. and destructive interference will result when the path-length difference is 12 in. At a crossover frequency of 3000 cps one half wavelength corresponds to a path-length difference of only 2½ in. and this small displacement will result in a severe dip appearing in the combined response due to interference.

Similar interference will result if the two speakers do not have their diaphragms in the same vertical plane even though the units are coaxially mounted.

As this trouble is a wavelength effect the amount of latitude in mounting is greater when low crossover frequencies are used. In cinema installations the use of backward sloping screens and radically different constructions for H.F. and L.F. speaker horns often makes it impossible to mount both horns in the same vertical plane and thus the latitude in positioning given by a low crossover frequency is invaluable.

Although the point is not well documented it would always seem unwise to divide the frequency range anywhere in the 600–1700 cps band for this region contains most of the important character-forming components (the formant bands) in speech and it would appear advisable to have them all appear from one point in space. It is always dangerous to change horses in mid-stream.

On considering all the foregoing arguments it would appear that the balance of advantage lies with a low crossover frequency, at least in professional installations. There can be no well defined optimum crossover frequency but somewhere in the region of 500–600 cps seems to have the majority of advantages. Choice of a crossover much below 500 cps results in too much power being diverted to the relatively fragile H.F. unit while the directivity and uniform throat impedance requirements necessitate large H.F. horns.

Crossover frequencies higher than roughly 600 cps bring the crossover into the middle of the important character forming band and demands that the large and bulky L.F. horn be designed to provide uniform directivity in the region above 500 cps.

It is perhaps significant that crossover frequencies of 250, 330, and 500 cps have all been employed in commercial sound film systems at some time or other, though it is equally significant that a crossover frequency of 500 cps is now almost standard with all the cinema equipment manufacturers.

### Domestic Systems

When a high-quality domestic speaker system is being designed there are a number of additional factors to be considered, while some of those already discussed have modified significance.

In general the listeners sit closer to the speaker system and interference between units due to path-length differences becomes a more serious problem, a point illustrated by (B) in *Fig.* 4. As the listener gets closer to the speaker assembly, the path-length difference increases and thus the dip in response due to interference moves lower down in the frequency range. Room reverberation is also less effective in masking the irregularities. Coaxial mounting of H.F. and L.F. units is almost essential if the smoothest possible performance is desired. This places an immediate limit on the dimensions of the H.F. horn if a horn type H.F. unit is used, for its length cannot greatly exceed the back-to-front depth of the L.F. unit, while the mouth must not be sufficiently large to obscure an appreciable fraction of the L.F. cone. A typical 18-in. coaxial speaker unit, *Fig.* 5, with an adequate magnet will have a depth of about 11½ in. but about 1½ in. must be allowed for the depth of the rear cover plate and the diaphragm assembly, leaving only 10 in. for the horn length. The horn mouth cannot exceed roughly 6×4 in. if it is not to mask off most of the center of the L.F. cone. These dimensional limitations fix the horn cutoff in the region of 600 cps but if the throat impedance is to be kept roughly constant the horn should not be used below about 1000 cps. However a 6×4 in. horn will have no real control of the directivity pattern at 1000 cps and this makes it preferable to use a crossover frequency nearer 2000 cps where the horn mouth is about one wavelength wide. This fits in fairly well with the previous decision not to use crossover frequencies between 600 and 1700

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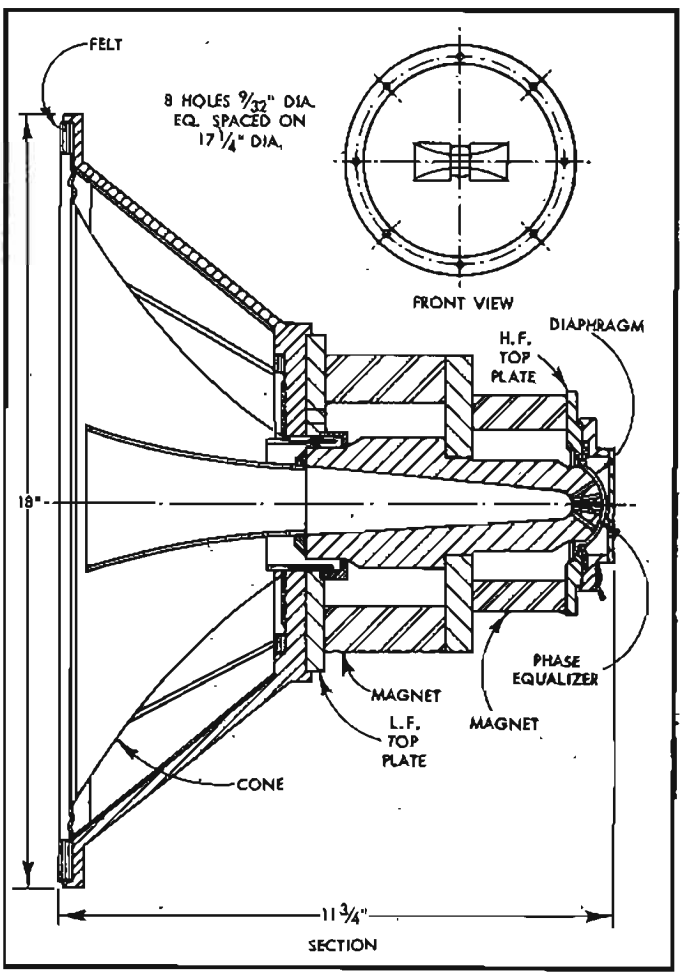


Fig. 5. Typical coaxial speaker unit.

# An Eight-Position Mixer

**For small studio, medium-sized studio, as an extra in a large studio, or for the advanced hobbyist-experimenter who does a lot of recording, this mixer panel will make ordinarily difficult operations much simpler, and still provide professional results.**

MORRIS DOLLENS*

IN SETTING UP a small recording studio for tape, disc, and film recording, we decided that a mixing panel would be the center of our sound activities, especially for dubbing and re-recording on film. Commercial mixers are undoubtedly worth all they cost, considering the engineering that goes into them and the quality that comes out, but our budget did not allow for such an eight-position mixer, so a number of standard circuits were adapted into a very satisfactory control panel, shown in *Fig.* 1.

For our purposes we needed one optical sound-on-film input, three microphone inputs, one tape input, and three high-level phono inputs. An extra tape playback with its own preamplifier can be substituted for one of the phono inputs when desired. Of course, it is impossible to handle all the knobs at once, but in use some of them are set to limit the volume to a desired level when the operator of each phono, tape, or film machine turns the preamp volume all the way up on cue. This makes the mixer's job much more practical.

Since the final recording in most of our work would be on 16mm optical sound track with a volume range of about 25 db, a volume compressor was built in, although this can be rendered inactive by turning the compressor-expander control to zero. For some types of films where the anticipated audience or projector noise is high, greater intelligibility results from compressing the volume range to as little as 15 db. Occasionally in playing back or correcting for final re-recording of old or noisy films or discs, the volume expander can be used sparingly to improve the signal-to-noise ratio.

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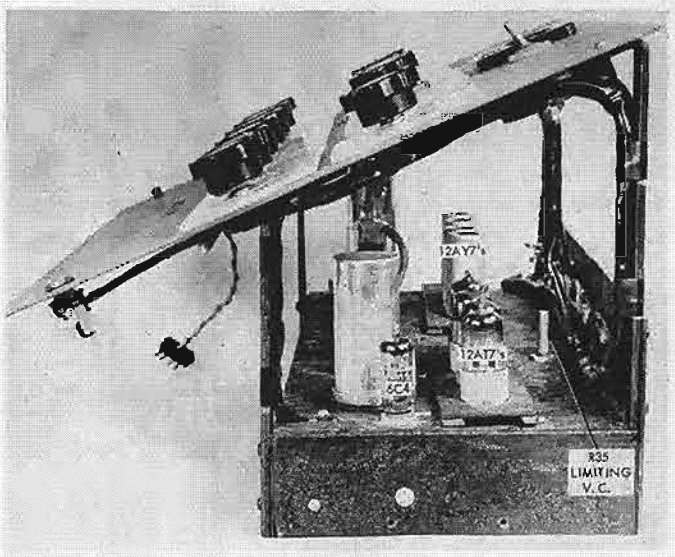



Fig. 2. End view of mixer panel and chassis showing sponge-rubber mounting of mixer and preamp tubes.

### Hum and Noise Prevention

Two annoying features in our previous experience with home-built mixers were hum and microphonics in the preamplifier circuits. Hum was attacked in a number of ways—separate aluminum chassis for amplifier-mixer and power supply to start with. A compact portable unit was desired, and with high-impedance inputs, the power supply chassis sitting next to the mixer does not seem to induce hum. If low-impedance microphone input transformers are used, it may be necessary to have the power supply three or more feet away from the mixer chassis. Sometimes it is possible to orient the power transformer so that little or no hum is induced in the mike transformers; connect each of the latter in turn to the input of another high gain amplifier, and with the 60-cps current applied to the power transformer primary, rotate the power and mike transformers until the hum is reduced or eliminated. The final test, of course, is made after the mixer is constructed, with the volume level set for pickup of the weakest sounds anticipated, and connected to a power amplifier and speaker —earphones will not reproduce the low-frequency hum efficiently. If too much hum is present, and the hum is reduced by moving the power supply away, a two-unit outfit is indicated, with a power cable long enough to put the hum out of sight (or ear, in this case).

The possibility of ground loops was avoided by insulating or taping the shielded signal wires where they might touch the bare chassis; grounding the shielded wires to the volume controls,

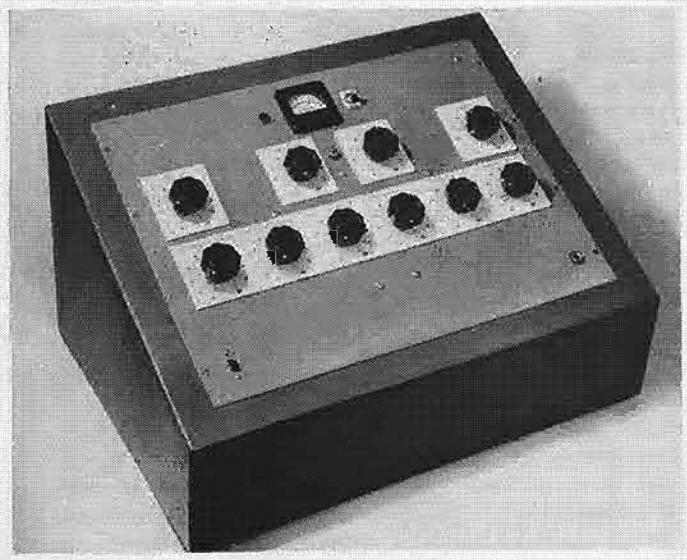


Fig. 1. Neat efficient appearance of this panel gives even the experimenter's workshop a professional look.

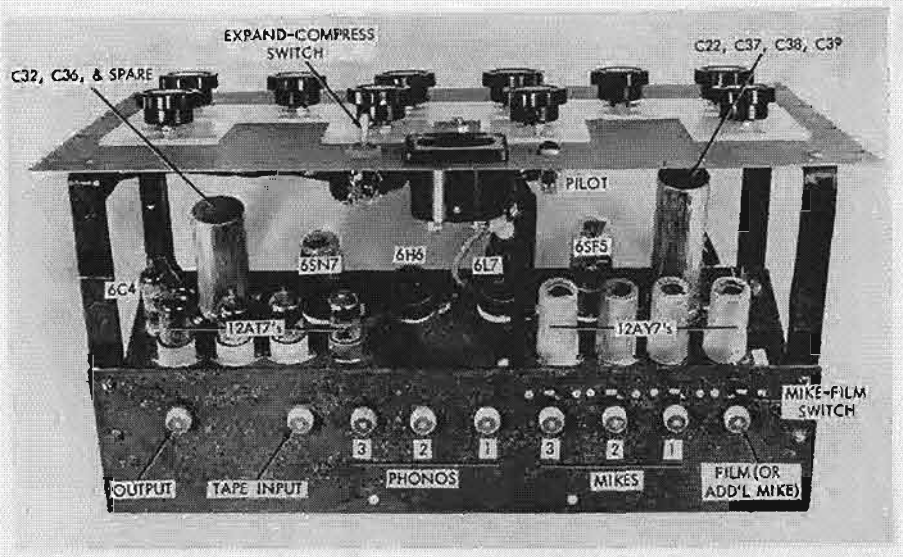



Fig. 3. Rear view of panel and chassis out of its cabinet to show tube arrangement.

which are insulated from the chassis by fiber washers. Inside the chassis, the braided shields were soldered to the grounding bus bar running the length of the chassis and connected to the chassis at one spot only. Using audio cable with outer insulation would eliminate the need for taping under the panel, but would require strapping down under the chassis, rather than soldering to the ground bar.

The final item in hum prevention was to supply all the heaters of the pre-amplifier and mixer tubes with filtered direct current, although perhaps only the mike preamplifier tubes would require d.c. A 115-volt isolating transformer, with rectifier and filter, conveniently supplies 150 milliamperes of d.c. for the eight series-connected heaters, and a 25-watt variable resistor is used for adjusting the exact voltage. If using d.c. on only the mike preamp tubes, a somewhat less expensive supply might result from running the four heaters in parallel, 12 volts at 600 ma.

Microphonics were subdued by using miniature dual triodes instead of our old (but tender and ticklish) standbys, 6SJ7's, and mounting the sockets on strips of aluminum which were mechanically insulated to some extent from the chassis by ¼-in. strips of sponge rubber cemented in place. Wiring was done with rather flexible hook-up wire from these sockets to terminal strips holding the associated resistors and capacitors. Preamplifier tubes are naturally fairly sensitive to vibrations; tube shields were added as an extra precaution.

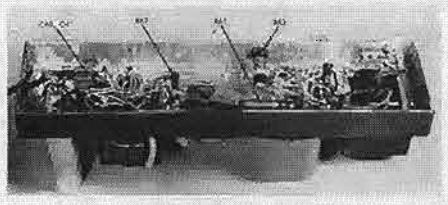


Fig. 4. Power Supply chassis, underside.

### Circuit Details

A bias control on the expander tube acts as a master gain control, although the effect is not exactly like a normal volume control—its action is slower in building up if turned fast due to the bias capacitor across it, but for our purposes it is used mostly to adjust for the level at which expansion or compression starts. A switch near the meter alters the circuit for either compression or expansion. An additional standard volume control, $R_{33}$, is mounted on the mixer chassis, as seen in *Fig.* 2, to limit the voltage fed to the 6L7—this can be mounted on the top panel if desired.

A jack for earphone monitoring was provided for the times when the mixer would be used in the same room or studio with actors or speakers, and where a monitor speaker would feed back. A separate tube for this function isolates the phones from the main audio channel, and prevents any drop in signal or audible clicks even if the phones are plugged in during recording. No volume control was used here, but one could be installed easily, preferably on the lower chassis, since it would not be changed much after initial setting.

The 2½-in. square volume indicator meter has a 0–1 ma movement, and was chosen from a number on hand because it follows the sound changes rather faithfully without jumping wildly about. Somewhat smaller than the size of meter usually selected for this purpose, it does its job adequately and leaves more room for control knobs on the panel. Of course, a larger meter could be substituted, but before mounting, hook up your choice temporarily (with its rectifier) to the 4- to 8-ohm output of another amplifier and observe its action—if it reacts too rapidly, it will be hard to follow in use. Budget and panel space permitting, a standard VU meter would be preferable. This one worked smoothly enough so that we never replaced it.

### Physical Details

The top panel of the mixer is 14 × 19-in. steel, a standard rack panel size, but since the one used was 1/16-in. thick, a ½-in. angle iron 17-in. long was bolted across the under side near the volume controls to prevent sagging. Flat head machine screws were used, and the heads were hidden by the control plates. This particular panel has round mounting holes instead of the usual slots. A ⅛-in. thick aluminum panel would be stiffer, but the sharp corners should be lightly filed to avoid scratching the operator.

*Figures* 2 and 3 show the 17 × 7 × 2½-in. amplifier chassis which was bent of 1/16-in. soft aluminum, with a 4-in. panel at the back to hold the Amphenol input and output plugs, which are insulated from the chassis with the fiber washers provided. Other types of input connectors could be used. A slightly larger chassis is recommended, such as a 17 × 8 × 3 (Bud AC412 or equivalent), mounting the input connectors on the upper part of the chassis back.

The top panel is supported by four brackets bent from ⅛ × ¾-in. strap iron; aluminum about this size is available in hardware stores, and it bends nicely. Allowance is made at the front for the height of the power supply, plus about an inch of space above the rectifier tube to install an insulated cooling vane if necessated by excessive heat. It was not required in our mixer when used for only two or three hours at a time. The angle of the panel top is set at about 22 deg., although this could vary depending on the builder's preference.

The power supply, *Fig.* 4, was built on another aluminum chassis bent especially for the purpose, approximately 17 × 4 × 2 in. Two smaller chasses about 8 × 4 × 2 might be bolted together end-to-end, or a 17 × 4 × 3 deep chassis (such as Bud AC432 or equivalent) can be used, with a sunken mount for the rectifier tube, as shown in *Fig.* 5. If a two-unit mixer is not considered too cumbersome, or is found necessary when using hum-sensitive mike input transformers, the power supply could be any shape, preferably enclosed in a steel box. In

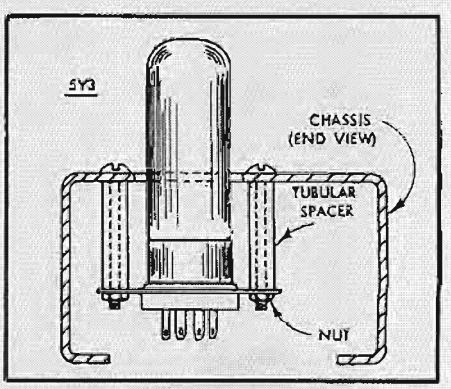



Fig. 5. Method of recessing rectifier tube socket to conserve height.

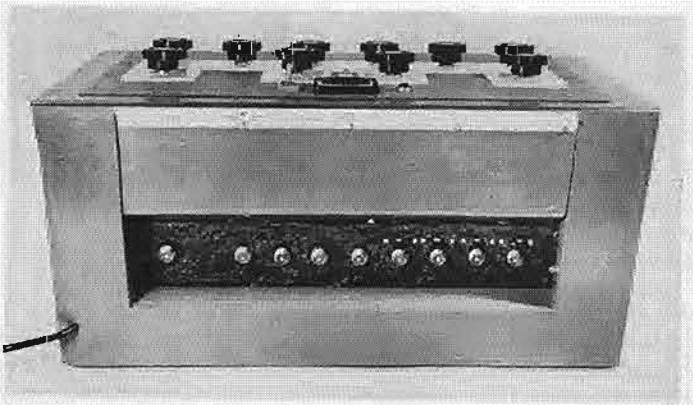


Fig. 6. Rear view of cabinet. Sunken panel for audio inputs allows mixer to be placed near wall. Hinged flap lifts to replace tubes.

turers do not advise more than 0.5 volt) this case, the mixer panel size could be reduced to about 10 × 19 in.

The cabinet, *Fig. 6*, was made of ⅜-in. plywood, with the top allowing about 1½ in. of wood to show all around the panel. A somewhat simpler box with sides flush with the panel would make a more compact cabinet for strictly portable use, but we preferred the solid impressiveness of a larger box. Three coats of dark gray-green satin enamel cover the plywood look, and make a pleasing combination with the gray wrinkled panel and black knobs. All-steel sloping panel cabinets are available from the supply houses for those builders not equipped to construct their own of wood.

*Figure 7* shows the special control plates which were made by paste-up art letters and photography; double-weight paper prints were mounted beneath ⅛-in. plastic dial plates, giving a professional appearance, although they are difficult to show clearly in the photos because of internal reflections in the plastic. Conventional stock aluminum dial plates can be used here at less expense. Round knobs with pointers might be preferred by other builders; approximate positions of knobs on our model are indicated by an orange-painted drilled hole on each knob.

To allow for the cooling space above the rectifiers, the power supply was dropped down about one inch; actually the amplifier chassis was raised one inch from the cabinet floor by a small plywood platform, as seen in *Fig. 8*. It seemed to be easier to build the box to fit the chassis as we did, rather than try to adjust the angled brackets to fit the box. Depending upon the chassis used and the exact layout of parts, the spacing will vary, so the box dimensions are not given.

An opening about 3 × 16 in. was left in the cabinet back to attach the audio cables, and a hinged flap above this allows tubes to be changed without taking the amplifier out of the cabinet. Above the four high-gain inputs are four slide switches which cut the gain of the preamplifiers by tapping down on an input voltage divider. This cuts the volume to the first stage to prevent overloading when applying signals from higher-level sources such as a film projector. Only the film sound input was wired as shown, the rest remaining unconnected.

The three mike inputs could be changed to low impedance inputs with the addition of input transformers, preferably well shielded; low-impedance mike cables will pick up less hum and lose less high-frequency response in a longer cable. One or more of the high-gain inputs could be changed to magnetic phono preamplifiers with the proper equalization. Many variations are possible for individual applications; circuits with various types of equalization for phonograph pickups can be found in the many preamplifier articles in past issues of this magazine.

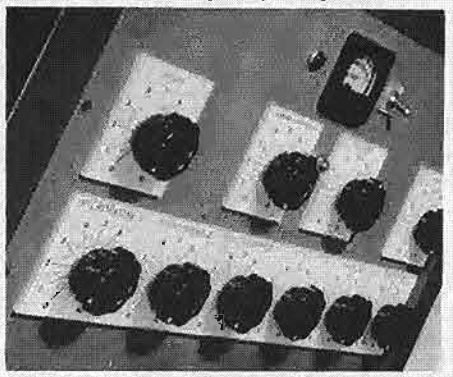


Fig. 7. White photographic paper dial plates under ⅛-in. plastic contrast with black knobs and gray panel.

If a tape playback head is not more than three or four feet from the mixer, one of the high-gain inputs can be equalized for this purpose; the system we use, however, has the preamplifier and equalizer on the tape chassis, boosting the signal up sufficiently to prevent hum pickup in a ten-foot shielded cable fed by a cathode-follower circuit. This same method is applied to a film projector about the same distance away.

Using a crystal mike and listening through 2000-ohm phones, the mixer has more than ample gain—chirping birds were heard with considerable volume through an open window, and a whisper a dozen feet away was clearly understood; along with such sounds came traffic and neighborhood noises for some distance. With this much amplification, trouble may be encountered with noisy resistors and tubes—in which case, cut-and-try selection of quieter resistors and tubes for the early stages is advisable. Little trouble in this respect was encountered, although some tubes seemed to have heater-to-cathode leakage, causing hum, and discouraging the original idea of operating the d.c. heaters from a rectifier directly off the power line—the isolation transformer eliminates the shock and hum possibility here.

### Circuit Arrangement

The actual mixer section consists of four dual-triode 12AT7's, eight triodes in all, with common cathode and plate resistors, as shown in the amplifier schematic, *Fig. 9* The superiority of this mixer circuit with a separate triode input for each volume control can be recognized in that turning one control to zero or full on does not affect the others, while the usual simpler mixer with three or four controls isolated with resistors from a common grid results in an undesired interaction; turning one control in the latter type of four-position mixer changed the sound level in the other circuits 10 to 15 per cent, admittedly of small importance in a public address or home music system, but not desirable in a quality recording system, with eight inputs increasing the effect.

Using a 1000-cps tone and a v.t.v.m., we measured the voltage gain of each 12AY7 dual-stage preamplifier at about 600; gain of the mixer stage is about 5, which can be dropped to 3 if desired by eliminating the cathode by-pass capacitor. The 6L7 stage has variable gain depending on the setting of its bias control, $R_{77}$, which acts as a master volume control on our model, with approximate gain (on our particular control) of 0.5 with the dial set at 4, a gain of 1 at a setting of 6, 2 at 7, and 10 with the control full on. With one volt applied to the 6L7 grid (the most allowable without distortion, although some manufac-

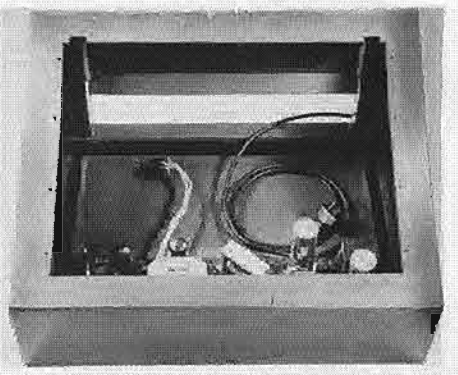


Fig. 8. Mixer cabinet, of plywood, with power supply installed. Cable with Jones plug supplies mixer chassis with power.

the voltage output to the cathode follower is approximately equal to the gain of the 6L7. Gain of the follower is about 0.9; we use a setting of the 6L7 gain control so that a maximum output level of about 3 volts allows the input gain controls of our power amplifiers to be set at one quarter to one half.

When using the 6L7 as a volume expander, a lower setting for average volume is desirable, so that high peaks will not overload upon expansion. Considerably increased contrast between soft and loud passages can improve the reproduction of older recordings with limited dynamic range, although some experimenting will usually be required for the most pleasing rendition. Some older records will be worn more in the loud passages and when expanded will sound much worse, so don't blame the machine if this happens. Distortion is less noticeable at lower volumes, so in salvaging old recordings, check the wear before re-recording. Many old 78's are worn at the start and finish of each side due to incorrect tracking throughout the swing of the pickup arm. It is possible to expand over 20 db more than the dynamic range of the original signal with this circuit, wherein the background scratch is completely inaudible and the loud passages come thundering out and take off into extreme overload—a little expansion goes a long way. Newer LP records, especially of large orchestras, have a much greater dynamic range, so that expansion will probably not be desired in playing these. In fact, for background or dinner music, it is possible to use the compressor to even out the large variations in volume, so as not to intrude on the conversation.

Volume compression is effective in recording or dubbing on to film the greater dynamic range of magnetic tape or live actors, and here a higher than normal setting of the 6L7 gain control seems to work best, giving a less abrupt cut-off in overloading. One comment in regard to room noise picked up by the microphone—if someone speaks too loudly, causing the amplifier to go into compression, a leveling out of the voice by this action will cause the background noise to be momentarily reduced, so that for the most natural compression, it is

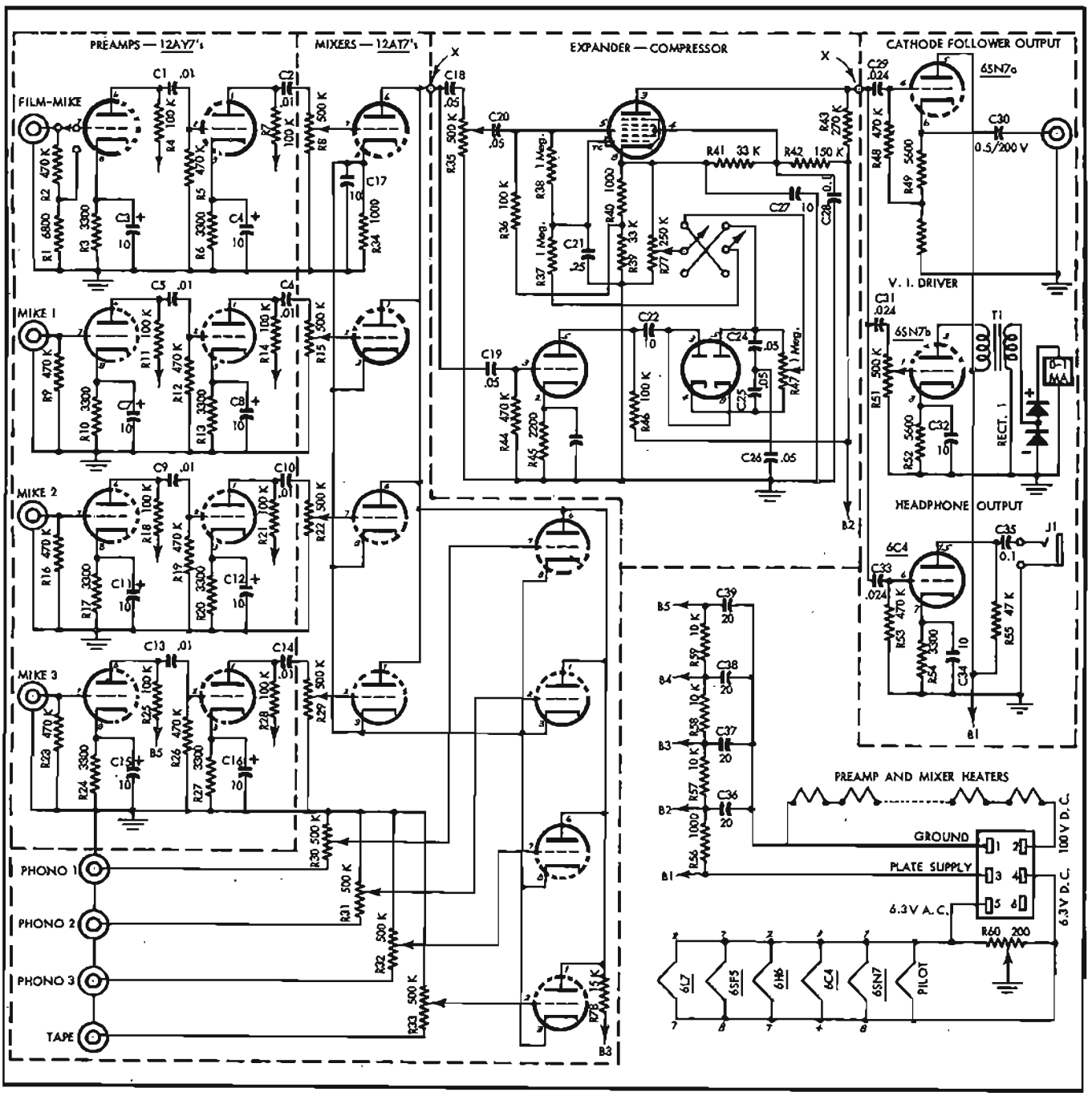
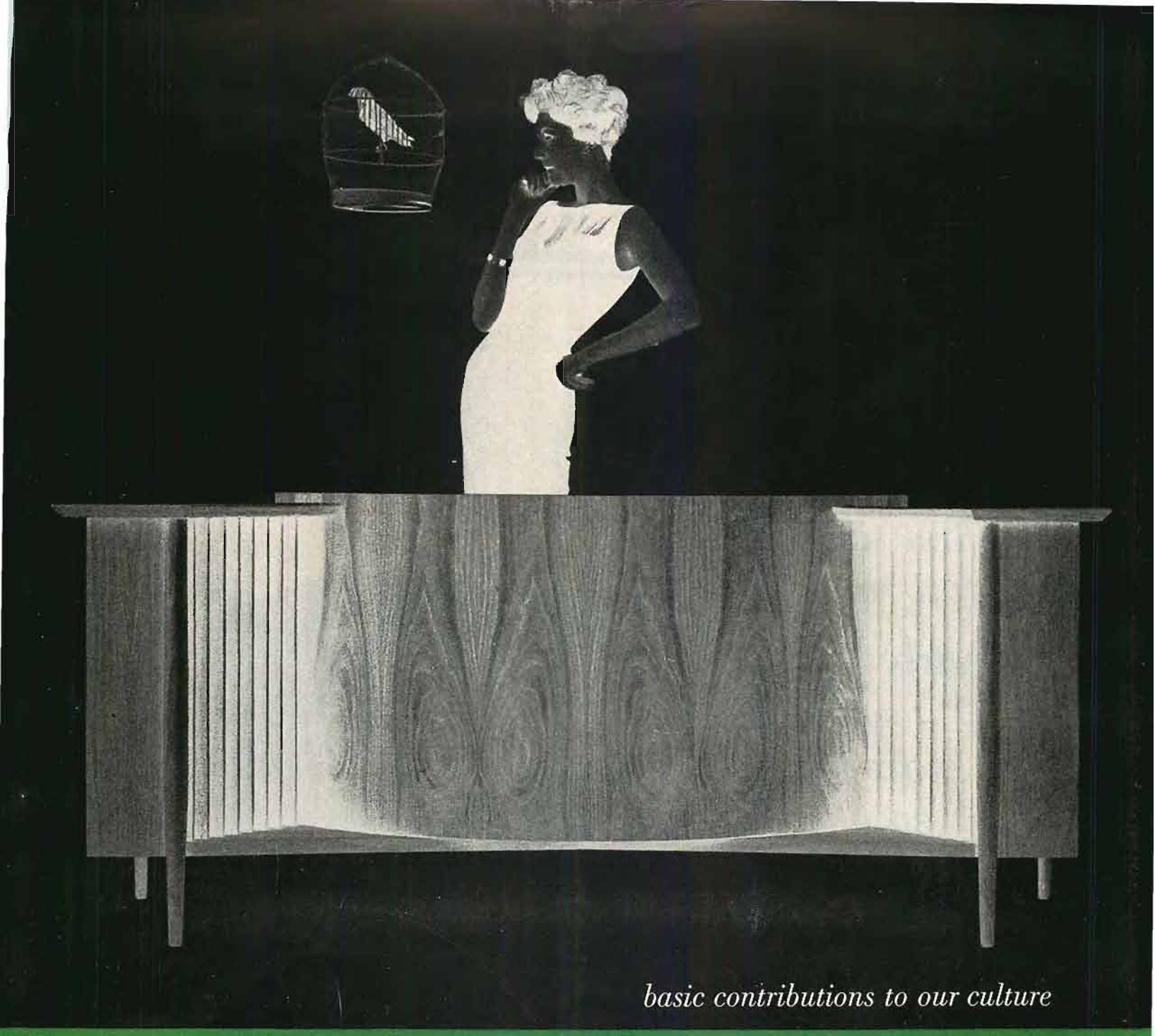



Fig. 9. Complete schematic of mixer amplifier section.



*basic contributions to our culture*

We are indebted to William Henry Fox Talbot for the invention of the photographic negative and discovery of the latent image. His work greatly advanced the art-science of photography. More than a hundred years later the laboratories of James B. Lansing Sound, Inc., developed the principle of radial refraction, a break-through which may prove to be equally significant in the field of stereophonic music reproduction. First applied to the magnificent JBL Ranger-Paragon, an instrument originally designed for use as a monitor in perfecting stereo recording techniques, radial refraction has now been used in a more compact, home-sized stereophonic loudspeaker system called the JBL Ranger-Metregon. The curved refracting panel on the front of the dual acoustical enclosure integrates two precision loudspeaker systems. A wide-angle stereo field is radiated throughout the listening area. Radial refraction obviates the hole in the middle, ping-pong effects, and split soloists which plague expedient stereo arrangements. No less than seven different speaker systems, including one with new high frequency drivers, exponential horns, and dividing networks may be installed in the Metregon. You may very well be able to use some of your present JBL loudspeakers. Write for a complete description of the JBL Ranger-Metregon and the name and address of the Authorized JBL Signature Audio Specialist in your community.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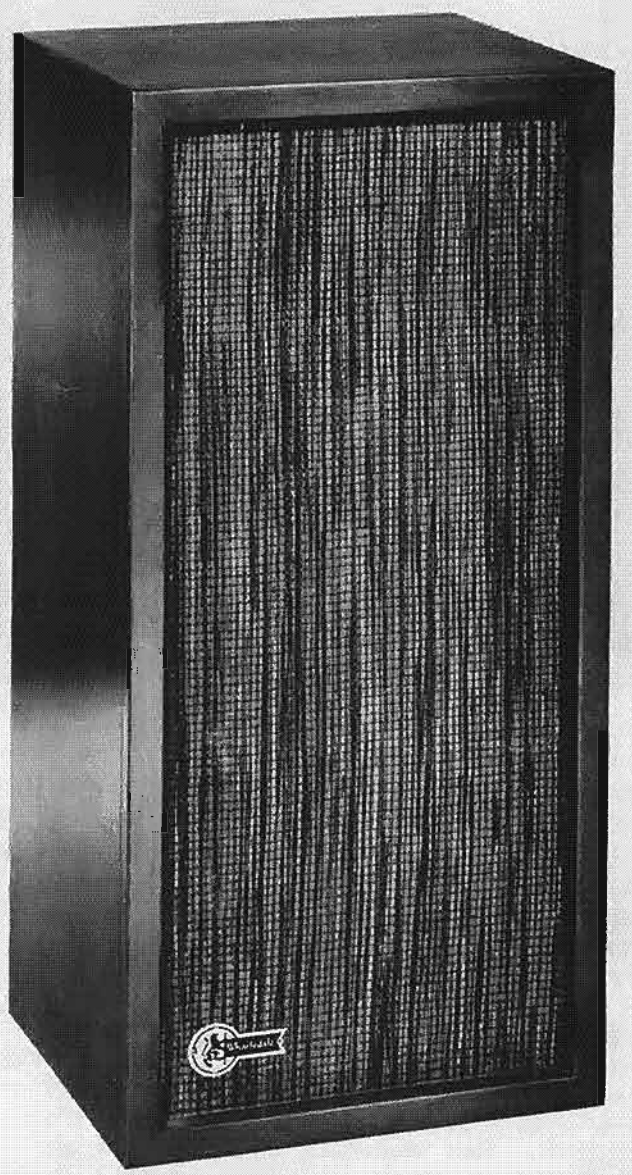

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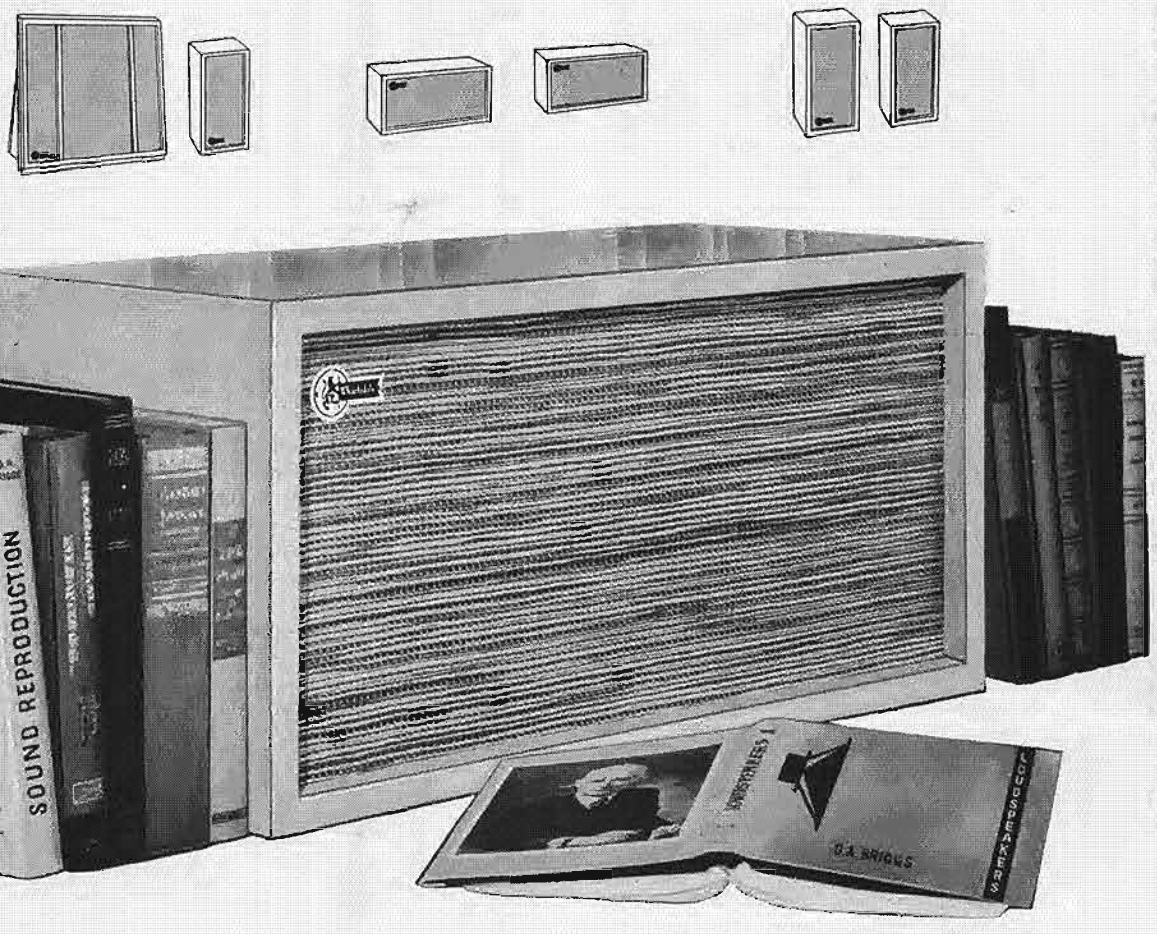


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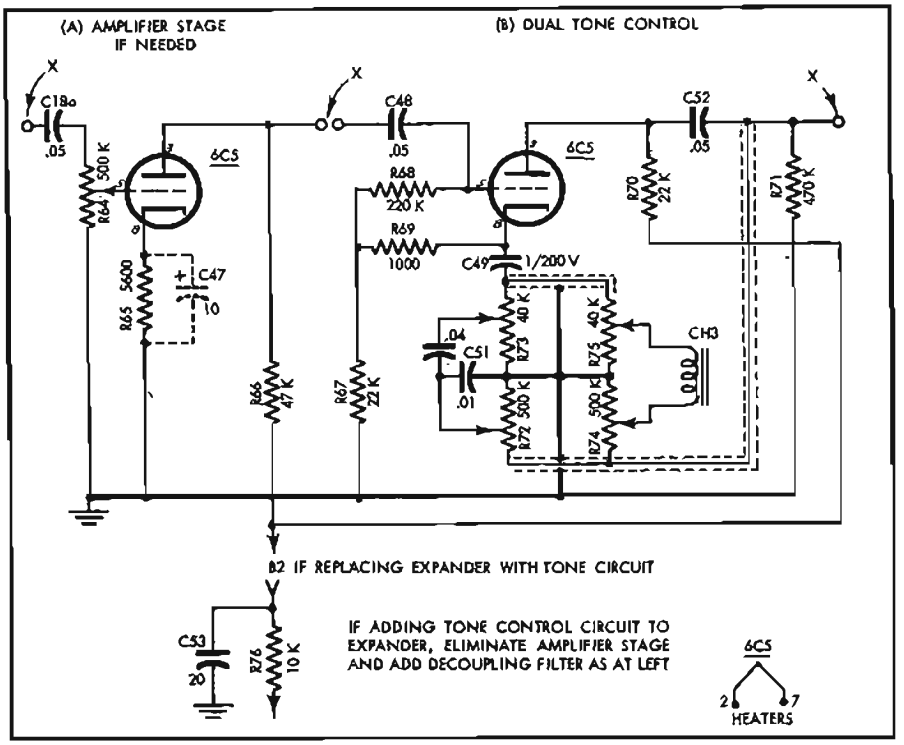


Fig. 10. Schematic of power supply section.

best to have a quiet room. Preamplifier noise acts similarly. Regardless of the background noise or the recording medium, group discussions between a number of people are often improved with respect to volume by careful selection of gain and compressor settings. Considerable rehearsal may be necessary to set the controls just right if much compression is used, or the loudest sounds may be throttled down to a whisper much lower than those of medium level, giving a peculiar inverted effect. A loud shout or gunshot can temporarily cut off the sound completely, until the rectifier capacitors discharge through the compression control, returning the system to normal.

The dynamic contrast of the output signal depends both upon the 6L7 bias-control setting and the amount of expansion or compression voltage. If the 12AT7 output voltage is too large for the 6L7, forcing the use of only the lower range of the bias control, $R_{77}$, turn down the limiting volume control, $R_{95}$.

### Tone Control

No tone controls were incorporated in our mixer, as each output amplifier has its own tone controls or fixed equalizers for individual requirements. The monitor-playback amplifier has a Thordarson dual tone control circuit, as has the disc recording amplifier, with the addition of a fixed equalizer; tape and film amplifiers boost the highs considerably, but the output of the mixer is normal.

A frequency run showed the mixer to be flat within 1 db from 60 to 15,000 cps; at 20,000 cps the response dropped off 2 db in the phono circuits, and 3 db in the mike circuits due to the long shielded audio lines. Shorter, more direct routes could be used, up the center rather than the side posts, with larger insulated low-capacitance cable resulting in less loss at the higher frequencies. No attempt was made to correct by equalizing, as it was felt that response to 15,000 cps was adequate for our purposes at the time, while 16-mm film response is limited to 7000 cps.

A tone control section may be substituted for the expander-compressor if film recording is not planned, as for tape and most disc recording requirements, compression is not usually necessary with a little rehearsal. Our choice would be the Thordarson circuit shown at (B) in *Fig.* 10. As this is a degenerative circuit, it has little gain at normal settings, so that an additional stage preceding it will ensure 4 to 8 volts being delivered to the cathode follower grid. Due to the possibility of hum pickup in the tone-control choke, the extra stage is best put before the tone control stage. If a cathode by-pass capacitor is used in the mixing stage, the gain will possibly be sufficient without this tube; if it is left out, the master volume control can be installed in the cathode-follower grid circuit. If the power transformer is mounted near the mixer, the tone-control choke may have to be oriented for least hum pickup.

Many other dual tone-control circuits have been published, most without the hum-sensitive chokes, and one of these could be substituted at less expense, as the special Thordarson reactor and two dual controls run about $16. However, most of these are interstage affairs using only resistors and capacitors, and represent a considerable insertion loss, so that usually a high-gain dual triode must be used, with the tone-control components between stages.

It may be desirable to have the Thordarson dual tone-control circuit in addition to the expander-compressor circuit shown—in which case, insert it between the 6L7 and the cathode-follower stage. An additional decoupling filter might be necessary to prevent motorboating; (B) of *Fig.* 4 alone (without the extra amplifier stage) includes this filter, as a resistor, $R_{76}$ and electrolytic capacitor, $C_{53}$, in the plate-supply circuit. Throughout the mixer circuits, a separate decoupling filter is used for each stage. Sometimes one such filter for every two stages is sufficient, as succeeding stages are out of phase and should not motorboat, but we decided not to take any chances. Paralleled tubes as in the mixer section and stages operating at approximately the same level (as the cathode-follower, phone, and volume-indicator tubes) do not have to be isolated from each other.

### Circuit Variations

Substitutions in many of the tubes can

(*Continued on page 75*)

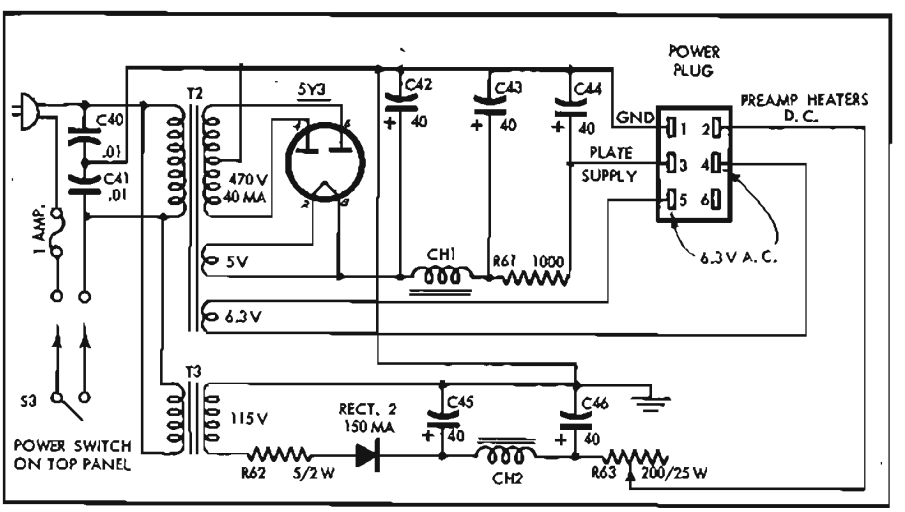


Fig 11. Schematic of tone-control section.

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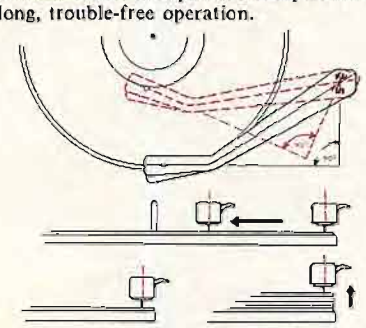
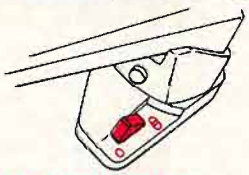


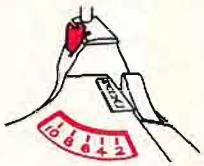
*Always perfect vertical and lateral stereo tracking because arm pivot axis remains 90° to cartridge axis.*

**TONEARM** – Rigid, *locking key* snap-in accommodation for all mono or stereo cartridges. Super lightweight *one-piece* construction eliminates multiple tonearm resonance, minimizes cartridge horizontal and vertical amplitude distortion developed in cartridges when mounted in two-piece or plug-in head type arms. This maintains original cartridge compliance specifications. *Double* set of direct-acting ball bearings (in *both* axes) insures complete freedom of vertical and lateral motion . . . and prevents tracking force variations possible with "damped" or otherwise poorly suspended arms due to changes in weather or environment. Fingertip stylus pressure adjustment is directly on tonearm assembly. Tonearm is *automatically secured* in place, when at rest.

**MANUAL OR AUTOMATIC SINGLE PLAY** Three choices with the 1006! Start manually, with *either* a rotating *or* motionless turntable, setting the tonearm anywhere on the record to play all or just a desired portion. Or push a button and the 1006 starts, and finds the record lead-in groove. In all cases, the tonearm returns to rest after play, motor shuts off, and drive disengages . . . all *automatically!* Stop, repeat, or reject (manually or automatically) any time you please.

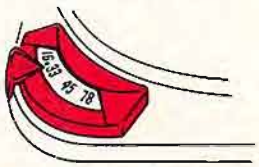


**STEREO/MONO SWITCH** – Does more than instantaneously adapt cartridge for either mono or stereo output! Also introduces special phase-cancelling feedback circuit for stereo cartridges when used on conventional single-track mono records. This *removes* random noises resulting from cartridge high vertical sensitivity to the rough, unused groove trough of mono records. Even mono records sound better. Two color coded 48" output cables are *individually* shielded to avoid ground loop hum.



**BUILT-IN PRESSURE GAUGE** – A *precision* stylus pressure gauge is a vital necessity for the preservation of valuable records and for optimum cartridge operation. A professional, *direct reading* gauge is conveniently located for instant check and adjustment of the entire tonearm, as different cartridges are used. No need for guesswork or to rely on arbitrary, printed calibrations on a tonearm. Tamperproof and factory-sealed for lifelong accuracy.

**TURNTABLE**–Large diameter, heavyweight turntable uses unique, laminated and concentrically girded construction for *positive* retention of dynamic balance and plano surface . . . vital to stereo cartridges. This, and the use of reliable Oilite type, permanently self-lubricating ball bearing assembly provide virtually frictionless, *non-resonant* rotation, avoiding need to rely on "fly-wheel action" of conventional castings, machine turnings, or "weighted" turntables to maintain constant speed. Properly designed table mat prevents record slip without surface strain to the delicate record grooves.

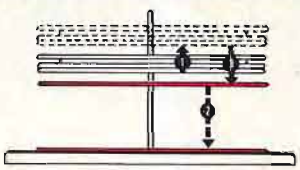


**FOUR SPEEDS**–Self-locking and trouble-free, a multiple transmission system is used. With a set of individual drive gears for *each* speed, possible future changes in recording speeds are thus accommodated. *All* drive and idler wheels automatically disengage after *each* playback and also when machine is turned off . . . nothing to adjust or remember, never any "flat spot thump." Speeds provided: 16⅔, 33⅓, 45, 78 rpm.

**QUIETING CIRCUITS** – Self-muting and squelch filter circuits keep the electrical operation of the 1006 as wonderfully quiet as the mechanical action of the skillfully crafted assembly. No "pops" or buzzes.

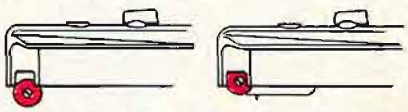
## AUTOMATIC CHANGER — *Whether for stereo or mono reproduction, the outstanding qualities of the 1006 as a professional turntable are remarkably preserved as a record changer too! Look . . .*

**MINIMUM CONTROLS**– Simple to operate in spite of its many special features – only three buttons start, stop, reject, or repeat action. Repeat button is *self-cancelling* after replay, or can repeat same record any number of times without disturbing the stack. Spindle need *not* be removed from turntable to remove records or rearrange record sequence...even while record is playing.

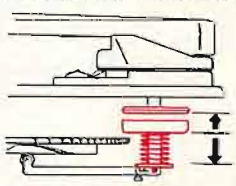


1. *Record stack separates from bottom record.* 2. *Bottom record descends.* 3. *Stack gently lowers for next play.*

**ELEVATOR ACTION** – The bottom-most record of the stack is separated by the action of the changer spindle into an *interim position*, ready for travel to the turntable, and divorced from the weight and pressure of the stack. The stack is gently lowered–*never dropped*–into position for the next record. This unique principle preserves and protects the record center-hole from wear and tear; and since no pusher arm or stabilizing guides are needed, warped records and chipped edges do not affect changer action. Furthermore, the "no load" condition of the stack eliminates damaging friction to grooves of adjacent records. Here is *truly gentle* handling of your precious recordings.



**OBSOLESCENCE-PROOF INTERMIX** –Patented roller-feeler guide in the *tonearm head* enables the 1006 to operate automatically, *regardless* of record size. Future record size innovations are of no concern to owners of the 1006! And, no sequence to observe in stacking up to ten varying size records. Fast change-cycle time is *constant* regardless of RPM or record load.



**FREEFLOATING TONEARM** – Not just a statement, but a *fact*. New, advanced-design clutch *completely frees the tonearm during play*. Since the record lead-in groove-finding device is a part of the tonearm assembly, the arm is engaged by the cycling cam *only* during the start and stop actions.

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# The Amplifier Distortion Story

NORMAN H. CROWHURST*

**Many are the elements causing distortion in amplifiers, ranging from basic circuit design to deficiencies in the individual components. The author points out where some of the pitfalls occur, and shows how to use the transfer characteristic of tubes to study their performance.**

**In two parts—Part I**

MOST OF THE QUESTIONS asked about amplifiers these days relate in some way or other to the question of distortion. According to research in other directions, it has been proved that the quantity of distortion measured in almost any high-fidelity amplifier should be quite inaudible. Certainly it should be inaudible in comparison with the amount of distortion produced by other elements of the system—pickup, loudspeaker, and so on. The fact remains that there are drastic differences between amplifiers that do not seem to be explained by the specification figures.

Over the past few years the writer has presented several different facets of this problem, sometimes in a merely qualitative way, sometimes with further evidence to support the suggestions made. Here is an attempt to document all of the different varieties of non-linear distortion produced in amplifiers as far as has been ascertained to date, together with some suggestions as to what can be done about them.

In discussing non-linear distortion we do not investigate frequency response as such. It is assumed for the purpose of this article that deviation from perfectly uniform frequency response can be tolerated provided it does not produce any spurious components due to non-linear distortion. But frequency discriminating factors in many instances contribute to the forms of distortion produced by non-linear elements in the system. Under these circumstances the frequency discriminating factors must be discussed.

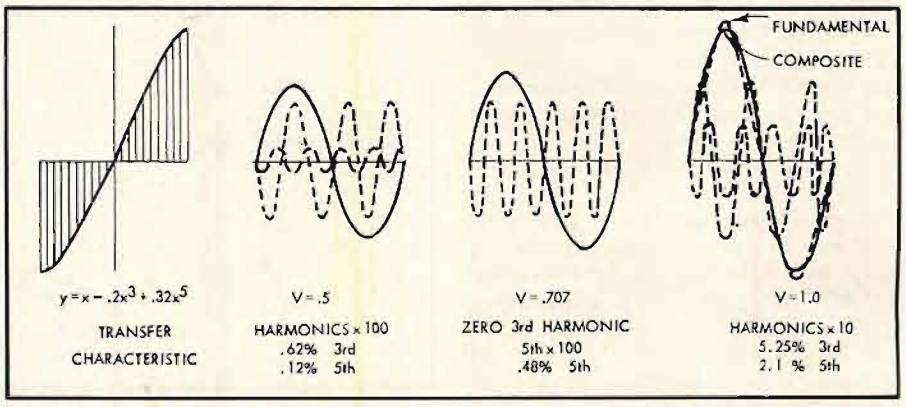


Fig. 2. A possible transfer characteristic, showing how the harmonic varies in order and magnitude over a comparatively small range of amplitude change (2:1 total).

### Harmonic vs. IM Distortion

In the earliest days of audio amplifiers, shortly after they ceased being the tail end of a radio receiver, the only form of measurement for non-linear distortion used the harmonic method. Before the advent of the pentode and other distortion-producing elements for use in amplifiers, the "good old triode" kept the harmonic order of the distortion quite low (usually second) and there was little possibility of confusion or ambiguity by quoting simple percentage figures.

A single-ended amplifier produced dominantly second harmonic and it had been ascertained that second harmonic much less than 5 per cent was not audible. Later it was discovered that an amplifier producing 5 per cent second harmonic also produced IM distortion that *is* audible. However, when push-pull came into use, this largely ended second-harmonic distortion and left a residual of third.

The advent of pentodes increased the order of distortion to fifth and higher odd-order components, each of which becomes progressively more audible as a harmonic and even more objectionable in its intermodulation effects.

The writer has found the best way to investigate what these different things mean in relation to the *amplifier's* performance is to refer the matter in terms of its *transfer characteristic*. This can quite simply be displayed on an oscilloscope by connecting the horizontal deflection to the input (before attenuation, if necessary) and the vertical deflection to the output of the amplifier. This enables the amplifier's transfer characteristic at any particular frequency and level to be displayed on the 'scope (*Fig.* 1).

Over a mid-range of frequencies the effect of reactances in the amplifier is negligible and there is no phase shift. Consequently, the transfer characteristic

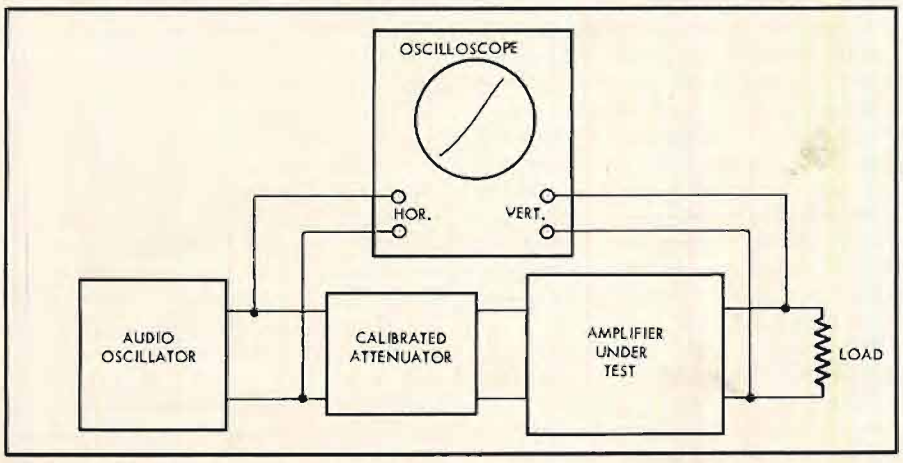


Fig. 1. Block schematic of method for displaying an amplifier's transfer characteristic on a 'scope.

* *216-18 40th Ave., Bayside 61, N. Y.*

is an approximation to a straight line with a series of curvatures that can be represented by power orders of the independent variable.

Second-harmonic distortion is caused by the presence of a second-order or square term, and third harmonic by a cubic or third-order term in the transfer characteristic.

Mathematically any line-transfer characteristic due to a succession of non-linear amplifying stages can be analyzed into a power series.

When considering the effect of an amplifier producing distortion, it should be appreciated that this transfer characteristic is the more basic property of the amplifier, not its effective generation of specific harmonics. Remembering this, the effect of different order terms in the transfer characteristic on harmonics generated can be mathematically deduced.

A second-order or square term produces second harmonic and a steady d.c. component which effectively alters the bias of stages possessing this non-linear distortion.

A third-order term not only adds third harmonic but also modifies the magnitude of the fundamental.

A fourth-order term introduces both second and fourth harmonic.

A fifth-order term introduces third and fifth harmonic as well as modifying the fundamental, and so on.

A term of any specific order produces alternate harmonics all the way up to that order. The coefficient of the harmonics produced by any individual term varies according to the magnitude of signal.

Thus a transfer characteristic that contains third- and fifth-order terms in opposite phase will produce third and fifth harmonics in the same phase at very low levels. At some intermediate level the components of third harmonic due to the third and fifth order terms will cancel leaving only fifth harmonic. While at higher levels the third harmonic reappears in opposite phase.

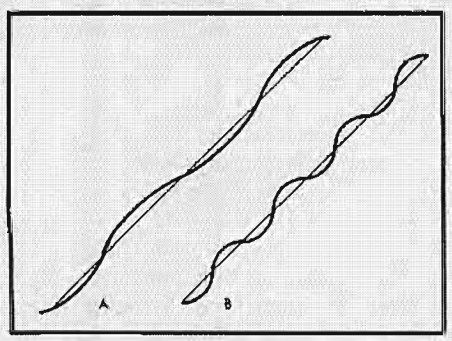


Fig. 3. Where the "kinks" occur can dramatically affect relationship between different distortion indications: (A) a typical deviation from straight (exaggerated for clarity); (B) a hypothetical (but not necessarily impossible) curve, investigated in Fig. 4.

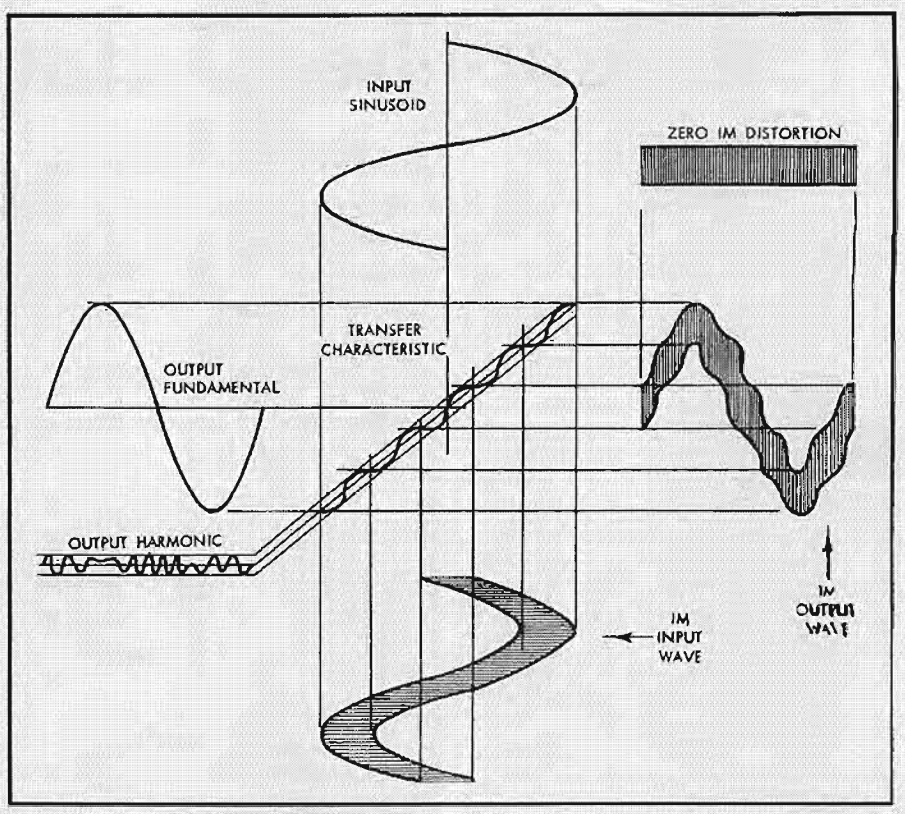


Fig. 4. How the rather unusual curve of (B) in Fig. 3, can give zero IM distortion indication, but quite a considerable harmonic indication.

This possibility is illustrated in *Fig.* 2.

This is a comparatively simple example. Any multistage amplifier compounds the curvature to quite a high order. For example, two stages of single-ended amplification, which may be assumed for simplicity to produce only second-order terms in each, will compound into an expression with second-, third-, and fourth-order terms. At one particular level the second harmonic due to the second- and fourth-order terms can be made to disappear. But this leaves a residual of third and fourth harmonic. This again is a comparatively simple case.

Compounding the amplifier into a push-pull form results in higher order components although the second-harmonic cancellation is achieved without such multiplication of order in itself, because the two second-harmonic components are additively (or subtractively) combined instead of introducing product terms. But this means that two stages of push-pull amplification, in which the even order terms are made to completely cancel leaving a residual of only third order (neglecting possible higher orders), will produce an over-all amplification introducing potential harmonics up to the ninth.

Theoretically the third harmonic could be made to cancel. This would then leave the fifth harmonic as the major component. But this theoretical cancellation can only occur for one specific signal level.

The effect of all this on IM distortion is even more complicated to investigate mathematically. It can, however, be relatively simply explained graphically. Any practical transfer characteristic consists of a power order series up to some point where it converges to negligible effect.

The simplest combinations of power order terms produce curves that get progressively more abrupt toward the ends of the transfer characteristic, (A) in *Fig.* 3. However, in theory it is possible to obtain a power order series that will produce any desired curvature. For example, the transfer characteristic could become a specific number of sine waves superimposed on the transfer characteristic as at (B) in *Fig.* 3. Admittedly this is a very improbable form of the transfer characteristic, but it is not impossible. And sometimes a transfer characteristic may come closer to this form than to the simpler forms usually explored mathematically.

Now here comes the interesting fact. Assume we use this hypothetical transfer characteristic as the basis for a theoretical IM test, in which the high-frequency exploratory signal has an amplitude exactly corresponding to the vertical height of the sinusoidal deviations. Then the IM test will give a reading of precisely zero distortion for this particular amplitude of high-frequency test signal. The residual distortion produced from a harmonic measurement of an amplifier with this hypothetical transfer characteristic is also shown in *Fig.* 4.

Admittedly this is a hypothetical case

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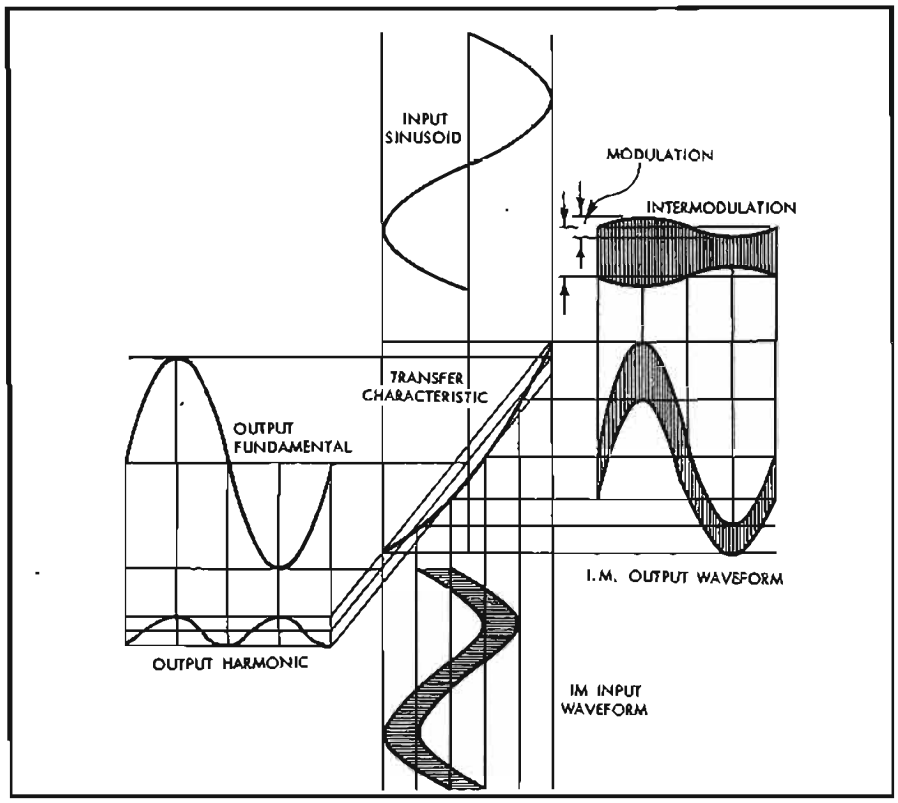


Fig. 5. Showing the more generalized relationship between harmonic and IM indications, referred against the transfer characteristic responsible.

but practical conditions may sometimes come nearer to this than to the simpler type of transfer characteristic usually theorized.

The original reason for going to intermodulation testing is that it comes closer to giving an indication proportional to audible effect. It actually tends to measure the rate of deviation from straight-line transfer characteristic rather than the actual deviation. This distinction is illustrated at *Fig.* 5. This means that the IM test measurement will be proportional to the order of distortion instead of linearly proportional to its magnitude. But realization of this improvement is dependent upon two assumptions.

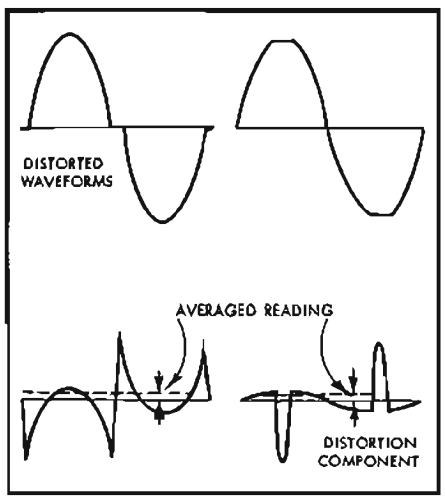


Fig. 6. Why either harmonic or IM measurement does not give realistic indications for sudden, short duration deviations from linearity.

First, that the exploratory waveform is of relatively small magnitude compared to the major waveform. That is, a ratio much higher than the one specified in the established SMPE standard should be used.

Second, that the deviation from linearity is more or less uniformly distributed over the low-frequency wave.

When either of these assumptions or their effects breaks down the validity of IM distortion in giving a more realistic figure fails. The example just quoted produced a zero IM reading because the deviation rate along a transfer characteristic exactly corresponded with the magnitude of the exploratory waveform. Of course, some distortion would be found by changing the magnitude of both signals together and consequently, a rather erratic IM distortion response would be produced for an amplifier with this hypothetical transfer characteristic.

The second reason for IM distortion measurement breakdown is one which also applies to harmonic-distortion measurements in almost the same degree. This is where the deviation from linearity of transfer characteristic occurs for a very short interval of the characteristic. For example, when clipping or crossover distortion is present, neither harmonic or IM distortion gives an adequate representation of the audibility of the distortion, because the measurement averages or "spreads" the magnitude of the deviation over the whole fundamental waveform, rather than measuring the relative magnitude for the short interval "kink" as compared with the fundamental magnitude (*Fig.* 6).

This is a characteristic considerably heightened by the effect of feedback with amplifiers. So it will be discussed in greater detail later on, after feedback comes into the consideration. For the time being we are considering basic amplifiers without the effect of over-all feedback.

### Reactive Elements

So far we have considered the performance of the amplifier in terms of a simple transfer characteristic in which reactive effects are not present. Under these circumstances the effect on amplification can be totally predicted by the power series method we have just outlined. However any amplifier produces phase deviation effects at the ends of its frequency response—an advance toward the low-frequency end and a delay toward the high-frequency end. Coupled with this is a progressive attenuation or in some instances peaking before a roll-off.

All these effects can be computed from the amplifier parameters as an over-all frequency-response prediction. But the non-linearities that produce the transfer characteristic curvature in mid-range also modify the effective frequency response at different points on the transfer characteristic. This can be seen by considering what causes the non-linearity. It may be referred either in terms of the transfer characteristic from input voltage to output voltage, neglecting the resistance or impedance parameters that produce it, or the amplifier could be considered to consist of elements that produce constant amplification with variable

(*Continued on page 68*)

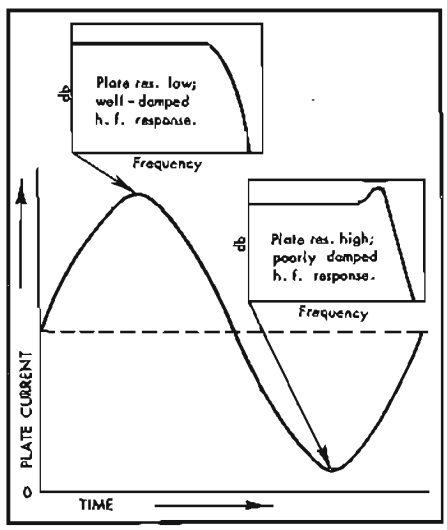


Fig. 7. Variation of transfer high-frequency response at different points on a large-amplitude signal waveform can be responsible for some forms of distortion that have received little attention to date.

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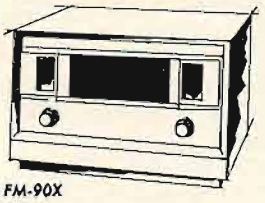

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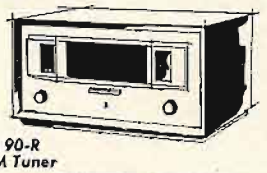

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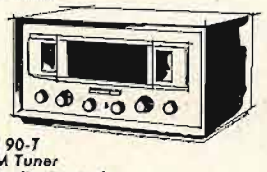

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# Reduction to Practice— A Patent Essential

ALBERT WOODRUFF GRAY*

**While it is—fortunately—not necessary that an invention be brought to perfection before a patent is applied for, it must at least have been tested and proven workable.**

DEFINITION OF THIS FEATURE of the patent law, made by a federal court is, "Reduction to practice is not merely a matter of construction, building and trial, but may consist in the disclosure of the idea by any kind of description, pictorial, verbal or written, which will enable one skilled in the art to make and use that which is disclosed. We think a drawing may be a sufficient reduction to practice, and an experimental machine insufficient, for the question is one of degree and the ultimate test is always whether the inventor has shown operative means to that theoretical omnipresent person, the man skilled in the art."[1]

Through a failure to observe this century old rule of the patent law, a leading manufacturer was recently denied a patent of radar apparatus, by reason of the omission of reducing its discoverey to practice. Application for a patent of this invention had been filed in France by a man named Gloess on October 2, 1937, and later in this country on September 22, 1938.

Eight days later, September 30, 1938, the patent application of this radio manufacturer was filed. Claims in this application for a radar indicator patent which provided both for distance and direction, were, "A radio vision device including in combination means for radiating radio energy toward a reflecting object, means for receiving said energy after reflection from said object, means for deriving directly from said reflected energy information including the angular position of said object and the distance of said object as a function of the velocity and the transit time of said energy and the indicator for combining said information to indicate the angular position and distance of said object."

Plans had been well developed for the operation of this invention during 1936 and on June 22, 1937, the apparatus was set up on the top of a building of the radio manufacturer at Camden, New Jersey. From this point efforts were made to operate the equipment and sight nearby objects as well as vessels on the Delaware River.

While the radar finder in these operations located buildings, smokestacks and other objects, the reliability of definition and measurements left much to be desired. Among other idiosyncrasies the machine located the smokestacks of a Camden factory in the middle of the Delaware River. After this attempt further efforts at a reduction of the invention to practice were abandoned.

Denying the application of this radio manufacturer, made for a patent, on the ground of its failure to reduce the invention to practice the United States Court of Appeals in its decision of this recent controversy, said,

"There has been built up a considerable amount of case authority upon what constitutes a reduction to practice. We find no disagreement among the decisions. Indeed, the language of them all seems to us to express the same idea in different ways.

"We think it is clear that reduction to practice does not mean that whatever is being worked upon has to be in shape to be marketed commercially. On the other hand it must be a demonstration that the inventor's idea works, not that he has thought the matter out and devised something that ought to work and may work, but actually something that will work to accomplish its intended purpose."

### Invention Need Not Be Perfect

It is however an old rule that this essential of the patent law does not require that the invention be perfect, or even that it be marketable. In the famous Bell telephone cases the Supreme Court said of this feature of the patent law,

"The particular instrument which he (Bell) had and which he used in his experiments did not under the circumstances in which it was tried, reproduce the words spoken so that they could be clearly understood but the proof is abundant and of the most convincing character that other instruments, carefully constructed and made exactly in accordance with the specification, without any additions whatever, have operated and will operate successfully."

This the court supplemented with a detailed summary of this rule of law that after more than a half century is still followed by the courts. "The law does not require that a discoverer or inventor, in order to get a patent for a process, must have succeeded in bringing his art to the highest degree of perfection.

"It is enough if he describes his method with sufficient clearness and precision to enable those skilled in the matter to understand what the process is and if he points out some practical way of putting it into operation. This Bell did. He described clearly and distinctly his process of transmitting spoken words telegraphically by creating the changes in the intensity of a continuous current or flow of electricity in a closed circuit, exactly analogous to the changes in density in air occasioned by the undulatory motion given to it by the human voice in speaking."[2]

In the long litigation involving the discoveries in wireless telegraphy by Marconi, the Supreme Court in holding his invention of the tuning of the antenna circuit had been anticipated, pointed out the fatal error in this inventor's failure to observe this demand of the patent law of reduction to practice.

"Commercial success," said that court of these circumstances, "achieved by this inventor and patentee cannot save his patent from the defense of anticipation by a prior inventor. To obtain the benefit of his prior conception the inventor must not abandon his invention but must proceed with diligence to reduce it to practice."

To this was added the further observation by the court, "Marconi's reputa-

(*Continued on page 67*)

* *112-20 Seventy Second Drive, Forest Hills, N. Y.*

[1] Curtiss Aeroplane & Motor Corp. v. Janin, 278 Fed. 454, New York, December 14, 1921.

[2] Telephone Cases, 126 U. S. 1, March 19, 1938.

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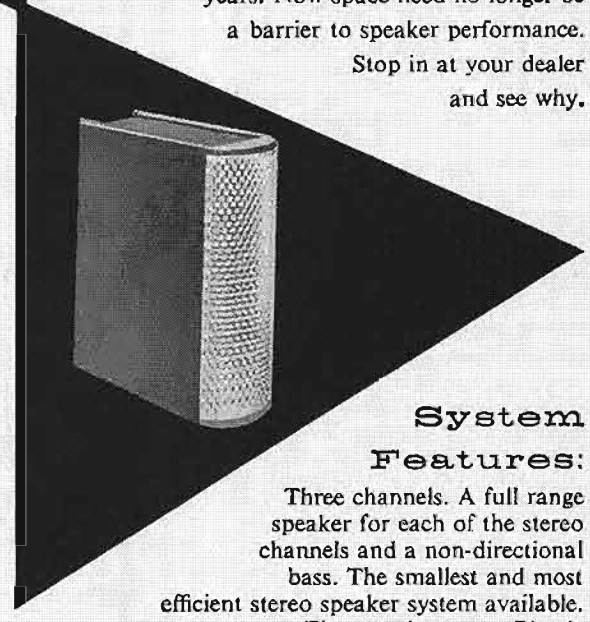

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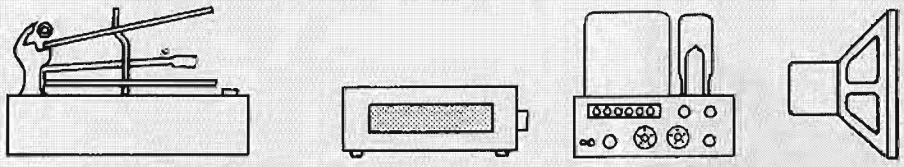


## HARMAN-KARDON "EPIC" MODEL A250 STEREO AMPLIFIER

Combining compactness, simplicity of design and operation, and excellent performance into a single package capable of putting out a clean 50 watts total is somewhat of a feat, in our opinion. Many units accommodate two power amplifiers in a cabinet 15¼ in. wide by 13⅞ in. deep and 4⅞ in. high, while still others can encompass the multiple intricacies of a stereo preamp in slightly less than that space, but to combine both without crowding and with several very desirable features into a single unit rates considerable approval. The manufacturer describes the A250, shown in *Fig.* 1, as a *formidable* instrument, and while, to us, formidable implies one which would incite fear—or consternation regarding its use because of complexity—there is no reason for it. The amplifier is easy to handle and it certainly does provide most of the necessary functions.

Listing these functions, with reference to the panel arrangement, we note six slide switches along the top of the control panel —an extruded aluminum form, anodized and permanently copper colored. From left to right they are: two speaker selector switches, a three-position contour control, rumble filter, and at the extreme right the scratch filter and the equalization selector. The six knobs are, from left to right: TREBLE, BASS, LOUDNESS, BALANCE, MODE, and FUNCTION. The first four affect both channels simultaneously, while the two switches provide, for MODE: LEFT, RIGHT, MONAURAL, STEREO, and REVERSE; and for FUNCTION: TAPE HEAD, PHONO, TUNER, AUX 2, and AUX 1. Inside the unit and accessible from the top if cabinet mounted or from the rear if in its optional cage, is a SEPARATE-PARALLEL switch which ties the output amplifiers together and to the right preamp so the A250 may be used as a stereo preamp feeding a single built-in power amplifier (50 watts) for the right channel; the output of the left channel is available on a separate jack for feeding another basic amplifier. When this switch is in the PARALLEL position the two transformer secondaries must also be strapped in parallel.

The speaker switching is apparently unique to the Harman-Kardon line—we have noted it before in the A224 "Trio." Each amplifier terminates in an output transformer with secondary impedances of 4, 8, 16, and 32 ohms, one end of the winding being grounded. Two additional terminals, marked A and B, are provided for each amplifier. These are connected to one of the speaker selector switches, similarly marked A and B, which grounds either the A or B terminals at the user's choice. A and B are used for the ground returns of two separate pairs of speakers, located in different rooms, perhaps. Thus either pair can be energized at will. Also, if desired, the second speaker selector switch may be set to ALL, instead of ONE, both sets of speakers will operate at once. The reason for the impedance range extending to 32 ohms is that when both output sections are paralleled, the speaker is connected to the tap twice its nominal impedance, which necessitates 32 ohms for a 16-ohm speaker, and so on.

Fig. 1. The Harman-Kardon "Epic," dual 25-watt stereophonic amplifier system.

Both channels are identical, and employ 12AX7's as phono/tape-head preamplifiers, 12AU7's as tone-control amplifiers, 12AT7's as amplifiers and phase splitters, and two 6L6GB's in the output stages, the latter being mounted at an angle of about 40 deg. in order to maintain a low silhouette in the cabinet. Tone controls are of the Baxendall type, which we consider most desirable, and phono and tape-head equalization is derived from feedback over the two stages of the preamp, and accommodates RIAA and EUR on phono, 7½ and 3¾ on tape. A 47,000-ohm load is provided as a fixed value for the phono cartridge or tape head, while a 100,000-ohm load is provided for ceramic cartridges, followed by a 26-db voltage divider. The scratch filter operates only on phono, while the rumble filter operates on all inputs—which we believe is desirable because some radio stations require rumble filtering for best listening results. The two contour curves turn over at about 350 and 700 cps, respectively.

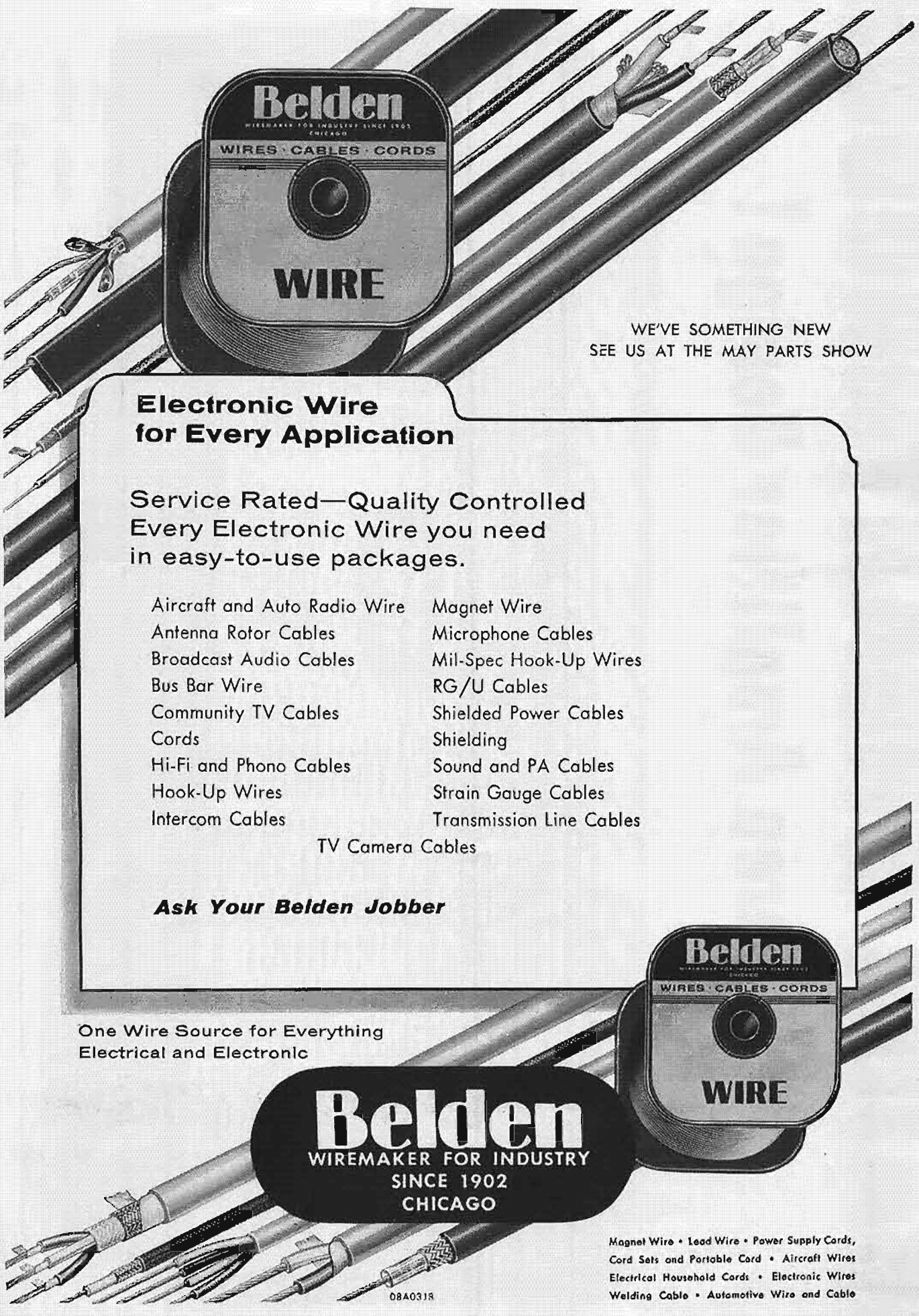
Plate supply is furnished from a voltage doubler circuit using the new silicon rectifiers, and resulting in extremely low hum levels. Plate currents in the output stages may be balanced with the controls provided, thus further lowering hum, and with d.c. on the first three stages the hum on phono is better than 62 db below a 1-watt output.

The power supply fuse and two a.c. receptacles are mounted on the rear apron, together with the two output terminal strips. All inputs are located on the top of the chassis, side by side in two separate rows. Four shorting plugs are furnished for insertion in unused inputs, and a plastic clamp is located on the rear of the chassis adjacent to the input jacks so that all leads to the amplifier may be dressed neatly where they come out.

### Performance

The amplifier has more than adequate gain. For a 1-watt output, and gain control at maximum, signals of 0.9 mv are required at the magnetic phono input and 20 mv at ceramic phono input, 0.35 mv at the tape-head input, and 52 mv at auxiliary and tuner inputs. At a 117-volt line, distortion was 0.85 per cent at 25 watts on one channel, 0.87 per cent on the other. Control tracking varied from a maximum of +3 to −2 db on volume, and from +4 to −3 db on tone at six points checked on both. At the specified input signals, the TAPE OUT jack provided a 0.45-volt signal to feed a tape recorder, unaffected by tone or volume controls.

On listening tests, the A250 confirmed the measurements as to sound quality, and as has often been said, "measurements mean little if the listening is bad." Using several different speakers and a widely varied range of program material, the amplifier performed admirably and even after hours of use it was still necessary to take the eggs into the kitchen to fry them—all three transformers run cool. Actually, this was to be expected in the output transformers at least, since the cross section of the cores measure 1 11/16 square, which is plenty for a 25-watt transformer. On the whole this is a unit of excellent performance and appearance, and should result in an equally excellent over-all system. D-25



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- IM DISTORTION: Less than 0.08% first-order difference tones (European CCIR standards) and less than 0.35% by SMPTE American standards.
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Fig. 2. Tandberg's new model 5-2 is similar in appearance to the earlier models, but offers four-track stereo performance.

## TANDBERG MODEL 5-2 STEREO FOUR-TRACK TAPE RECORDER

Some months ago we were called upon to give a talk on stereo, and because of a certain amount of physical efficiency on our part (that's laziness to you) we cast about for a machine that was light enough to be called portable. In many instances the presence of handles on the carrying case is sufficient to warrant that name, but the Tandberg in its case weighs only 27 pounds. We had previously been acquainted with the Model 3-Stereo, but the newest Model 5-2 was still strange to us. *Figure* 2 shows its appearance with its case.

To begin with, this unit is fitted for four tracks, and for three speeds. Thus it will accommodate the promised four-track tapes —removed from the magazine/cartridge and respooled on conventional reels. In addition it provides for extra long playing time at the 1⅞-ips speed. It is entirely self-contained for monophonic recording and for mono or stereo playback, but requires the addition of a second amplifier for stereo recording. This unit is 2¼ in. wide, 8¾ in. long, and 5¼ in. high, and in use is placed alongside the recorder at the left end. It is fitted with a male power receptacle and an output cable which plugs into a receptacle on the recorder head cover. A short power stub is coiled up in the recorder's cable compartment, and furnishes plate and heater power to the auxiliary amplifier when it is in use. The unit accommodates microphone and high-level inputs, and matches in performance the amplifier built into the recorder. A gain control is provided, as are an equalization switch and a level indicator tube.

The recorder itself is a marvel of compact design, and it appears as though each part were made for it, rather than being chosen from usual parts manufacturer's stocks.

There are two complete amplifiers, from tape head to output transformer, each having a 4-watt output. A monitor speaker—5½ by 8 in.—is built in, as is the necessary power supply. In the record mode, one of the output tubes becomes the high-frequency oscillator. The input stages of both playback amplifiers have d.c. on the heaters for a hum level measured at 58 db below the maximum recording level (defined as the 4 per cent distortion point).

Frequency response at 7½ ips was measured as within ±1 db of the Ampex standard tape No. 5563, and with signals recorded and played back the response was ±3 db from 30 to 15,000 cps. At 3¾ ips the output was 3 db down at 10,500 cps, and at 1⅞ ips it was down 3 db at 5300 cps. Flutter and wow at 7½ ips was below 0.15 per cent as nearly as we could measure it—which is not an easy trick, incidentally, when it is so low.

In addition to the low-impedance outputs for direct connection to speakers, a switch on the chassis connects the outputs to the cathodes of the stage preceding the output tubes, thus providing a higher-impedance output without the potentially present distortion of the output stage pentodes. The level at this connection is around 0.7 volts. For our purposes, we fed the low-impedance signal from the output stage direct to two external power amplifiers which gave a possible 50 watts each for auditorium use. The cathode follower output was not sufficient to drive the external amplifiers, although it would be adequate for insertion at the AUX input of any stereo preamp.

A speed control knob at the top between the reels selects the desired speed and changes equalization at the same time. Just above this switch is the speaker control, which connects the internal speaker to either of the two channels or disconnects it entirely. To the left of the lower head cover is the main circuit control switch, with positions for record, playback, and public address. In the latter position the microphone is fed through to the loudspeaker outputs directly. The volume control knobs are dual, with a friction clutch causing both to turn at once in normal use, but balancing may be done by displacing one with respect to the other. Under this dual knob is a lever which selects the mode of operation—stereo, or mono tracks 1–4, or mono tracks 2–3. The indicator eye is just above the volume control knobs, and to its left is a bass-lift switch, which increases lows by 12 db at 70 cps.

The mechanical operation is controlled by a single gearshift-type knob at the right. For recording or playback the knob is pulled forward; for rewind it is pushed to the left; for fast forward, to the right.

All inputs and outputs except the microphone, which plugs into a jack on the top panel, are available at a terminal panel at the rear. A small compartment is provided for the power cord.

From this description one might surmise that the machine is almost ideal—and so it is, for every use to which we have put it, at least. Starting and stopping is smooth with no spillage of tape, provided the operating knob is pulled forward slightly to start the motor before engaging the idler wheel against the highly polished capstan, and one learns to do this automatically in a very few minutes.

We have used the machine for stereo playback, for dubbing from another machine, and for long-playing background-type music, and so far we have no faults to find with the machine. For any semi-professional or home use we would consider it ideal. **D-26**

Fig. 3. Hartley 217-Duo—a complete stereo system in one cabinet.

## HARTLEY 217-DUO STEREO SPEAKER SYSTEM

Under most circumstances we would not consider that a single cabinet only 36 inches wide could suffice as a complete stereo system, in spite of the fact that we have suggested previously a modification to a conventional corner cabinet for stereo application in a small room. But when one considers that practically all listening is done in typical living rooms instead of in anechoic chambers, one must realize that reflections from walls and furniture have a large effect on the sound pattern in a room and thus modify the classic characteristic which might be deduced from two sound sources spaced some six to eight feet apart. Obviously, of course, if one were to listen to the 217-Duo in the middle of a prairie it is doubtful if much stereo effect would be observed. In the average room, however, it is more than adequate.

The 217-Duo, shown in *Fig.* 3, is 36 in. wide, 30 in. high, and 15 in. deep, and houses two Hartley 217 full-range speakers splayed out about 30 deg. from the center line between them. When used as a monophonic system it shows a pleasant wide-source effect, completely free of the oft described "hole in the wall" feeling. As a stereo speaker, under direct A-B listening tests with two conventional speakers spaced 8 feet apart, the single cabinet with the two splayed speakers gave a better over-all sound, and the stereo effect was distributed throughout the entire room so that no matter where you listened the stereo spread was still there. We believe there is much work yet to be done to determine just what is the optimum speaker for stereo, and we have learned that if there are two speakers in the room, the listener is likely to hear two speakers as separate units, rather than as parts of the whole—which is the principal reason why this observer insists on evaluating stereo installations with both eyes covered, and this applies equally well to a two-way monophonic speaker system when both speaker units can be seen.

Be that as it may, the 217-Duo does have a better stereo effect with the eyes closed —as does any other system in which two speakers can be seen. We have suggested that the grille cloth cover the entire front in one sweep.

As to the actual quality of the 217-Duo, we found it capable of going down to below 40 cps, and to have considerable audible output at 14,000 cps—above which we do not think we can hear very much, nor do we believe much source material extends that high, even if the records could retain it or the pickups all play it. Quality was judged by many listeners as excellent, being described by the more experienced as smooth and free from objectionable peaks—purely subjective, to be sure, but it is fairly well established that the choice of a loudspeaker is pretty much a subjective thing anyhow. Let it suffice that one compare speakers for himself, preferably on the same material and in the same acoustic environment, rather than accepting the judgment of some one else. But to these standards of judging, we can only say that we would consider this speaker to give good quality and an excellent stereo effect in any room larger than 9 × 12. D-27

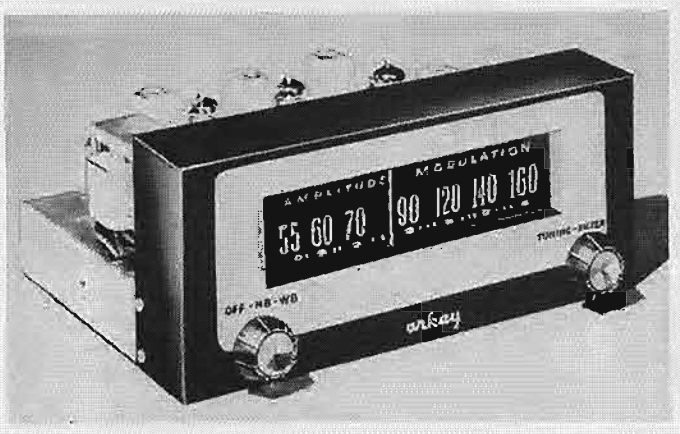


Fig. 4. Arkay AM tuner—a broadband unit for high-fidelity reception.

## ARKAY BROAD BAND AM TUNER KIT, MODEL AM-5

With more and more stations using AM and FM together for stereo, it finally becomes necessary to improve AM radio performance if there is to be a satisfactory match between the two channels. While it has been stated many times by those who are apparently misinformed that the frequency range transmitted by AM stations was limited to a top of 5000 cps, let it be said here that this is just not so. Except in rare instances where interference results between two adjacent-channel AM stations, there is no reduction in the audio band, and even when such a reduction is ordered by the FCC, the top frequency transmitted is rarely if ever lower than 7500 cps. In other words, the limiting element in the AM transmission picture is the usual narrow-band superheterodyne receiver rather than the radio station itself. Old timers may well remember the wide-range t.r.f. receivers of the mid-thirties—sets which were capable of receiving well over 10,000 cps at the top end. And while no such receivers appear to be on the market at the present, there has been no change in transmission standards.

Arkay's AM-5 tuner kit takes a step in the direction of good audio quality with the extension of the upper limit of the pass band to around 8500 cps in the BROAD position, yet still maintaining normal superheterodyne selectivity — and consequent narrow audio band—in the SHARP position. This tuner, which makes up in the form shown in *Fig.* 4, utilizes a single i.f. stage with variable bandpass i.f. transformers. As seen in *Fig.* 5, these transformers are constructed with the bottom ends of the fixed tuning capacitors separated from the coils; these capacitors are joined together and connected to ground through .005-μf capacitors, across which sections of a three-position rotary switch are connected. In the first position, the a.c. power is off, controlled by a section not shown in the diagram; in the second position the broadbanding capacitors are shorted out, so the i.f. transformers have their normal selectivity; in the third position, the switch is open which overcouples the coils and gives the usual flat-top response. Another section of the switch changes the audio response in the broad position by removing a shunt capacitor across the output and inserting in its stead a 10-ke whistle filter.

The over-all sensitivity is about 2 μv for 20 db of quieting, which gives more than adequate pick-up ability. The broad-band feature is only useful for fairly close stations because of man-made and atmospheric static, but in good weather conditions it should still be usable for all but the most distant stations.

The circuit is—aside from the broadbanding—quite conventional. It employs an r.f. stage, a mixer-oscillator, one i.f. stage, a diode detector, and a cathode-follower output stage. The power supply uses a selenium rectifier with RC filtering. Since we actually build every kit that we review, we can truly say that this one is simple and straightforward, and can easily be built in one evening. Had we started from scratch with all the parts and a schematic, we might have followed a slightly different order in placing some of the wires than is outlined in the kit instructions, this is likely to be the result of one person's opinion instead of another's. Suffice that the unit, when completed, worked perfectly from the beginning, and the alignment of i.f. transformers was correct for optimum performance in both broad and narrow positions.

Few modern test oscillators have a frequency-modulated r.f. output in the AM range, but the old RCA Model 150 test oscillator—now about twenty-five years old —was hauled up out of "archival storage" and put to work on this model. After checking the original alignment of the i.f. transformers—to make sure that they were, as the factory claims, adjusted so that no further alignment would be required by the constructor—the band width in the broad position was observed on a 'scope. As originally set up, the curve indicated a pass band 18 ke wide, (down 6 db) which is adequate for the specification of 8500 cps for the audio spectrum.

In actual listening, this tuner was found to be superior to any conventional superheterodyne not equipped with some means for broadbanding, and on the average broadcast did not seem to be appreciably different from the FM affiliate, with respect to frequency response. On stereo broadcasts, there was a definite improvement in the broad position over the narrow, and the two channels appeared to be identical.

Just to review theory a little, it is a characteristic of two coils that when they are tuned to the same frequency and coupled together to a critical amount, the response curve is single-peaked, with symmetrical sides. When the amount of coupling—either by decreasing the spacing between the coils, or inductively such as by wrapping a few turns of one coil around the other, or by introducing some common capacitance as is done in the Arkay kit—the response curve takes on a double peak, with a spacing depending on the amount of overcoupling. If too great, there is a pronounced dip at the center of the top of the curve; if correct, the curve is practically flat topped. This avoids the sideband cutting that produces the usual response heard from tuners that are too sharp, and results in improved audio quality. D-28

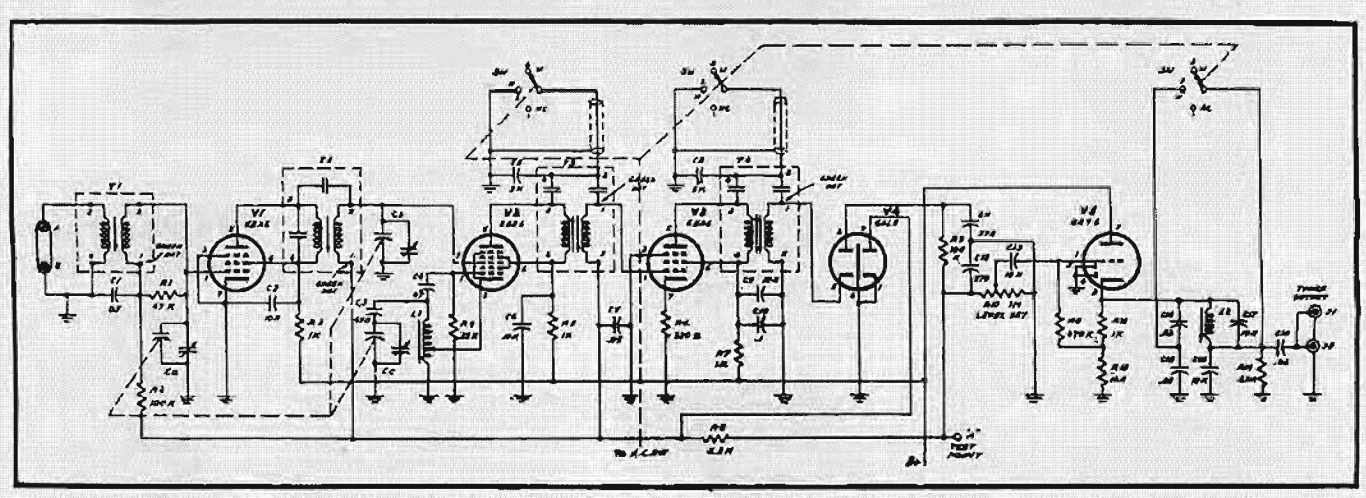

Fig. 5. Schematic of the Arkay AM-5 broadband AM tuner kit. Conventional selenium power supply not shown.

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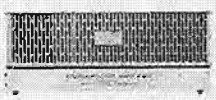
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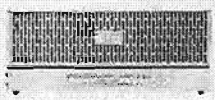
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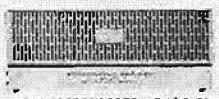
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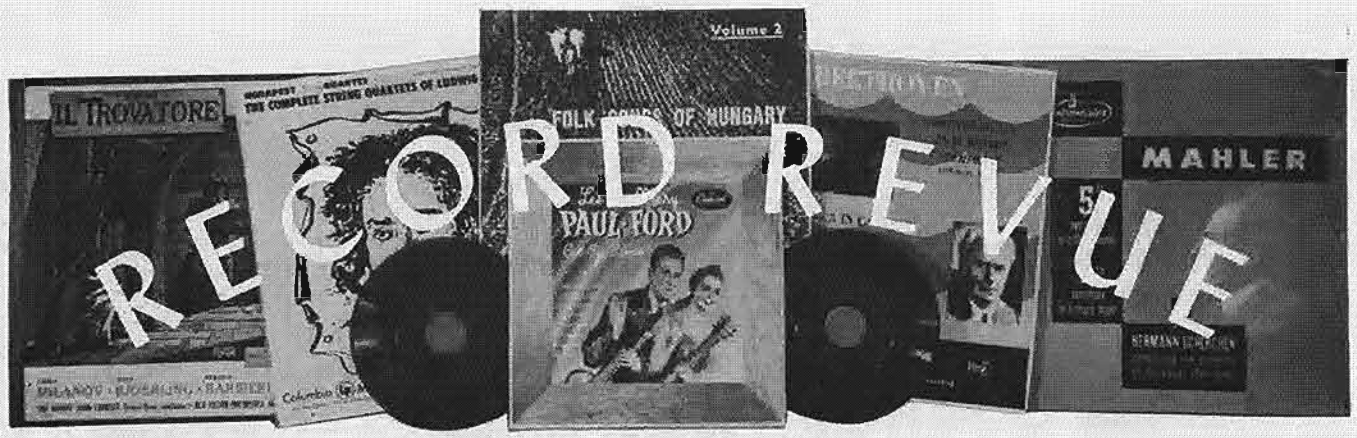


EDWARD TATNALL CANBY*

## 1. HI-FI IN STEREO

**Marches from the Operas. (Damnation of Faust, Carmen, Prince Igor, Marriage of Figaro, Meistersinger, etc.)** Virtuoso Symph. of London, Winograd.
**Audio Fidelity FCS 50,008 (stereo)**

This, rather to my surprise, turned out to be the outstanding disc in the entire Audio Fidelity initial release in the "First Component" series.

You'll pardon me if I suggest that the true First Component in any musical recording is not the record itself, as A-F maintains, but the music. Here is a fine collection of war-horse marches calculated to bore anybody to tears if played in less than superb styling—and, by golly, I found every one of them alive here, full of good playing, rhythmically vital. This record is worth its salt in 100 percent musical terms, against enormously large competition in the catalogues, and as I say, nobody was more surprised than I. The fact that the disc is super-hi-fi as well is, for me, quite secondary, though pleasing.

It's Winograd, the conductor, I presume. He is a relatively young man, still on the way up, master of a splendid series of rather specialized recordings in the classical field for M-G-M. This was surely a big opportunity for him, and he proves here that he is a wider, more versatile conductor than one might have thought from the scope of the M-G-M series as far as I heard it.

It is immediately clear, as we listen, that Winograd has no intention of turning out a mere hi-fi potboiler. The musical marches, after all, are distinguished music from many big minds, their only failing being a too-great familiarity and consequent degradation to the war-horse level. This record snatches them right out again. Highly recommended on all counts.

**Tchaikowsky: Symphony VI ("Pathétique").** Virtuoso Symph. of London, Wallenstein. **Audio Fidelity FCS 50,002**

Here's the kingpiece of the A-F opening collection and, I'm sorry to say, I find it on the dull side, if very hi in the fi and—speaking purely technically—an unusual *tour de force* of disc cutting, probably of considerable importance in marking out new territory for the disc process.

These records, the new Audio Fidelity First Component Series, are clearly intended as spectacular technological hi-fi rather than significant music. You can tell this merely by looking inside the album folds and noting the proportions of the technical write-up *vs.* musical: the music comes off a poor second in sheer area of black print. Nothing wrong with this—unless you happen to find the music of some significance. If you are mainly interested in the fi, Audio Fidelity is doing you a technical service that is, indeed, a follow-up on the company's initial stereo coup, the famous stereo disc of December, 1957, that set the whole stereo movement under way a year ahead of itself! The only trouble you may encounter here is purely technical: the odds are considerable that you won't be able to play the disc successfully with your present set-up. If this intrigues rather than annoys you, so much the better. And without any doubt, Audio Fidelity is on solid ground if it disclaims responsibility, in case of non-playing. Our equipment *should* be better and probably will be, if it isn't yet. These records look to the future. But they are tough babies to cope with, right now.

Music? Wallenstein is the big catch in the new Audio Fidelity artist stable and the idea of snagging him was good enough. He is an experienced major conductor who hasn't been too busy these last days. He has lots to say and has said it with profound effect, notably in his famous WOR broadcasts of years ago, among the very first "high brow" broadcasts to attain national importance. But unfortunately, Wallenstein is too nice a guy, too accommodating, for this assignment. I can't believe that Audio Fidelity's 100 per cent conventional, entirely unimaginative choice of music repertory could have pleased the conductor of the first Bach Cantata broadcasts ever heard in the U.S. The result, here, is the least distinguished "Pathétique" recording ever to hit the market, hi fi or no. It's as though Wallenstein (I'm guessing) had said, I'll do my best . . . it is, indeed a fine opportunity, but if *only* . . . and the thought went no further.

The music is accommodating, pleasant, without drive and often sounds unrehearsed, with bits of shockingly sloppy playing showing through the generally good ensemble. No fire; the musicians are just going through proper motions. The last movement seems particularly desiccated to me. It really sounds as if W. just doesn't like Tchaikowsky—and old Tchaikowsky is not a man to take half-measures in the playing. . .

Enuf said. I only hope that Audio Fidelity will show in its future classical offerings the sort of enterprising individuality it has been so well known for in its "popular" lines. I loved 'em, but I don't like this.

**Ravel: Bolero. Bizet: Carmen Suite.** Virtuoso Symph. of London, Wallenstein.
**Audio Fidelity FSC 50,005 (stereo)**

Well, well! To heck with those complicated and indecisive terms that measure stylus compliance—4 times xxx to the minus something-or-other. I've just devised my own compliance measurement, right off this record. It's called the B.F., the Bolero Factor, and is determined ever-so-simply by measuring the number of millimeters from the final, inside groove at which your pickup stylus says UNCLE! It'll say it, all right, and loudly.

Most of my styli—I tried several—gave up the ghost and yelled UNCLE! at around B.F. 30, well over an inch from the end of the side. I defy you to find one stereo set-up in a thousand that will play this Bolero straight in to B.F. 0, the final groove on side 1.

"Carmen" is slightly milder, not having in its musical nature quite the same progressive index of increasing loudness characteristic of the Bolero. Mr. Wallenstein does a straightforward job on the suite, quite indistingnishable from at least two dozen other straightforward jobs I've heard.

**Offenbach: Gaité Parisienne. Khachaturian: Gayne Ballet Suite.** Boston Pops, Fiedler. **RCA Victor LSC 2267 RE (stereo)**

Same music, same orchestra as RCA's stereo disc of last summer, LSC 1817, and you may wonder why a new version so soon? A number of good reasons. The old "Gaité," taped in stereo around 1955, was a superb two-track job; this one is an even better three-track recording and the difference is clearly noticeable on direct comparison. Nothing wrong at all with the earlier one—not with such a marvelously lilting performance and such brilliant acoustics and fine mike pickup. But the new version, doubtless made in the same spot, has a greater dynamic range, a larger and more realistic hall-sense, and a sharper, clearer cut. Also a more natural spread of the musical instruments.

But maybe the biggest technical advance here is the compression of two sides into one-and-a-half, with no observable loss of quality, allowing room for the "Gayne" suite in addition, where the earlier stereo disc had "Gaité" alone. This in effect, note well, reduces the cost of this stereo music by around 25 percent and if you can hear any sacrifice in the sound quality in the new record, I can't.

In matter such as this, RCA Victor traditionally exercises admirable caution and conservatism. The earlier version was one of the very first stereo discs available and yet it remains an entirely satisfactory job today—even with original recording that is some four years old. The additional running time of the newer disc was added only when quality could be maintained at a high par. I'd suggest these two as permanent demo discs for anyone who is interested in showing off the solid progress of stereo disc during its first commercial year.

P.S. Again—don't underestimate the Boston Pops itself! There is nothing—absolutely nothing—to compare with the Fiedler zest and lightness of touch, the Popsian polish, humor, lift and sheer accuracy of performance, in this sort of music, as played by the Pops orchestra.

**Copland: Billy the Kid; Statements for Orchestra.** London Symphony, Copland.
**Everest SDBR 3015 (stereo)**

Everest has made an impressive beginning with its new catalogue and this is perhaps a good sample of the kind of thinking that dominates the new company at the moment. An easy, "popular" classical piece, "Billy the Kid," (but an important one) is coupled with a less well known work by the same man, an interesting piece, and the whole is set down in records by the composer himself, adding a special appeal that raises this recording up to an even importance with others, such as the excellent recording of "Billy" by Morton Gould for RCA Victor.

"Billy," with its cowboy songs, was one of the earlier of the folksy Copland ballets and it never fails to please. "Statements," a series of short pieces with adjectival titles—Cryptic, Dogmatic, Subjective, etc.—comes from the very beginning of the new and popular Copland, composed in the early Thirt-

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

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The English performers aren't quite as crisp in this American idiom as Morton Gould's boys, but mostly they do very well indeed. Lovely, straightforward stereo.

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Maybe I'm not being very accurate but my feelings are *very* accurate. Try it if you wish and see for yourself. You probably have already, if your system is big enough.

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**Billy Eckstine, Sarah Vaughan Sing the Best of Berlin. Mercury SR 60002**

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The Max Roach Quintette waltz-time jazz offers a neat and imaginative solution of the recording problem involved when so few instruments play, all on terms of equality including the percussion. The solo parts again are usually taken "in" the right or left speaker or very close behind each, as you listen. The percussion is generally in the middle and back a bit, rounding out an audible half-circle from one speaker around to the other. The skill with which the intervening three-dimensional space is joined up for the ear, tied at each end to the speakers themselves but extending smoothly around and in back between them, indicates Mercury's know-how. This sort of thing, again, could be better done than I've heard it in a

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Side 2 is all one waltz ("Valse Hot") chorus after chorus, sort of 18th century tune, done up in modern. The percussion solo —that must be Roach—is quite fabulous, musically and in the stereo.

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(See also Vol. 1, SR 90009.)

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**Exp. Anonymes EA 0034**

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**Vanguard BG 576**

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Worth it. The Golden Age group is—or was—in my opinion the best, the most satisfactory madrigal group on modern records. These singers have an unmatched smoothness and precision, they sing musically and with feeling and excellent diction, their tone is unusually steady (in spite of some vibrato) and the blend, for clear harmony, is better than that of any other group I can think of. All of which makes their music more than usually accessible to the ear.

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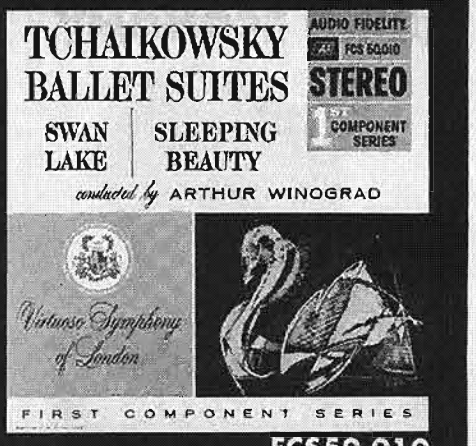


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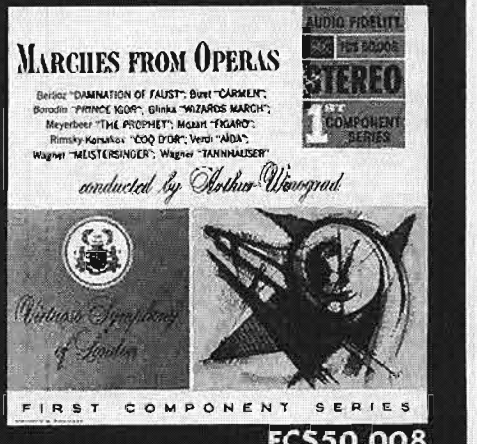


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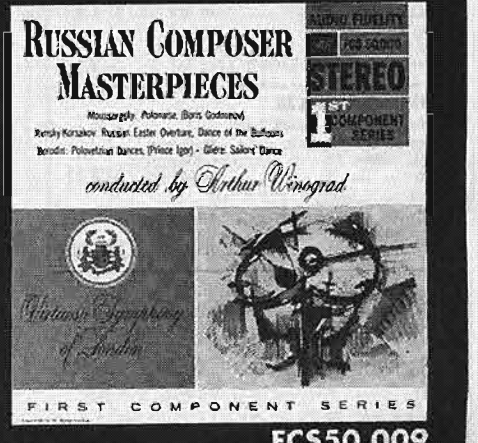


FCS50,009

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**Gesualdo, Monteverdi: Madrigals.** Randolph Singers. **Westminster XWN 18652**

Nothing loth, here Westminster continues another series that competes, I suppose, with its own Golden Age releases.

It isn't easy to pin down the difference between the two, since outwardly both sets will at first sound much alike to the unpracticed ear, in general voice quality and blend. But the Randolphs, as I hear it, do more singing for less musical effect. There is more vibrato, more "technique," less ensemble even though the whole is strictly professional in execution.

I couldn't prove it but where the Golden Age people sing pure intonation, I can't help feeling that the Randolphs are singing tempered pitch or equivalent. This amounts, in the hearing, to a correct, but colorless harmonic sound, all chords of the same impact, minus the marvelous shadings of contrast that ought to be there. In addition, the Randolphs sing with good but rather mouth-filling diction, the vowel sounds unclear and too much alike. Ah yes—that's our unfortunate American heritage and the toughest problem of all for every American singer.

**Madrigals of Thomas Morley.** Deller Consort. **Vanguard BGC 5002** (stereo); **BG 577** (mono)

**Madrigals of John Wilbye.** Deller Consort. **Vanguard BGS 5003** (stereo); **BG 578** (mono)

These are two in another series, available in stereo or mono format. Firstly—if you want the darndest set of stereo test records ever launched, get the stereo versions of these! They are guaranteed to confound your pickup into a tailspin, every so often, no matter how good it is. But if you want the music minus technical distractions, better stick to the mono form.

The cause of the above is mainly to be found in two very vocal, voluble, high-strung, nervous soprano singers, who in their moments of excitement produce such charges of high-powered difference-sound that no playing stylus I've tried can keep up with them! Whether the grooves themselves are undistorted I could not say—I rather suspect that they are OK and could be so proved, via microscopic examination if in no other way.

Musically speaking, the Deller Consort has decidedly mixed values. I am not overly enthusiastic about it though I admire its musicality and serious intent. First, the ensemble is uneven, with Deller's pure, unwavering voice placed in and among a collection of varied wobbles that defy blending no matter how musical the intent. Better a fine musicianship than an outward perfection, of course, but still. . . The chief offenders, again, are the two sopranos, who in every rapid or exciting passage are so wildly uneven in tone production that ensemble and pitch suffer confusion. The emotional expression is beyond reproach and I admire both ladies. But I don't enjoy the sound.

On the other hand, in the slow, smooth, sustained sort of music the Deller group is superb. Then, the ladies are able to produce a continuous and lovely tone with an unusually good feeling for long phrases and expressive harmony. Nothing wrong with anybody's ears in this group.

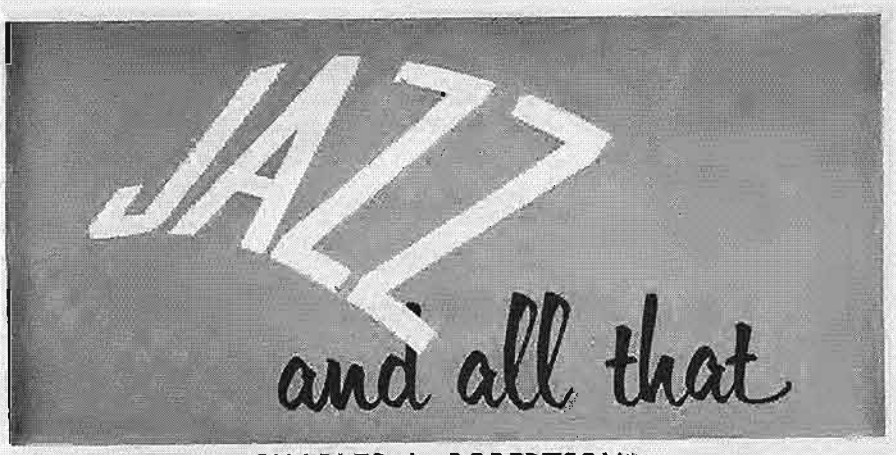
Therefore, to get to the music itself, I highly recommend the Wilbye record, since Wilbye's finest music is in the slow, expressive vein of the ultra-serious madrigal. He is out of this world in example after example on this disc. The serious music of Morley is less important and tends towards a relatively academic expression; his finest is in the light, effervescent "ballet"—the music with the falala refrains. The Dellers are physically not so good in this though, again, the spirit is wonderful and the musicianship excellent.

## 3. VARIETY

**Easter at Grailville.** (Woman's Chorus, unaccompanied.) **Period SPL 746**

This might seem to have a specialized or even a forbidding look to it according to the

(*Continued on page 74*)




CHARLES A. ROBERTSON*

## STEREOPHONIC

**Buddy Tate: Swinging Like Tate!**
**Felsted FAJ7004**

**Buster Bailey: All About Memphis**
**Felsted FAJ7003**

**Earl's Backroom and Cozy's Caravan**
**Felsted FAJ7002**

A subsidiary of English Decca, dispensing music in the popular vein, Felsted enters the American jazz LP market with these three releases, the first of a promising new series. Recorded in this country last year and already issued in England, they return here by a reverse flow of the usual channels of distribution. They are designed to satisfy the desire of British fans to hear more mainstream jazz, a longing only partly assuaged before through the import of recordings supervised by John Hammond for Vanguard, or by George Avakian in his various capacities.

Generally regarded as applying to the middle-period in jazz history which links traditional and modern styles, the term mainstream jazz was coined by Stanley Dance, one of its leading protagonists and the most experienced critic in England. An enduring ambition to record some of his favorite musicians was realized when a commission to produce the series allowed him to journey to New York, where his presence enabled him to uncover several newcomers. Their support of established leaders shows that this music is still very much alive in forming the voices of a younger generation, is continuing to grow and not remaining static.

By personal preference and in his writing, Dance is partial to the elder statesmen and has helped create the impression, no matter what his intentions, that mainstream reached full-flood in the 30's and has since receded. His present definition, printed on each liner, makes no mention of any time span, calling it "jazz of a central kind, a music not inhibited by any particular instrumental combination, but emphasizing the twin virtues of communicable emotional expression and swing."

A statement of considerable scope, in all, and one which makes room for those modernists who are stepping more frequently along the stream to build a warming fire on its banks. When Thelonious Monk finds himself sounding like James P. Johnson, or Miles Davis pays his respects to Louis Armstrong, and Julia Adderley returns to Alabama field songs, the current is flowing strong. A few more trips across the Atlantic may help Dance to be more receptive of modern-mainstreamers, whose references to roots and soul are what he has been talking about all this time. His critical encouragement of latter-day efforts in the idiom might do much to draw attention to his own productions and the work of players he feels are being neglected.

One of the places visited by Dance was Harlem's Celebrity Club to hear what he has since cited as the best regular small group encountered in his travels. Led by Buddy Tate, who held a chair with Count Basie longer than any other tenor saxist, it has a large and interesting library of originals, many of them worthy of preservation on records. It plays the three selected for this date with relaxed strength and approaches the blues with the directness of long familiarity, particularly on *Walk That Walk*, distinguished by Skip Hall's rolling piano and Ben Richardson's fluid clarinet. On the remaining three numbers, Tate recalls his eventful years in the Basie band by acting as host to four alumni, Buck Clayton, Dicky Wells, Earl Warren, and Jo Jones all perform in consistently excellent fashion, and Lord Westbrook provides a fine rhythm guitar. This portion has the air of a jam session, but Tate's own octet is generally more cohesive. In a day when most tenor men are striving for the unexpected, his playing is almost a novelty, being curiously unadorned and free of frills. His phrasing is always right and young aspirants would do well to listen to him rather than try to imitate more eccentric stylists.

Buster Bailey grew up in Memphis and became a member of W. C. Handy's band at an early age. He remembers taking part in the first performance of *Memphis Blues*, in a schoolyard near his home. With the aid of a septet and arranger Dick Vance, he conjures up early memories of a marching band on *Sunday Parade*, and a vivid picture of a part of town known as *Bear Wallow*. A rhythmic salute is given to the Indian tribe whose tents once occupied *Chickasaw Bluff*, and *Hot Water Bayou* is a return to the old swimming hole. Bailey's *Hatton Avenue and Gayoso Street* is an intersection pleasantly close to *Beale Street*, which he revisits as soloist with rhythm section. He recalls it at a faster tempo than usual and then plays a slow, lingering *Memphis Blues*. Herman Autrey, Vic Dickenson and Hilton Jefferson are paced by another favorite son in drummer Jimmy Crawford, who left Memphis with Lunceford. The late but welcome debut of Bailey as a writer and his fluent solos make this his crowning achievement on records.

The Earl Hines Quartet and the Cozy Cole Septet divide one disc, permitting the leaders to provide a seminar in their respective specialties. The presence of Curtis Lowe, formerly a member of Lionel Hampton's sax section, on baritone and tenor allows Hines to display his exceptional talent as an accompanist. The pianist appears with Charles Oden, bass, and Earl Watkins, drums, the rhythm section of his current group at San Francisco's Club Hangover. His dazzling solo flights on three blues—played in medium, fast, and slow tempos—are superb and restate his claim as the greatest of jazz pianists.

Cozy Cole makes a long and intricate drum solo of *Caravan*, and Lou Jones, one of the newcomers, takes a melodic trumpet passage on *Margie*. Trombonist Phatz Morris provides a blues original, switching to harmonica for a chorus in the style of Sonny Terry and allowing room for a robust vocal from guitarist Dick Thompson. Others introduced are Boe McCain, tenor sax, and Pete Compo, bass, while brother June Cole is pianist. This is the only item not available in stereo, possibly because the Hines section was recorded in San Francisco under the auspices of Yannick Bruynoghe, the Belgian jazz writer. The tapes were sent to England for processing and received all the care lavished on products of the London label. If the rest of the series measures up to the standard set so far, Stanley Dance should be booking passage soon with another commission in his pocket.

**Shelly Manne & His Men Play "Peter Gunn"** **Stereo S7025**

Contemporary and Good Time Jazz Records operate under one roof and their combined stereo output is being channeled into one outlet on the Stereo label. Work on assembling a stereo catalogue started last Spring, but not until the rush began for this popular television score were both versions issued simultaneously. Shelly Manne and Vic Feldman joined the band used on the show last November and are competing here with their employer's release of the sound track. Henry Mancini gave his blessing, however, as their announced intention is toward an improvised and spontaneous reading. It is attained through one of Contemporary's famed all-night sessions, this one lasting twelve hours, and is somewhat of a tribute to the viability of the composer's themes.

The most relaxed and intimate sounding of the various recordings, it features Feldman on both vibes and a ripe-toned marimba. Herb Geller, a new member of Manne's crew, plays alto sax, and Conte Candoli is on trumpet. Russ Freeman, piano, and Monte Budwig, bass, join the leader in the rhythm section. With Ray Anthony's big band exploiting the larger aspects on a best-selling single, Mancini may yet convert a younger generation to jazz, just as his hero is weaning it from blue suede shoes to Brooks Brothers suits. Roy DuNann and Howard Holzer, of the engineering staff, were in close proximity to the Westrex stereo cutterhead during its development and shakedown cruises. The vibraharp affords an excellent example of their mastering procedures, and you are likely to forget all about directionality when you hear that marimba.

**Bob Brookmeyer: Kansas City Revisited**
**United Artists UAS5008**

What it was like to be a youngster growing up in the Kansas of the late 30's and early 40's is lightly sketched on the liner by Bob Brookmeyer, along with his reasons for not wanting to revisit his hometown as it is now. Remembering a more invigorating time, he sets about recreating it with determination and considerable zest. The tunes are in the Basie tradition, and Big Miller is there to shout a resonant blues and sing *Travelin' Light*.

In lieu of a trumpet player, Brookmeyer delivers the requisite obligatos on trombone and has additional solo space. Jim Hall runs into trouble, however, when he essays a trumpet voicing on guitar and overloads his amplifier. The theory seems to be that unison passages of two tenor saxophones, played by Al Cohn and Paul Quinichette, are more essential than a trumpet and it works out that way in stereo. Both have interesting solos, with Quinichette better acclimated to the idiom, and no boxscore is needed to tell them apart. Nat Pierce, Addison Farmer, and Osie Johnson complete the rhythm section, but the date belongs to Brookmeyer and his reminiscenses. May he supply another chapter soon.

**Jonah Jones: Jumpin' With Jonah**
**Capitol ST1039**

**Red Nichols: Parade Of The Pennies**
**Capitol ST1051**

**Jackie Davis: Most Happy Hammond**
**Capitol ST1046**

At the turn of the new year, production facilities at Capitol moved into high gear and a total of sixteen popular items, plus two from "Capitol of the World," entered the expanding stereo catalogue. The promise of double this number in the next release can only mean that this company finds the response to the new medium gratifying, and anticipates a growing market. Already firmly established, its leadership in the popular field is likely to become even greater due to the variety and scope of the conversion program.

Up until now, the emphasis was entirely on the larger and dramatic aspects of the stereo stage. Material was drawn from its stable of bands, choral groups, original-cast musicals

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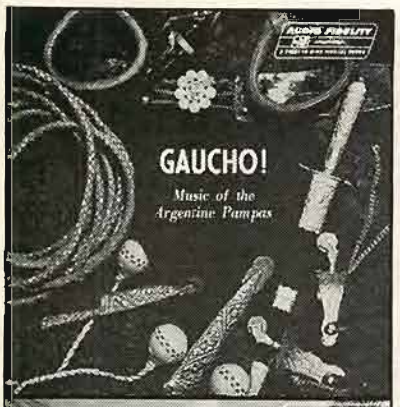


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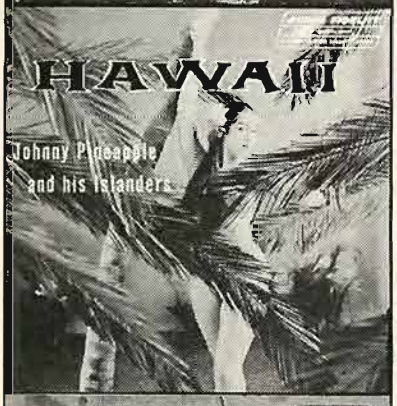


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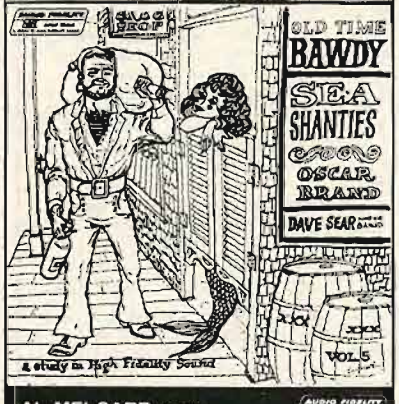


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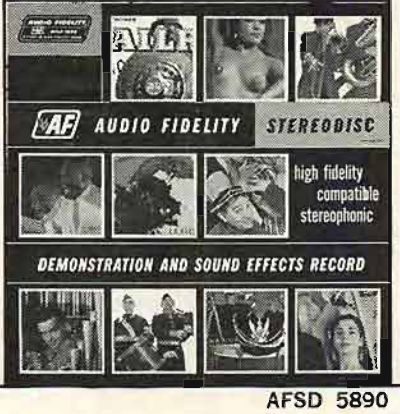


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AFLP 1897
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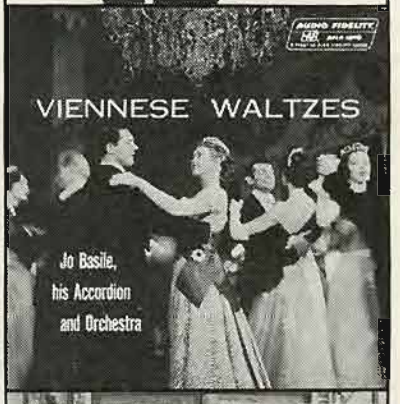


AFLP 1868
AFSD 5868


AFLP 1869
AFSD 5869

and sound tracks. They continue to be most prominent on the current list, but several smaller units make their first appearance and demonstrate that the ears of the engineering staff are also attuned to the more intimate stereo picture.

Jonah Jones seems unable to keep any of his offerings off the best-seller charts and his muted trumpet, when centered between two speakers, sounds sprightly and bold. It growls nobly on *The Blues Don't Care*, and swings in vigorous and straightforward fashion throughout. As guest at the session, Hank Jones is benefited most and the clear definition given his piano accompaniments makes them as interesting as his solos.

Red Nichols, still going strong after more than thirty-five years in the business, is awaiting the film of his life story. The first to use a bass-sax lead, he is able to hear how his early innovations sound in stereo and collaborates with Heluie Beau on a new theme for Joe Rushton, appropriately called *Bass Face Joe*. After he featured Eddie Lang, the downfall of the banjo was imminent, so Allan Reuss sits in on guitar. He introduced the mellophone to the jazz band and Jackie Coon is there to play it. Vic Berton added tympani and bells, and Adrian Rollini the vibraphone —all three now handled by Ralph Hansell. And the Nichols cornet pays tribute to his friend Bix Biederbecke on *Davenport Blues*. You may see it all happen in the movies and want to make comparisons with the sound track.

Jackie Davis, one of the swingiest and most melodic of jazz organists, plays a dozen top tunes from as many musical comedies. In taking his Hammond to Broadway, he is joined as the occasion demands by Kenny Burrell or Mundell Lowe on guitar, Eddie Costa, vibes, and drummer Burtell Knox. They blend pleasantly with the organ and an exemplary balance is maintained between the instruments, with more bass in evidence than last season.

"Oklahoma!" in the movie sound track version, heads the list of larger productions. Richard Jones conducts the strings of the Pittsburgh Symphony in "Stringtime." Meredith Willson's "The Music Man" is sung by Fred Waring's Pennsylvanians.

Harry James, Stan Kenton, and Ray Anthony represent the cause of the big bands. George Shearing, Jackie Gleason, Don Baker, and Freddy Martin provide material for the mood music contingent. And from the corps of vocalists are albums by Nat "King" Cole Dakota Staton and June Christy.

"Jet Flight" (Capitol ST10190), an atmospheric world tour on a Boeing 707, was recorded in London by Norrie Paramour. He also leads his ample orchestra on the other item from the international section, a gorgeous arrangement of tunes from "My Fair Lady" (Capitol ST10100).

### Ted Heath: Swings In High Stereo
**London PS140**

London's Kingsway Hall is the scene of this session and an enthusiastic audience voices appreciation after each of eleven tunes. One of the more swinging Ted Heath concerts, it finds him spotlighting his sidemen at length and introduces a new member of the band. Stan Tracey debuts as vibraphonist, soloing on *Love Me or Leave Me*, and a beautifully conceived *Over The Rainbow*. Bassist Johnny Hawksworth and drummer Ronnie Verrell engage in an informed dialogue on *Big Ben*. Ronnie Chamberlain adds the distinctive sound of the soprano sax on *My Funny Valentine*. Trombonist Keith Christie brightens the tempo for *I Like To Recognize The Tune*. And Henry McKenzie's agile clarinet weaves blithely through *Wrap Your Troubles In Dreams*. There are fresh arrangements of Ellington's *C Jam Blues* and *Sophisticated Lady*.

The recording meets the high standards set in previous ventures at the auditorium.

### The Mastersounds: Kismet
**World Pacific Stereo 1010**

### The Mastersounds: Flower Drum Song
**World Pacific Stereo 1012**

On the heels of a successful jazz interpretation of "The King and I," The Mastersounds apply varicolored tints to the music from two other hit shows. Oriental sounds and patterns are implicit in each score and the quartet, at this stage of the game, is quite expert at conveying these effects. Combined with the rhythms of jazz, they result in a pleasant blend, unlike that achieved by any other group.

"Kismet" finds a quintet at work as Wes Montgomery, on guitar, joins his brothers Buddy (vibes), and Monk (Fender electric bass), along with Richie Crabtree (piano), and drummer Benny Barth. He helps impart the necessary zest to *Stranger in Paradise, Fate,* and *Baubles, Bangles, and Beads*, tunes readily adaptable to jazz and the ones from the show most often heard in the idiom. What sets the unit apart is the ability to handle the more obscure pieces, and the readings are always palatable, if not the most righteous jazz. Offered in evidence are *Olive Tree* and *Not Since Nineveh*. The recording originates in the Forum Theater, Los Angeles, and is beautifully balanced in stereo.

"Flower Drum Song," as is the case with many musicals today, emerges in a new setting before most people have absorbed the original version. It is said that Rodgers and Hammerstein, impressed by the treatment given "The King and I," forwarded a copy of the score before the Broadway opening. Even so, there was only a week to rehearse and prepare the arrangements. Operating as a quartet this time, the group concentrates on the songs best suited to jazz and provides an inclusive overture. Buddy Montgomery adds *The Flower*, a composition designed to fit the general feeling of the show. Nat Hentoff supervised the date at RCA Victor studios and the stereo separation is just right for most living rooms.

"New Bottle Old Wine" (World Pacific Stereo 1011), a wedding of Gil Evans arrangements and the alto sax of Julian Adderly, met with critical acceptance. The subdued textures of the orchestra are more brilliantly communicated in stereo.

"Something For Both Ears" (World Pacific Stereo HFS2) is a demonstration sampler at a bargain price. Ten numbers are played by The Mastersounds and groups headed by Johnny Mandel, Charlie Mariano, Jerry Dodgion, Bud Shank, Chico Hamilton, Gil Evans, and Gerry Mulligan. The demonstration track consists of sounds in the studio before recording begins on a stereo date.

### Jo Basile: Accordeon di Roma, Vol. Two
**Audio Fidelity AFSD 5871**

The volume number is deceptive as this is the seventh album to feature Jo Basile on this label. He accompanies a vocalist on three occasions, having mastered the art in support of Patachou, but this time is free of encumbrance and romantic sentiments flow unimpeded. Those who have met him on previous tours know he is equally at home in France and Italy. He ably varies the dozen tunes by mixing lesser known items with such familiar melodies as *Toselli's Serenade, Ciribiribin, Carnival of Venice*, and *O Marie*. The accordion is carefully centered among vibrant strings in stereo.

### A Night At The Tropicoro
**Cook 2187SD**

The Hotel El San Juan Intercontinental is part of a large chain which blankets Central and South America and the show at its Tropicoro is a typical tourist attraction. Lita Pena's Orquesta Panamericana is composed of native Puerto Ricans, but is commercial enough to play at a club in any quarter of the world. The musicians seem to be intent listeners to bands from the States and mix what they hear with local rhythms. The real life sound of singing tree-toads, on a merengue dedicated to their breed, may appease the persons who expect Emory Cook to uncover something unusual on his trips. For Latin American music equally good and authentic, this expedition needed to go no further than Broadway, which seems to be the ultimate aim of the band. Of course, Cook enterprises now extend to Puerto Rico, but the moral seems to be not to mix business with pleasure.

Mastering was accomplished by means of the new Cook vector stereo cutter and claims for a full bass range seem justified. There is not much it can do to improve the sound of a guitarist who evidently learned his instru-


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AFLP 1871 AFSD 5871


AFLP 1891 AFSD 5891


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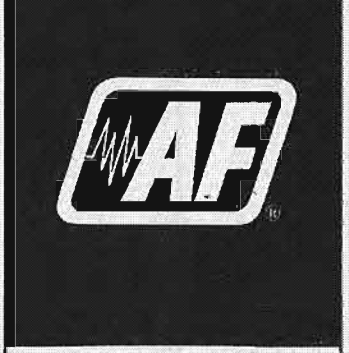



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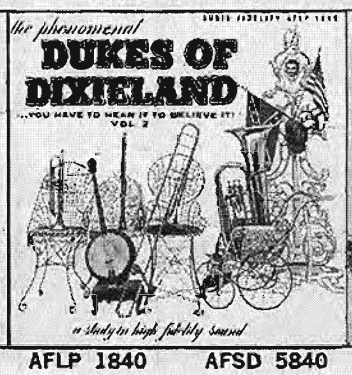


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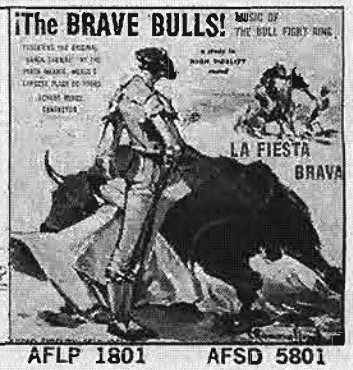



AFLP 1801 AFSD 5801

ment by studying old Les Paul records, however, and it would be unfair to judge the overall results on this basis.

### Coney Island In Stereo
**Riverside RLP1114**

The many attractions of the world's largest amusement park are visited and much of their fun and excitement conveyed on this stereo outing, along with quite a bit of uproar from a happy throng. The fun house, side show, freaks, and shooting gallery are part of the tour, plus rides on miniature cars and the Thunderbolt. With microphones placed near the top and bottom, the apparatus for the contest of "test your strength" is turned on its side, making it easier to hit the bell. There is the big carousel at Steeplechase Park, a smaller one at an enclosed merry-go-round, and two calliopes, all with varying degrees of inherent distortion. But this never bothers anyone on the Boardwalk, where Nathan's is always handy to replenish the hungry and weary. The enticement of hot dogs sizzling on the griddle and the sound of the cash register may cause listeners to reach for their wallets. Next time, why not stay for the fireworks?

### Lenny Herman: Music In Motion
**Janus FST2004**

Trust a hotel manager to know a bargain, and most of them are happy to buy a society band which comes all wrapped up at the price of five musicians. Under the trademark of the mightiest little band in the land, Lenny Herman offers just such a volue and works as hard as any of his men by doubling on vibes and accordian. Alan Shurr plays clarinet and an assortment of saxes; Earl Comfort, violin and bass; Charles Shaw, piano and organ; and the drummer is Stan Scott. How the arrangements achieve the unique blend of sound is clearly defined in stereo, and it makes for fascinating listening a few times around. After that, the tempos are always good for dancing and the seventeen tunes include *Skip To My Lou*, *La Cinquintaine*, and *Miss You*. Olmsted Sound cut the masters, and in the dimensions of stereo the quintet is more than a match for any society band on one-channel.

## MONOPHONIC

### Les Baxter: African Jazz  Capitol T1117

Always on the prowl for exotic sounds, Les Baxter ventures deep into Africa in search of primitive rhythms and the chants of native rites. Also making the trip are jazzmen Larry Bunker, Milt Bernhart, and Plas Johnson. As several of the compositions are designed to show the entry of the twentieth century into the dark continent, the perils of the safari are less hazardous than the Hollywood Freeway. They ride to the jumping-off place on *Congo Train*, and even locate a nightclub on *Mombusa After Midnight*. Johnson's tenor sax wails with uncanny realism on *Elephant Trail*, as Bernhart assists on some highly untraditional trombone passages. Bunker plays vibes, xylophone, and marimba on a visit to a *Cairo Bazaar*, and adds to the pulsing beat of *Balinese Bongos*.

Baxter employs a number of percussion instruments in his impressionistic sketches and distributes effects for the high fidelity enthusiast with a lavish hand. His jungle downpour is intense and includes echoing thunder. The nanigo rhythms of *Walkin' Watusi* are adventurous and colorful. Of the several spectacular albums released under his name, this is the most unusual and absorbing.

### Benny Carter: Jazz Giant
**Contemporary C3555**

When so many minor jazz figures are recording weekly, if not more often, the appearance of Benny Carter in any capacity is somewhat of an event and an album under his name is a prize worth coveting. Since departing the band business, he has resided in Los Angeles, where his work as conductor, arranger and writer keeps him busy in films and other media. His few LP's, for some strange reason known only to the producer, give a partial picture of the artist, stressing the elegance and urbanity of his playing.

This time he enjoys the same carefree small-group setting he experienced in the 30's, before the cares of fronting a band weighed him down. Ben Webster falls heir to the tenor-sax position once taken by Coleman Hawkins and becomes a partner on equally valid terms in inspired choruses on *Blue Lou*, and *Old Fashioned Love*. In addition to alto sax, Carter plays trumpet on *I'm Coming Virginia*, and *How Can You Lose*, a composition of his own with earthy trombone comments from Frank Rosolino. Bassist Leroy Vinnegar introduces Carter's *A Walkin' Thing*. Shelly Manne and Andre Previn complete the rhythm section which accompanies the lone sax soliloquies on *Ain't She Sweet* and *Blues My Naughtie Sweetie Gives To Me*.

### The Playboy Jazz All Stars, Vol. Two
### Barney Kessel: The Poll Winners Ride Again
**Contemporary C3556**

A few thousand more voters indicated their favorites in the 1958 Playboy Jazz Poll than in 1957, but there is little change among the winners and the second album is much like the first. Because it is the largest of the polls, many choices are based on past performances to begin with and the shifts in position which signal the trend of public taste are apt to occur slowly. The only significant change in the 1959 results, announced in February, is the rise of Miles Davis, so the third volume probably will be cast along similar lines. Harry James may wait two years to see his comeback of last year, both as a band leader and player, reflected in either category. Playboy has found a successful formula, nevertheless, and is likely to stick with it as long as returns come in.

Twenty-two musicians and singers are allotted tracks of their own on the two discs, suitably encased in a lavish album with notes by Leonard Feather, and several reappear in support of other stars. Small groups fare well, but the default of Stan Kenton leaves big bands poorly represented. Large studio groups are headed by Benny Goodman and Shorty Rogers, who uses several Kenton sidemen, and

neither has the permanence of a contribution from Ellington or Basie. RCA Victor pressed the album and Columbia is distributing it. Other cooperating companies are Frank Sinatra's Essex Productions, Benny Goodman's Park label, Fantasy, Verve, World Pacific, and Audio Fidelity.

Contemporary produced last year's edition and its perennial poll winners again take part, each more than once. Barney Kessel, Shelly Manne, and Ray Brown consistently win all national polls in this country and are united for a second time on a session commemorating that feat. Kessel contributes three swinging originals and amusing guitar passages on Domenico Modugno's *Volare*. Brown's *Custard Puff* gives him an opening for a brilliant bass solo. Manne's choice of tempos justifies his drummer rating on *Surrey With The Fringe On Top*, and *The Merry-Go-Round Broke Down*. Each comments on his task with insight on the liner. The performances are of the highest order and excellently recorded.

**Nat "King" Cole:** Welcome To The Club
**Capitol W1120**

The velvety voice of Nat Cole is unruffled, if slightly less languorous, in welcoming the surging challenge of a band under the direction of Dave Cavanaugh. A quick perusal of the roster reveals that all the men Count Basie took on his West Coast trip last summer are present. Contractual obligations relegate the leader to the sidelines and his place at the piano is ably filled by Gerald Wiggins. The rest of the party is in fine form and ready to meet the singer on his home grounds, especially Sonny Payne who delivers an infectious beat. He quickly grasps Cole's buoyant conception of *Baby, Won't You Please Come Home*, and his drum solo prepares the way for a tricky stop time vocal on *Avalon*.

No more complete picture of the many facets of Cole as a singer is contained on one LP. Cavanaugh's arrangements are fashioned to show him in all capacities, on ballads, blues and straight rhythm tunes. There is a ravishing *Mood Indigo*, a rollicking *Wee Baby Blues*, and a relaxed *Anytime, Anyday, Anywhere*. In all likelihood, a stereo release can be anticipated.

**Beverly Kelly Sings**
**Audio Fidelity AFLP1874**

**Kitty White:** Sweet Talk
**Roulette R52020**

The Pat Moran Trio provides top notch backing for the voice of Beverly Kelly, a singer capable of toying in modern girl-meets-horn style with *Lover Come Back To Me*, or imparting a fine swinging beat to *I Get a Kick Out of You*. Like most of her contemporaries, she has certain mannerisms that wear thin on discs and are best left in night clubs. The patrons, however, expect to find them on the record. She shows her awareness of this problem by splitting her program neatly down the middle. When not doing her act, she sings in straightforward fashion and is helped, of course, by the trio and fine recording.

Kitty White is blessed with the relaxed sort of accompaniment that is all too rare these days. Such men as Harry Edison, trumpet, and Benny Carter, alto sax, make it one of those memorable sessions where everything seems informal, yet falls into the creative order necessary to jazz. Everyone solos or molds warm obbligatos behind the voice. Larry Bunker, Laurindo Almeida, Jimmy Rowles, Ted Nash, Bill Pitman, and Red Callender all participate in a lesson on what a singer needs most, although the recording balance could be better. Carlo Vical's bongos open *When The Wind Was Green*, and Alvin Stroller is on drums. As for Miss White, listen to the record once for her, once for the musicians, and again for *Lazy Afternoon*.

**Sing Along With Basie**
**Roulette R52018**

The latest movement to wed poetry and jazz seems to have bogged down, possibly because too few of those concerned possessed the intimate knowledge, experience, and willingness to work which characterize this production. Ten Count Basie instrumentals are sung to lyrics written by Jon Hendricks to fit horn lines created by the original soloists. By joining his voice to those of Annie Ross and Dave Lambert a trio is formed capable of complex ensembles or individual flights on *Jumpin' at the Woodside, Every Tub*, and *Swingin' the Blues*. Multitaping enabled them to imitate a full band sound successfully on a previous recording. Electronic aids are replaced, in this case, by the Basie band and its big-voiced vocalist Joe Williams, who helps describe *Shorty George, Going to Chicago*, and *Rusty Dusty Blues*.

A reading of the texts, printed in full on the liner, fails to disclose the greatest of poetry and it is hardly likely that Hendricks was trying to do more than fit words to predetermined lines. They do work when sung, however, and form as valid a point of departure for a marriage of poetry and jazz as any yet disclosed. The group's popularity undoubtedly will cause it to collaborate with musicians on new compositions of much interest. Be advised to look for an early pressing containing *Li'l Darlin'*, withdrawn because of a hassle with the composer and already a collector's item.

**George Wright:** The Roaring 20's
**Hifirecord R718**

**Eddie Dunstedter:** Mister Pipe Organ
**Capitol T1128**

Built when a fabulous decade was at its peak, the San Francisco Fox Theater makes an ideal place to recollect the days when the movies were silent and the organ roared unchecked. The gilt-encrusted console of the four-manual Wurlitzer is a choice period piece, and its like will not be seen again. George Wright remembers its days of glory and commands the thirty-seven sets of pipes, distributed over five chambers, with the skill that comes from long experience. Among the four-

(*Continued on page 66*)

# ABOUT MUSIC

HAROLD LAWRENCE*

## Let's Sing a Symphony

LEONARD BERNSTEIN's last television appearance of the season (February 22) was titled, "The Infinite Variety of Music," but it could have been called, "Variations on How Dry I Am." The New York Philharmonic conductor took the first four notes of the familiar drinking tune and showed us how Handel, Beethoven, Strauss, and Shostakovitch used this particular sequence in their compositions. "How Dry I Am" was heard in the major and minor keys, as well as in a variety of moods ranging from the festive, to the lyric, playful, romantic and martial. Before the program was over, one found oneself yearning for a good stiff drink.

To exclaim how wonderful it is that a composer can express so many different things by means of an alphabet of twelve notes tells us very little about the art of music. After all, the composer performs no less a miracle than the writer with his twenty-six letters, the painter with his three primary colors, or the mathematician with his nine integers. Having once enunciated his thought, Mr. Bernstein would have done well to have gone on to more substantial areas. Instead, he chose to repeat his theme without alteration, thereby turning his program into a reverberating platitude. He is too talented and versatile to indulge in an approach that smacks of the "music appreciation" class, which many of us will remember from our public school days.

The music appreciation period in the week's schedule usually involved marching into the assembly hall to the tune of Sousa's *King Cotton*, or *Washington Post*, played vigorously on the piano by the music teacher. Most students regarded this as the easiest class in their curriculum; they rested comfortably in the auditorium's less battered seats and listened to recordings of classical music played on a portable phonograph. Between recorded selections, the teacher picked out melodies from the compositions on the program. The educational objective was simple: to learn great music by remembering themes from famous works. Teachers long ago discovered the obvious fact that mere exposure to classical music will put most of their classes to sleep. (A glance at the audiences at symphony concerts demonstrates that this holds true even for ticket-paying adults.) Therefore, they had to devise a method for engaging the students' full attention.

The association of words and music seemed the answer to the problem. In memorizing a sentence or a poem linked with a melody from a popular symphonic piece, it stands to reason that the student will memorize the music, too. This proved a practical scheme. Too practical, in fact. For no matter how much we now try to eradicate these words from our mind, they cling to us with the tenacity that only certain youthful memories are wont to possess.

Before proceeding further, the reader should be warned that this subject has its contagious aspects. How often have we been pursued by a tune from which we cannot escape? This writer, like thousands of music lovers who attended the same kind of music appreciation classes, has had certain words inscribed indelibly in his memory alongside themes from great musical scores. Here are a few examples.

Schubert—*Symphony No. 8:* first movement.

This is the *sym*-phony
That *Schu*-bert wrote but never *fin*-ished.

Beethoven—*Symphony No. 5:* opening

This is the Fifth!
Beethoven's Fifth!

This is the fifth sym-*phony*
That Beeth-*ov*-en wrote.

Haydn—*Symphony No. 94:* second movement.

Papa Haydn made this tune
A surprise is coming soon.

Grieg—*Peer Gynt*

Morning is breaking,
And Peer Gynt is waking.

In the hall of—the mountain king,
Mountain king, mountain king . . .

Some of the best specimens of music-appreciation poetry are written in England, where one music educator set to words the themes of the entire *Well-Tempered Clavier*. English school-children remember Mendelssohn's *Hebrides* Overture by means of the following lines:

*Opening theme*

How *love*-ly the *sea* is!

*Second theme*

Oh! Listen to the *love*-ly second *subject*!
On the *'cellos*,
Lucky *fellows*!

In dancing class, schoolgirls tripped to Beethoven's *Minuet* while singing these special lyrics:

Come and let us make a pretty bow.
Make a bow, make a bow.
Come and let us make a pretty bow,

* *26 W. Ninth St., New York 11, N.Y.*

Make a pretty stylish, fancy turn.
Now we'll walk off so straight,
Make a bow, make a bo-ow.
Come and let us make a pretty bow.
Make a bow, *vis-à-vis.*

In his book, "Great Symphonies—how to recognize and remember them" (Comet Press), Sigmund Spaeth, the high priest of music appreciation, sets to words the principal and subsidiary themes of well known symphonies. With impressive determination, Dr. Spaeth performs verbal acrobatics in order to make the words fit the tune. Take, for example, his settings of Mozart's *Jupiter* Symphony.

1. *Allegro vivace*
Jove! Great Jove! Mighty Jove!
We come to thee with trembling.
Jove! Great Jove! Mighty Jove!
Our fears are past dissembling.

2. *Andante cantabile*
Even Jove ma-ay fail! Ha!
Even Jove tu-urns pale! Ha!

3. *Menuetto*
*Mo*-zart used this progression be-*fore.*
Look for it in his G Minor se-*ore.*

For Beethoven's *Funeral March* from the "Eroica" Symphony, Dr. Spaeth contrived this stark verbal setting:

Muffled drums tell a hero's ending,
Slow steps, mourners wending.
Raise not the head.
The eyes are closed, the hero is dead—
*Cold and dead.*

In the above examples, Dr. Spaeth built his poems on a title or an implied program. He was greatly handicapped by such a work as Mozart's *Symphony No. 39*, which bears no subtitle and has no extra-musical allusions:

*First movement*
E Flat the key.
Great symphony.

Dr. Spaeth's comprehensiveness, however, proves to be his undoing, for how is one to recognize the themes of great symphonies when the key words are too numerous and difficult to remember? The concise phrase used in the public schools may serve to highlight only one theme per work —and often merely part of the theme—but it is a simple phrase.

Which brings us back to "How Dry I Am." Mr. Bernstein's purpose in using this drinking song differs from that of the music appreciation teacher. Yet he has unwittingly injected an element of uncertainty into the field, for "How Dry I Am," while a handy identity key, *now stands for several different pieces.* In addition, the words do not refer specifically to the music in question, with the possible exception of Handel's *Water Music.*

In view of the confusion, perhaps this would be a good time to end the practice of writing lyrics to great musical works once and for all. Did Mendelssohn anticipate the era of music appreciation when he composed his "Songs Without Words"?

AE

# NEW PRODUCTS

• **Ampex Tuner and Audio Control.** Marking its entry into the high-fidelity components field, Ampex is introducing a stereo AM-FM tuner and a matching stereo audio-control-preamplifier, both of which were developed for incorporation into Ampex console home music systems, but which are being made available separately as individual components. The

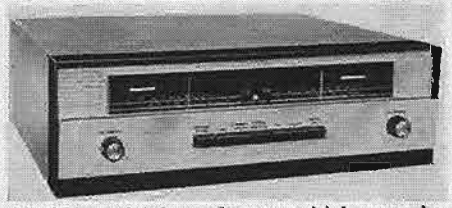
Model 502 tuner incorporates on a single chassis two completely independent but matched tuning units, for either or both FM and AM reception. Offering excellent selectivity and sensitivity, the tuner was designed as a precision unit to provide optimum balance between the two parallel channels at all levels of operation, a feature critically important for stereo recording off the air. AM circuitry provides broad and sharp selectivity positions. Engineering features include accurate visual tuning indicators and flywheel tuning mechanisms. The unit also features provision for adaptation to FM multiplex. The Model 402 audio control center offers instant selection of any desired source of

stereo or monophonic reproduction. Two loudness controls, one for each channel, are mounted on concentric shafts and friction coupled to permit setting and maintaining uniform calibration and balance of audio levels, with automatic treble and bass compensation at any desired listening level. Individual bass and treble controls permit maximum boost and cut of 16 db. Full technical information will be mailed upon request to Ampex Audio, Inc., 1020 Kifer Road, Sunnyvale, Calif. **D-1**

• **Shure Stereo Arm-Cartridge Combination.** Virtual elimination of record and stylus wear has been accomplished with

the stereo version of the Shure Studio Dynetic integrated tone arm and magnetic cartridge. Intended for use in professional turntables, the unit will track at less than two grams stylus force; at this force the cartridge can actually be swept back and forth across a spinning record without causing damage to either the record or the diamond stylus. Channel separation of the Studio Dynetic is more than 20 db at 1000 cps. Frequency range is 20 to 20,000 ± 2.5 db. Output is 5 mv per channel at 1000 cps. Compliance, both vertical and lateral, is $8 \times 10^{-6}$ centimeters/dyne. Manufactured by Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. **D-2**

• **Harman-Kardon Stereo Tuner.** The "Madrigal," Model ST350, is a tuner which sets a new high in simplicity of operation, being operated entirely by push-buttons with exception of the tuning function itself. Also it is exceptional in its versatility. It contains separate AM and FM sections for simulcast stereo reception, and is equipped with signal and power supply to drive the new Harman-Kardon

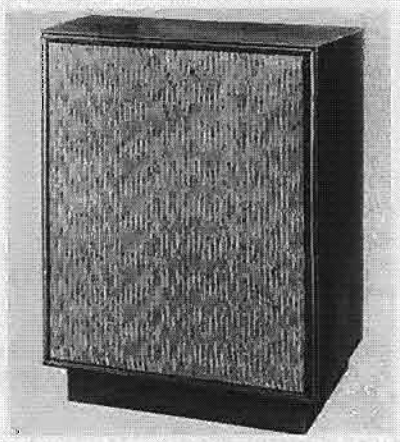


MA350 multiplex adapter, which may be mounted within the tuner enclosure. When equipped with the adapter the tuner is fully capable of receiving Crosby compatible multiplex broadcasts. FM sensitivity is below 1 microvolt for 20 db quieting; 1.9 microvolts for 30 db quieting; frequency response is 20 to 20,000 cps within ± 0.5 db. AM sensitivity is 20 microvolts/meter; frequency response is 20 to 8000 cps ± 3.0 db. The ST350 tuner is ideally suited for use with the Harman-Kardon Epic, Model A250, 50-watt stereo amplifier. Further information will be supplied upon request. Write Harman-Kardon, Inc., 520 Main St., Westbury, N. Y. **D-3**

• **Dual Turntable/Changer.** Embodying many exclusive features essential to stereo reproduction, the new Dual (pronounced du'-al) Model 1006 is a combination 4-speed turntable and deluxe record changer. The unit will track and operate the automatic cycling mechanism with stylus force as low as 2 grams. A built-in direct-reading pressure guage insures

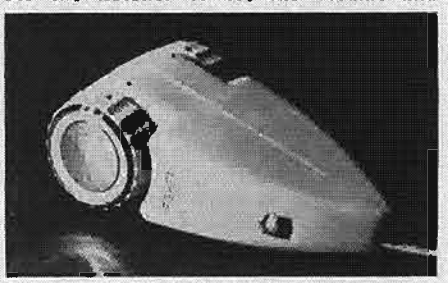
optimum cartridge operation and long record life. The turntable proper weighs 5¼ lbs. and is laminated and concentrically girded to retain dynamic balance and a plane surface. The motor is of sufficient power to drive the turntable to full speed within a half second from a dead start. A one-piece tone arm employs a double set of direct-acting ball bearings for both vertical and lateral axes. A Stereo-Mono switch includes a phase-cancelling feedback circuit which removes vertical noise signals resulting when monophonic records are played with stereo cartridges. The changer mechanism is unique in that it will operate with any diameter record from 5 to 12 ins., and will intermix ten records in any sequence. These and other special features of the Dual 1006 are described in greater detail in literature available from United Audio Products, Inc., Desk 6, 202–4 E. 19th St., New York 3, N. Y. **D-4**

• **G-E Speaker Enclosure.** Proportioned for minimum width, with its height compatible with the G-E EQ-1 series equipment cabinet, the new "Stereo Classic" EN-50 series is a 5-cu.-ft. "distributed-port" speaker enclosure which is introduced by G-E as the top quality enclosure in its hi-fi components line. When used with a high quality coaxial or biaxial



speaker system, it has more than double the low-frequency power output capability of comparable closed-type enclosures. The seven "distributed port" openings are in the rear panel, to eliminate grille cloth interference and improve the enclosure's acoustic resistance function. Possible spurious sound from air turbulence through the openings is eliminated by the size and placement of the ports. The EN-50 is designed to accommodate air pressures of speakers of up to 60 watts. Further information is available from: General Electric Company, West Genesee Street, Auburn, N. Y. **D-5**

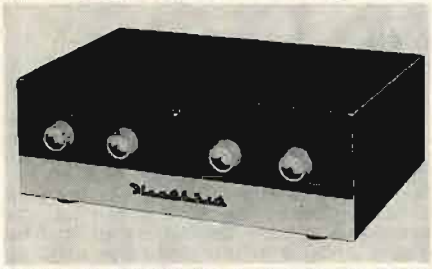
• **Fisher Stereo Remote Control.** The Model RK-1 stereo control unit permits adjustment of speaker level anywhere within the listening area. Developed for use with the Fisher 400-C master audio control, this attachment makes it possible for the listener to set the volume and



balance of his speakers at the spot where he hears the program instead of at the control center. The RK-1 consists of a control assembly, a 30-ft. connecting cable, and an adapter plug for connection to the 400-C. In operating position, volume of both left- and right-hand speakers may be controlled independently. Fisher Radio Corporation, 21–21 44th Drive, Long Island City 1, N. Y. **D-6**

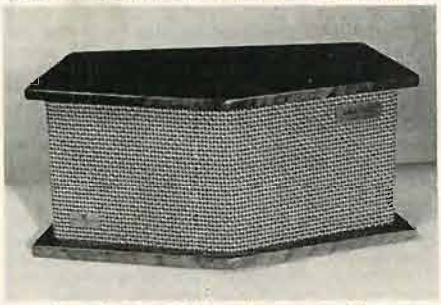
• **Heathkit 12-Watt "Bookshelf" Amplifier.** This compact little amplifier provides the same high quality sound reproduction as the Heathkit Williamson-type amplifiers and is limited only in power output. The EA-2 has more than enough power for the average home and provides 20-to-20,000-

cps response within ±1.0 db, with less than 1.0 per cent harmonic distortion at full output. Miniature tubes are used throughout the advanced circuitry, including Type EL84 output tubes in a push-pull tapped-screen output circuit. Output trans-



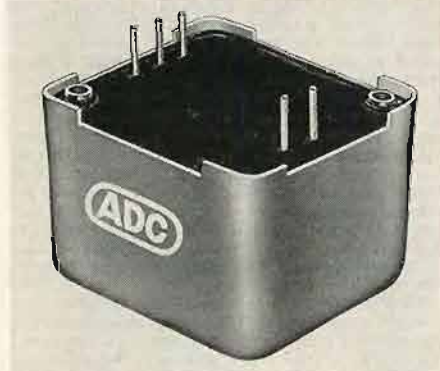
former is tapped at 4, 8, and 16 ohms. Built-in preamp has provision for three inputs, magnetic phono, crystal phono, and tuner. Separate bass and treble controls provide both boost and cut. Vinyl-clad steel housing with brushed-gold trim is exceptionally neat in appearance. For further information on this excellent low-priced amplifier kit, write Heath Company, Benton Harbor, Mich. **D-7**

• **Electrostatic Tweeter.** Introduced as the Model AH! Electrostatic Transducer, this unit is equipped with a self-contained r-c crossover network, and may be connected in parallel across any low- or full-range speaker without additional facilities. Frequency range is 500 cps to well beyond the limit of audibility. Built-in fused power



supply affords 1000 v.d.c. polarizing potential. Two capacitor elements permit 120-deg. dispersion. Push-pull construction holds distortion to an absolute minimum. The AH! is designed to match an 8- or 16-ohm output of a 15- to 50-watt amplifier. Cabinet is finished in hand-rubbed walnut. For further information write Cosmos Industries, Inc., 31-28 Queens Blvd., Long Island City 1, N. Y. **D-8**

• **Miniature Transformers.** A new series of small transformers intended for use with printed circuits has been added to the line of audio components manufactured by Audio Development Company, 2833 13th Avenue, South, Minneapolis 7, Minn. Five standard case sizes range from




0.56" square by 0.60" in height up to 1.27" square by 0.94" in height. Audio, power, and ultrasonic transformers and inductors in these sizes are available for either transistor or vacuum-tube circuitry. Terminals and inserts are on standard 0.1" grid multiples. **D-9**

# JAZZ AND ALL THAT

(*from page 61*)

teen tunes are *You Were Meant For Me, Then I'll Be Happy*, and *Just A Memory*. The immense size of the house contributes to the monophonic version, and the placement of the pipes on either side of the auditorium should be dramatically realized on the forthcoming stereo disc.

Eddie Dunstedter combines the effects of a four-manual, twenty-four rank Robert Morton studio organ and a three-manual Hammond, equipped with vibraharp, celesta, and a Krueger string bass attachment. Multiple recording turns up almost everywhere and it was merely a matter of time before an organist tried it. In this case, the tapes are blended so skillfully that the scoreboard must be followed to tell what is going on. Dunstedter sticks to one instrument on several tracks, switches amiably from one to the other on some, and joins their effects on others, even dubbing in piano embellishments in one instance. His repertoire includes *The Toy Trumpet, Poinciana, Brazil*, and *Serenade to a Wealthy Widow*.

### Beauties of 1918 World Pacific WP1245

Described by his employer of the past three years as "one of the most underrated if not the most underrated alto man in the country," in a liner quote, Charlie Mariano is likely to be remembered for his unusual choice of tunes for this album, no matter how it affects his rating. Quite a few listeners who would hesitate to name Shelly Manne's alto saxist will recall the man resourceful enough to revive *Hello, Central, Give Me No Man's Land*, and other songs of World War I vintage. His partner, on alto and flute, is Jerry Dodgion of Red Norvo's quintet, a fluent performer capable of meeting the needs of *Till We Meet Again, and 'Til the Clouds Roll By*. Victor Feldman, vibes, and pianist Jimmy Rowles deal with the subtleties of *K-K-K-Katy*, and Monty Budwig delivers a well timed bass line.

Best of all, these modernists treat the old tunes with affection and seem to have a good time doing it. The arrangements, credited to Mariano, are skilled and reveal hidden beauties. On *Deep River*, he plays recorder in a setting which will evoke memories in some of Willard Robison, a modernist twenty-five years ago before the term acquired its present connotation. Boss Shelly Manne is on hand to give direction and a martial sound to *Over There*, and *When Johnny Comes Marching Home*.

### Pete Rugolo: Percussion At Work EmArcy MG36122
### Drums On Fire! World Pacific WP1247

Freed from the conventional role of the jazz drummer, the percussionists at work on these two albums combine varied tonal qualities in complex rhythmic patterns, using them to tell a story or simply as interesting sounds. To enlarge upon four compositions he wrote while chief arranger for Stan Kenton a decade ago, Pete Rugolo enlists sixteen men and returns Jack Costanzo, on bongos, and Shelly Manne, who alternates as tympanist with vibist Larry Bunker, to their original posts. *Bongo Riff, Fugue for Rhythm Section*, and *Artistry on Percussion* all shine under the brilliance of improved recording techniques. Any preponderance of brass and kettledrums is lightened by the use of rhythm section alone, with Mel Lewis as an added drummer on several numbers. Andre Previn's inventive piano passages break up the succession of drum solos and his playing is a feature of *Chorale for Brass, Piano and Bongo*. A stereo version is listed on Mercury.

Chatur Lal, one of India's leading Tabla players, visited the United States as accompanist to the Sitar virtuoso Ravi Shankar and was televised matching wits with Jo Jones on a memorable "Omnibus" program. His variations in Tintal style provide a fascinating eleven-minute introduction to the second collection. Under his agile fingers, an astonishing array of tones flows from his two small drums and the recording conveys them faithfully. Benny Barth, drummer of The Mastersounds, takes *Caravan* on an extended journey and his cohorts speed him along on gourds, rattles, claves, woodblocks, cowbells, and other gear. Extracted from previously released LPs are Art Blakey's *Ritual*, a three-part tribal suite descriptive of his experiences on a visit to the interior of Nigeria, and Gerry Mulligan's *Bark for Barksdale*, a grandly humorous vehicle for his quartet and Chico Hamilton's parade beat.

### Jim Copp Tales Playhouse 101
### Germany's Bielefelder Kinderchor Capitol T10149

Adults often find children an excuse to satisfy their own fancies and these two items are reason for such indulgence. The audiofan who could not justify the purchase of a sound effects record before will find trains, cars, breaking glass, running water, hammering and slamming doors woven into the eight original fables produced by Jim Copp and Ed Brown. Not always as authentic as Mr. Nunn or Mr. Cook, they take their thunderstorm from a bathroom shower and do considerable multiple recording. Copp narrates, plays several instruments, blows up balloons, and sings all seventeen voices of a schoolroom chorus. Youngsters will be enthralled by *Miss Goggins and the Gorilla*, and you will enjoy telling them how it is done.

If the records or performances of the Obernkirchen Choir gave you pleasure, Germany's other great children's choir needs no introduction. Founded more than twenty-five years ago by Freidrich Oberschelp, still its director, the Bielefelder Choir has yet to visit this country. But the proceeds of European tours enabled it to build a school, including modern sound studios, and this fine recording is the first of its products to reach these shores. A dozen native folk songs are sung with all the charm and lilt of youthful voices.

### Bess Bonnier: Theme For The Tall One Argo LP632
### Vito Price: Swinging The Loop Argo LP631

Due to the concentration of jazz record companies on either coast, the aspiring young musician in the Chicago area must often leave home base to achieve recognition. Activity in the local studios is directed chiefly at the name artist passing through the city. This label has been making some tentative gestures at changing the situation and is here rewarded by the discovery of Bess Bonnier, a 29-year-old Detroit housewife and mother of three children. Blind at birth, she studied music in Braille classes and has played jazz piano since her teens. Especially fruitful is her recent association with drummer Bill Steen and bassist Nick Fiore, a talented arranger and composer of a romping blues and the title piece. *Dorian* is a reflective melody, dedicated by the pianist to her daughter, and it is well worth becoming acquainted with her and the trio.

Vito Price is a native New Yorker, now a staff musician at Chicago's station WGN, who served a long apprenticeship on the road. His compatriots from the studio orchestra join him on five swinging numbers, arranged for big band by Bill McRee. On five others his warmly moving tenor sax is supported by an itinerant rhythm section of Lou Levy, Max Bennett, Freddie Green and Gus Johnson. Price's three originals are uncluttered and his unassuming style should win him friends.

positions. Thus when the low-frequency high-amplitude waveform swings the plate current of a tube up into the high current region, its plate resistance is much lower than when the plate current approaches cut-off. This means that, correspondingly, the frequency response contributed by the interstage coupling will be changed at different points on the high amplitude wave form (*Fig.* 7). This produces a form of intermodulation that has not received much consideration.

It is analogous to the Doppler effect which has been much talked about. But it includes possible amplitude fluctuation as well as phase fluctuation, in the high-frequency components of a signal present along with a high-amplitude lower frequency. And this form of intermodulation, as well as being different from that determined by the standard IM test, will be quite critical of the frequency used for the high-frequency measurement, if such a measurement is used to detect it. It will also be critical of level in the sense that higher levels of the low-frequency component are more likely to produce it than lower levels. But it is not necessary to run into maximum output conditions or even close to them for such effects to become noticeable.

### The Villain in the Black Hat

So far we have talked about a variety of distortion forms that can occur in almost any amplifier, even without feedback. We have not mentioned a component that is often accused of being the principal distortion-contributing element of an amplifier: the output transformer.

An earlier article examined the question of how an output transformer produces distortion in detail. Suffice it here to summarize by saying that an output transformer does not produce appreciable distortion over the mid-range frequencies. Assume its non-linear magnetizing current approaches 10 per cent maximum level and the lowest audio frequency, say 20 cps. Then this will only be 0.2 per cent at 1000 cps and, if the source resistance of the amplifier is much lower than the load resistance, the effective harmonic generation is correspondingly smaller than this. There is not a tube or transistor made that produces distortion as low as 0.2 per cent operating at maximum output.

So unquestionably, over the majority of the frequency range, the output transformer does not contribute any material distortion.

However, it can contribute by combination of other effects, as we have just suggested. The output transformer can be one element responsible for changing the high-frequency response at different points on the waveform because of the variation in plate resistance of the output tubes. In the more complex circuits, such as Ultra-Linear or unity coupled, a poorly designed output transformer can be responsible for distortion due to the voltages it presents to various tube electrodes not being in precisely the correct phase relationship to achieve the intended operational mode. But these distortions are actually generated by the tubes and their non-linearity rather than by the pure reactive effects introduced by the transformer.

But because circuits eliminating transformers would eliminate these effects, it may be argued that the transformer is responsible for the effect. However, we have not yet seen an Ultra-Linear circuit for a direct-coupled output that does not use a transformer.

As the earlier article on transformer distortion showed, there are two contributing elements to the way a transformer can cause distortion: (a) due to the non-linearity of its magnetizing current directly; and (b) due to the inductive loading of the magnetizing current in addition to the amplifier normal output load. This is illustrated in *Fig.* 8. Here it is assumed that the source resistance presented by the amplifier is relatively low, so that, provided the amplifier can deliver the additional current required for saturation magnetizing current, no appreciable distortion is produced.

When the transformer alone is con-

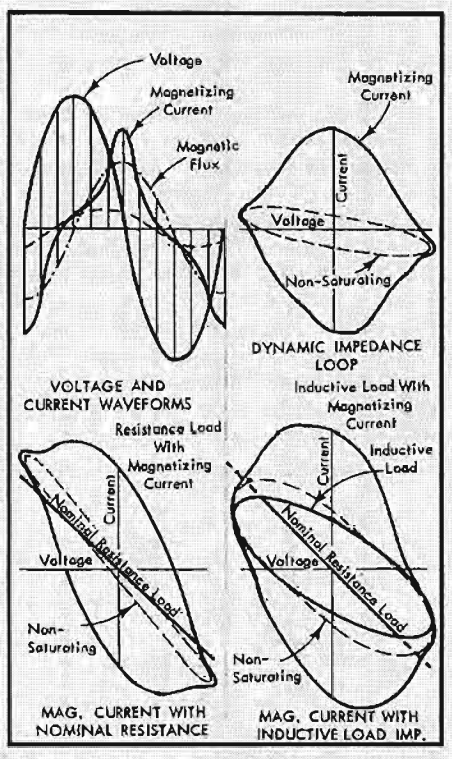



Fig. 8. Showing how the additional load of the output transformer magnetizing current, at saturation, combines with normal loads to produce variable distortion or restriction of maximum output.

nected to the output, the saturation current is not in excess of that available from the amplifier's output and consequently the output voltage is relatively undistorted at this point.

When the nominal resistance load is connected, the additional current swing required to produce the saturating magnetizing current is still not very much greater.

But when the load applied to the amplifier becomes inductive, as it usually is when an amplifier is supplying a dynamic loudspeaker at a frequency below its fundamental resonance, then the two inductive effects add to produce an excessive current demand on the amplifier. Then the undistorted output is severely restricted due to the magnetizing current demand of the output transformer, and distortion sets in "early."

### Mr. Fixit

So far we have discussed amplifiers without the addition of feedback, but some of the work we have gone through provides the basis for what happens when feedback is added to the amplifier.

Taking the matters we have discussed in sequence, the first thing we consider is the effect of feedback on the over-all transfer characteristic. Examining this externally on the 'scope it is immediately noticeable that feedback linearizes the curvature of the transfer characteristic approximately in proportion to the amount of feedback applied, which complies well with theory. But when we take a look inside the feedback loop, we find that all may not be as well as the simple transfer characteristic might lead us to believe.

Feedback operates to utilize the transfer characteristic *against itself*, so to speak, in the cancellation of distortion. The output of the amplifier is applied back to the input again to be reamplified in opposite phase. This means that most of the harmonics or other components present will be neutralized, or considerably reduced, due to the feedback action. But the multiplication of harmonic products that occurs in successive stages with similar order distortion but in opposite phase will also occur with feedback.

So, if a two-stage amplifier produces harmonics up to the ninth and has feedback applied over-all to reduce these harmonics, this will extend the converging series on out to the 81st harmonic. True it will converge much more rapidly because the feedback is present and consequently the measurable distortion, either by harmonic or IM test, will be almost infinitesimally small.

But now we come to some other factors that we may have overlooked so far. These are the possible combinations *on program material.* Either of the test signals utilized a simple sine wave or combination of sine waves which operates the amplifier in its phase-shift-less region. The presence of phase shifts in the fed back signal can result in failure to cancel or even in additive production of spurious components. Continuing this by using a complexity of audio frequencies such as occurs in program material we may well end up with a wide range of extremely low-level spurious components, that gives the amplifier the familiar rough sound often noticed in feedback amplifiers.

The phase shift that may give rise to this can be due to the fact that the load applied is not purely resistive. This is especially likely to occur in a pentode-type amplifier because the plate resistance is a much higher value than the load resistance or impedance. Consequently, the phase of the fed back signal will have the same phase as the impedance of the load, being fed from a constant-current source. True, the feedback tends to make the whole thing look like a constant voltage source, but not before the *loop gain* phase has been shifted by the impedance of the load.

This means that any of these spurious components occurring will not be canceled to the same extent that is measurable with a pure resistance load.

Further than this, the amplifier may have a variable degree of peaking in its over-all or loop-gain response either at the top end of the audible range or beyond it. This will fluctuate with position on the transfer characteristic in the mid-band range due to wide excursion

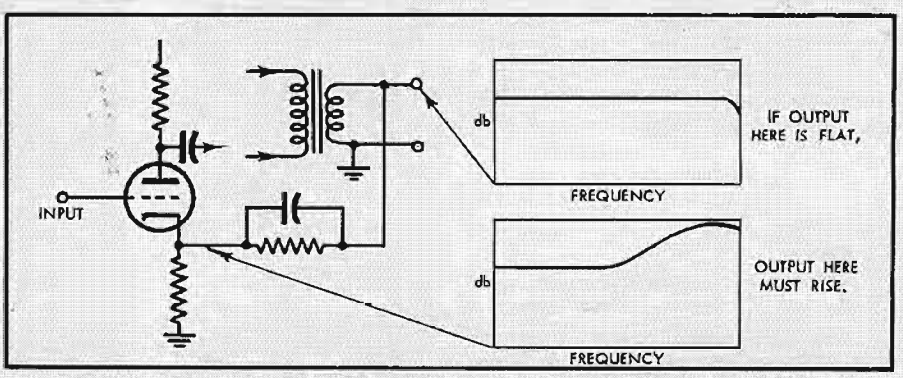



Fig. 9. Why the use of a "phase compensating" capacitor across the feedback resistor may be considered an inherently bad feature.

signals. Consequently, these high-frequency spurious components, even though of low magnitude, will be amplitude and phase modulated in the loop gain of the amplifier and thus provide further opportunity for making themselves audible as spurious components under program amplifying conditions.

This leads us into another trick often used in feedback amplifiers, the use of phase compensation in the feedback. It is well known that an amplifier with a peaked characteristic, or even too sharp a rolloff, will produce high-frequency transient distortion. Frequently, however, an amplifier is stabilized by applying a phase compensating capacitor across the feedback resistance, or across part of it. This levels off the frequency response where otherwise it might show a peak. Also it sometimes effectively eliminates square-wave distortion, as well as allowing a quarter amount of feedback to be applied than would be possible without it. So why is this not a legitimate method?

Assume that the use of the phase-compensating capacitor at the amount of feedback used does achieve a flat response running into an ultimate rolloff. This means the fed back signal must have a rising response because of the phase-compensating capacitor (*Fig.* 9). So the loop gain characteristic of the amplifier must have a rising characteristic which, from the well established principles, means the amplifier, regarded from input back through the feedback network to the input again, suffers from transient distortion and a square wave traced through this path would also show excessive ringing.

The ringing is only apparently eradicated because the feedback network is a contributing element to it.

If all the amplifier elements were linear, that is, if the plate resistances did not change with instantaneous signal value as we discussed earlier, it is possible that the over-all response to transients under this condition might be acceptable. But a closer examination of the square-wave response of an amplifier performing like this shows that the residual effect is not a pure ringing one. Usually the amplifier has been skillfully adjusted so that some of the overshoots are canceled and then, as the top or bottom of the wave settles down to its steady value, later excursions of the "ring" show up a little more than the earlier ones.

This is measured at the output. But if you put the 'scope across the cathode resistor to which the feedback is applied it is quite a different story. Here very considerable ringing is evident, possibly with an amplitude even as great as that of the square wave itself. This indicates that the smoothing-out effect on the

output square wave is due to skillful balancing of time-constant effects due to residual capacitances around the amplifier in conjunction with the phase-compensating capacitor across the feedback resistor.

This can happen where the wave is a simple repetitive one such as a square wave. But when combined with the action of more complicated transients present in program material, sharp high-frequency transients can get quite broken up by comparison with an amplifier that has not been treated in this way in order to get more feedback with stability.

*(To Be Continued)*

## PUSH PULL

*(from page 21)*

80 ma. Assuming a cathode resistor of 100 ohms ($R_g$), the voltage across this resistor is $iR_g = (50\ ma + 30\ ma)\ 100\ ohms = 8\ volts$. Under the conditions illustrated in *Fig.* 1, the plate current through tube I would be 20 ma less than the plate current through tube II.

Following the same line of reasoning, consider the circuit of *Fig.* 7. The plate current in tube I is 30 ma, through a 200-ohm resistor, resulting in a bias voltage of $(30\ ma)\ (200\ ohms) = 6\ volts$; the plate current in tube II is 50 ma, through a 200-ohm resistor, resulting in a bias voltage of $(50ma)\ (200\ ohms) = 10\ volts$. If this condition can exist, the difference in quiescent plate current would still be 20 ma, as in the case shown in *Fig.* 1.

However, the 6 volts bias at tube I will permit more than 30 ma to flow in *Fig.* 7, since a bias as high as 8 volts in *Fig.* 1 was necessary to limit the current to 30 ma. The plate current will increase, increasing the bias which is directly dependent on this plate current ($E_k = i_b R_g$). It will increase until a point of equilibrium is reached. Let us say this equilibrium point is where the plate current is 35 ma and the bias voltage is $E_k = (35\ ma)\ (200\ ohms) = 7\ volts$.

In the case of tube II, quite the opposite effect is achieved. The 50-ma plate current is possible only with an 8-volt bias. When the bias is 10 volts, the plate current must be less than 50 ma. It will decrease until a point of equilibrium is reached. Let us assume this point to be 45 ma—the cathode bias will then be $E_k = (45\ ma)\ (200\ ohms) = 9\ volts$.

It then becomes obvious that the difference of quiescent currents due to the configuration in *Fig.* 7 is 45 ma for tube II minus 35 ma for tube I which is equal to 10 ma, while the difference in the case of *Fig.* 1 is 50 ma – 30 ma, which is equal to 20 ma. It is obvious that the case with the two separate bias resistors will tend to make a better balanced output stage than with the use of a single resistor.

It should be noted that the figures taken for the current in the second case is purely theoretical. However, the example goes to indicate that the tendency is toward better balance with separate cathode resistors than with a single resistor. However, with a good pair of balanced tubes this difference is negligible.

### D.C. Balance?

D.c. balance adjusts the bias on tubes so that the quiescent, or d.c. plate current of the two tubes are equal.

Since the d.c. balance is usually adjusted on both tubes to a portion of the curve with equal nonlinearity, there is a tendency toward lower distortion. This is not the main function of the d.c. balance adjustments.

The d.c. saturation current in the output transformer is a limiting factor on the low-frequency response.

The d.c. current flows from both tubes in opposite directions through the transformer. When these two currents are made equal, the effect of each d.c. current is cancelled by the d.c. current passing through the transformer from the opposite tube. With no d.c. magnetization of the transformer core (saturation) the low-frequency response is increased.

This d.c. balance will incidentally also help balance out the hum. Since relatively unfiltered voltages are applied to the plates of the output tubes, there will be a large hum ripple across the transformer due to plate current. When balanced, the hum ripple across one half of the transformer cancels that appearing across the other half—resulting in no hum output. In fact—the condition for minimum hum is an excellent point of adjustment for the d.c. balance control.

### Fixed Bias

Schematics of two popular circuits used in fixed bias operation are shown in *Fig.* 8.

All the d.c. current passing through a tube—the sum of the plate and screen currents—must pass through the cathode as well. To measure the total tube current conveniently, a small resistor can be placed in the cathode of each tube. Due to the cathode current being conducted through the resistor, there will be a voltage drop across this small resistor. This voltage is proportional to the total tube current [$E_k = (i_p + i_{sc}) R_s$]. The voltage $E_k$, measured across this small resistor with any type of voltmeter, is actually a measurement of the tube current.

In (B) of *Fig.* 8, a 10-ohm resistor is included between cathode and ground in each tube. A balance control is provided so that the d.c. currents in both tubes can be adjusetd to be equal. This goal is achieved when the measured voltages across both resistors are equal.

The bias on a tube controls the current through a tube. This current is measured as a voltage across either 10-ohm resistor. The bias voltage is adjusted to the point that the voltage across either of the 10-ohm resistors will indicate the optimum operating point for the tubes used.

In *Fig.* 8, (A) shows the two cathodes connected together and provides a common 10-ohm resistor between the junction of the two cathodes and ground. The current through this resistor is the sum of the plate and screen currents through both tubes. A bias adjustment is also provided here to adjust the total currents to a predetermined value. No balance control is provided and thus only the sum of the currents through both tubes is controlled. The individual currents through each of the tubes are assumed equal. This may be the case if the tubes are identical.

The advantage of the two-resistor system over the single resistor is only in the flexibility in permitting the individual adjustment of the d.c. currents through each tube.

A good case can be made for the two-resistor system similar to the excellent case made for using two individual bias resistors in *Fig.* 7. The voltage developed across the two small resistors or the small single resistor of (A) in *Fig.* 8 are too small to have any real effect in providing balance—signal or d.c. They serve the sole purpose of convenience in measurement.

The advantages of d.c. balance need not be discussed further. The facts outlined above for the self-bias conditions, apply here as well.

### A.C. Balance

The fact that the voltage inputs to the grids and the outputs to the transformer must be exactly equal and out of phase, is indisputable.

The inputs to both grids may be kept identical without an a.c. balance control when carefully selected load resistors are used in the phase-splitter circuits. The excellent modern phase splitters[4] make any further balance controls unnecessary.

The signals from both tubes to the output transformer are kept equal only when the tubes have equal gain and fairly similar curves. Providing any balance control or "gimmick" will be worthless if the tubes are not similar. However, dynamic balance can best be achieved in similar tubes when they are first statically balanced with a d.c. balance control. Æ

[4] Mannie Horowitz, "Phase inverters for hi-fi amplifiers," *Radio & TV News*, May 1957, pp 92–97.

# RECORD REVUE

(*from page 55*)

title and the cover—but I found it most agreeably pleasant in the listening.

Grailville is evidently the seat of the Grail movement, or *a* seat; the interest is religious, but its expression in this case is in musical terms and therefore "universal"—or at least, directly appealing to a large number of us who also enjoy and understand the language of music. The girls who sing are clearly dedicated, sincere but, more important, they are very musical. The singing is excellent, beautifully in tune and well balanced, without show-off solo work (the solos sing modestly). Music ranges from some nicely done Gregorian chant, sung with real understanding of the style, through music by sixteenth-century men such as Palestrina, and on to Negro spirituals, folk-style songs of various nationalities. A nice record to have around as a change.

**Texas Folk Songs.** Alan Lomax; with Guy Carawan, John Cole. **Tradition TLP 1029**

Don't know whether you know the name Lomax—you surely do if you have ever bought or heard folk music. He has dug up, collected, organized, promoted, codified, recorded folk music until it runs out his ears; he produced singlehandedly the huge Columbia collection of the folk music of many countries, then later on the currently-appearing Westminster collection of the folk music and dances of Spain (region by region) which runs to eleven LP's. But never a note from Lomax himself until now.

To be sure, he is no singer. His voice just ain't. (It would be better if the engineer hadn't tried so hard to put him into the background.) He has never, if I'm right, made any pretense of being a folk artist himself nor a folk singer. But if you thought Lomax maybe doesn't know his stuff, this'll disabuse you. After all, he and his pa were the ones who dug up Lead Belly, and he has been listening to every known folk singer day in and day out these twenty years and more.

Thus, the Lomax Texas tunes are of the best and the singing style is obviously first-hand—by which I mean just that: he gets this stuff right from the source. In content and in style, both are excellent. It's only when you run onto a song that some real big folk singer has sung for you (in person or on records), that you realize what a good imitator Lomax is. I was thinking in particular of "Black Betty (Lam-de-lam)"— one of the most potent of the songs Lead Belly used to sing. Lomax does it in the Lead Belly manner but the voltage is about one half. If you hadn't heard old Hudie himself, you'd think Lomax was terrific. In this sense, he is. (The song wasn't actually Lead Belly's own, but must have been one of those he polished up for his own productions.)

The guitar and banjo accompaniment to Lomax has a nice, authentic quality but somehow is very polite and, for my ear, too genteel. The reason is, I presume, that the cooperating artists are English—they play Texas with a faint British accent. The Peter Kennedy who made the recording must be the son of the long-time and distinguished leader of the English Folk Dance and Song Society. The Lomax operating base in recent years has, I gather, been London.

**Offenbach: La Grande Duchesse de Gérolstein (complete opera).** Eugenia Zareska, André Dran, Gisele Prevet, etc., Paris Lyric Chorus, Pasdeloup Orch., Leibowitz. **Urania USD 1015-2** (stereo)

The "Gilbert et Sullivan" of France, dapper M. Offenbach, turns out here one of his very numerous comic operettas that are so largely unknown for us—except in such frothy concert suites as "Gaîté Parisienne." This one is really a honey, and most amusingly sung and acted for the stereo mikes. It's all about a rakish lady who is absolute monarch of a state suspiciously like Monte Carlo—especially in the cover picture on this album, which features a Grand Duchess who is the spitting image of Princess Grace herself. Deliberate, I'll bet, though not Offenbach's original intent.

Anyhow, the spirited lady has been brought up well protected from the facts of life by a Baron Puck and a General Boum—until she casts here roving eye upon a raw recruit in her army called Fritz. The fat is in the fire at once and in no time at all Fritz is a pampered General, running the show—but, alas, he has his own gal friend and the doughty Duchess gets annoyed; when Puck and Boum, and the rest start a plot to assassinate Fritz, the Duchess bursts in and offers to join them. Real, spirited gal.

This—and much more. The whole thing has the preposterousness of the best Gilbert and Sullivan, but instead of Victorian propriety it has French can-cannery, if you see what I mean. Especially the slightly lusty scene near the end where Fritz has been caught with his pants—well, anyway, a jealous husband is after him and has twisted his sabre into a corkscrew. Lovely, lovely—and just as well it's in French.

This high spirited performance makes a fine contrast to the sad-sack singing of Offenbach's "La Périchole" (in English, toned down) heard in a recent RCA Victor album.

**Denis Matthews Plays Beethoven Bagatelles for Piano, Op. 33, 119, 126. Vanguard VRS 1033; VDS 2018** (stereo)

Vanguard has been enterprisingly shipping both stereo and mono review copies of almost everything it has released lately, thereby inviting a comparison that could well be disastrous if this company weren't pretty darned careful to cut stereo that can take the comparison with its mono. I would not want to state that the stereo is always exactly as clean, loud, sharp-edged and what-not as the corresponding mono cut; but since the music is virtually always more satisfactory in sound in the stereo version,—even in solo piano, such as this disc—there's a bit of leeway allowable.

I guess the mono disc here is technically a shade better in the cutting, though it could easily be a matter of my pickup performance. But the stereo piano is clearly a better piano sound, more mellow, larger, more alive, more natural; and for this reason I am decidely prepared to take a bit of noisiness in my pickup now and then for the extra value of the stereo disc.

Yes—Vanguard adds proof to London's and Decca's stereo piano that *a solo instrument* in stereo is an excellent idea. No trouble whatsoever with any sort of double image, if your speakers are set properly and phased right. The piano is between and behind the speakers, in a fine, big space.

I don't mean to neglect the music. The Bagatelles are very dear to my musical heart. I've long thought them to be miniature examples of the very essence of Beethoven, notably the superb late ones in Opus 119 and 126. Right after the Foldes recording and that by Artur Balsam comes this—three in a row. Matthews, British by birth and training, plays gently and poetically, is much at his best in the earlier pieces, as also is Artur Balsam. But the concentrated intensity of the later Bagetelles seems to me to be largely lost on him; he treats them like poetic little things—which they are not. Try Andor Foldes on these, for a thrill. He's on Decca.

**Beethoven: Thirty Two Variations in C Minor; Variations in F Op. 34; Variations in E Flat Op. 35 ("Eroica").** Denis Matthews, piano. **Vanguard VSD 2017** (stereo)

No doubt about it, Denis Matthews is good at the more lyric sorts of Beethoven, among which two out of the three sets of piano variations on this record belong. He does a fine job with the somewhat frilly and relaxed Variations in F and a fine one, too, with the much more impressive and large-scale Variations called "Eroica"—the work upon which the last movement of the "Eroica" Symphony was later built. But the short, fiery, intense Variations in C Minor, not unlike the first

movement of the Fifth Symphony (same key) in spirit, are not so happily treated. For them, again, I recommend among recent recordings the LP by Andor Foldes mentioned above (Decca DL 9964). Where Matthews excells in the lyric, Foldes triumphs in the steely, intense Beethoven.

It seems to me to have been a mistake, though perhaps unavoidable, to put the C Minor Variations in all their impetuosity right before the gentle F Major set on one side of this disc. The effect is to downgrade the F major music, which is much too relaxed to follow so suddenly after the violent C Minor. They just don't match, this way. Better to have put them the other way around, I'd say, even at the risk of inner-groove trouble with the loud ending of the C Minor set. (That's undoubtedly why Vanguard chose this arrangement—but it doesn't help in the listening.)

If you know the "Eroica" Symphony and have never heard the Variations of the same name, you're in for a revelation. These piano Variations were the mould for the last movement of the Symphony, which came later and was built directly upon them. The Symphony is bigger and better, but the piano Variations are not far behind and the comparison between the two, with the same theme and a very similar sequence of musical ideas, is a fascinating listening experience.

The Variations in turn were based on the famous tune that had appeared still earlier in Beethoven's "Prometheus" ballet music. The proper term should be the "Prometheus" Variations—the Symphony hadn't yet been written. The tune also appears as a Beethoven contradance, one of a series of little country dances, Viennese style. Æ

# MIXER

(*from page 32*)

be made by the experimenter, especially if attempting to economize by raiding the junk box collection of parts and tubes. A little study of the tube manuals will indicate similar types although a few suggestions follow—not always best choices, but capable of giving satisfactory services. For the mike preamp tubes, 12AT7's, 12AU7's, 12AX7's instead of the quieter and costlier 12AY7's may be used with varying gains. The same type tubes may be used in the mixer stages, and here the effective gain is far below the rated maximum, but this stage is mainly used for mixing, not amplification. A less microphonic 1612 may be used instead of the 6L7, although at the high signal level here, no trouble was encountered. A pentode such as a 6SJ7 may replace the 6SF5, with a gain-reducing network of resistors at its input. A 6AL7 or crystal diodes should work well instead of the 6H6. The 6SN7 and 6C4 could be replaced by numerous double and single triodes such as 6J6, 6C5, 6J5; or where more gain is needed, 6SC7, 6SL7, or 6SF5. Power rectifier substitutes are too numerous to mention —check with the tube manuals. The mixer shown draws around 30 milliamperes, at the plate supply voltages shown, but would draw somewhat more higher plate supply. Cathode and plate resistors will differ from ones used in our mixer, with these different tubes. *Figure* 11 shows the schematic of the power supply, and *Fig.* 12 shows its physical layout.

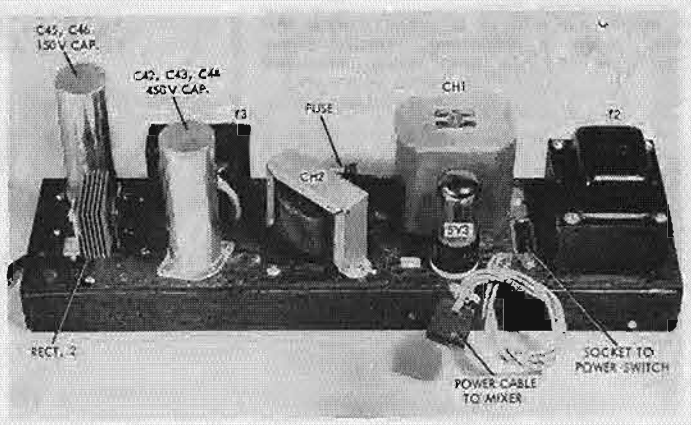



Fig. 12. Heater and plate supplies are built on a long chassis to fit under the top panel, as shown in Fig. 8.

For six channels instead of eight, change the mixer cathode bias resistor, $R_{34}$, to 1500 ohms, and the plate resistor, $R_{29}$, to about 33,000 ohms. For four channels, these should be about 1800 and 47,000 ohms respectively. Additional series resistance should be inserted in the d.c. heater supply—approximately 85 ohms for each 12-volt tube left out. Calculate the voltage drop across the series resistor and multiply by 0.15 to find the wattage dissipated. The heater supply choke could be replaced with the dropping resistor. The ripple in 96 volts of supply used here is only 0.25 volt. Slight lowering of hum is sometimes obtained by adding a 20 µf. 150-volt capacitor from each heater to ground, but we left these out, as the preamp stages were sufficiently hum-free.

Many of the filter capacitors in the plate power supply and decoupling filters could be reduced in capacitance if desired, although it is best to use the largest practical as they sometimes lose some capacitance in aging.

With care in construction, especially in modifying for individual applications, this mixer can be a worthwhile and often indispensable addition to the recording enthusiast's equipment or to round out the facilities of a small studio. Since few tape recorders have controls for elaborate mixing, a mixer like this would be invaluable to high school and college dramatic groups, advanced home movie makers, and others engaged in serious audio work. Connected to a good power amplifier, it would give the public address operator unusual control of many inputs for quality sound coverage and versatile musical entertainment.

*Figures* 13 to 15 show parts placement to aid anyone who wishes to duplicate this unit. While parts placement is not extremely critical, some care should be exercised to keep leads short and to avoid capacitive coupling between stages.

Although it could be permanently built into a control desk, in its present form it is small enough to be portable, yet no apologies need be made for its appearance.

PARTS LIST

**Mixer Amplifier**

| | |
|---|---|
| $R_1$ | 6.8 ohms, ½ watt |
| $R_2$, $R_3$, $R_9$, $R_{12}$, $R_{16}$, $R_{19}$, $R_{23}$, $R_{26}$, $R_{31}$, $R_{48}$, $R_{58}$ | 470k ohms, ½ watt |
| $R_4$, $R_6$, $R_{10}$, $R_{13}$, $R_{17}$, $R_{20}$, $R_{24}$, $R_{27}$, $R_{51}$ | 3300 ohms, ½ watt |
| $R_5$, $R_7$, $R_{11}$, $R_{14}$, $R_{18}$, $R_{21}$, $R_{25}$, $R_{29}$, $R_{46}$ | 100k ohms, ½ watt |
| $R_8$, $R_{15}$, $R_{22}$, $R_{30}$, $R_{32}$, $R_{33}$, $R_{35}$, $R_{51}$ | 500k ohms, audio taper potentiometer |
| $R_{34}$, $R_{36}$ | 1000 ohms, ½ watt |
| $R_{37}$ | 1 megohm, ½ watt |
| $R_{39}$, $R_{41}$, $R_{50}$ | 33,000 ohms, ½ watt |
| $R_{42}$ | 150k ohms, ½ watt |
| $R_{43}$ | 270k ohms, ½ watt |
| $R_{52}$ | 2200 ohms, ½ watt |
| $R_{57}$ | 1 megohm, audio taper potentiometer |
| $R_{59}$, $R_{62}$ | 5600 ohms, ½ watt |
| $R_{65}$ | 47,000 ohms, ½ watt |
| $R_{76}$ | 1000 ohms, 1 watt |
| $R_{77}$, $R_{78}$, $R_{79}$ | 10,000 ohms, 1 watt |
| $R_{80}$ | 200 ohms, wirewound potentiometer (hum balance) |
| $R_{77}$ | 250k ohms, linear potentiometer (6L7 bias) |
| $R_{78}$ | 15,000 ohms, 2 watts |
| $C_1$, $C_2$, $C_3$, $C_6$, $C_9$, $C_{10}$, $C_{13}$, $C_{14}$ | .01 µf, 400 volts, paper (if power transfomer supplies higher voltage than specified, use 600-volt capacitors throughout) |
| $C_4$, $C_5$, $C_7$, $C_8$, $C_{11}$, $C_{12}$, $C_{15}$, $C_{16}$, $C_{17}$, $C_{22}$, $C_{27}$, $C_{32}$, $C_{34}$ | 10 µf (or more), 25 volts, electrolytic |
| $C_{18}$, $C_{19}$, $C_{20}$, $C_{23}$, $C_{24}$, $C_{25}$, $C_{26}$ | .05 µf, 400 volts, paper |
| $C_{28}$, $C_{31}$ | 0.1 µf, 400 volts, paper |

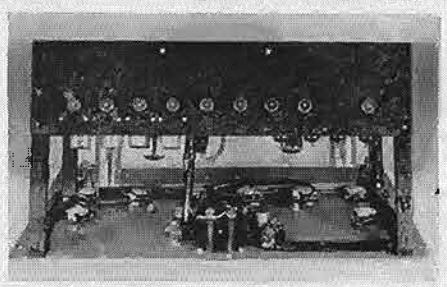


Fig. 13. Rear view of chassis showing audio chassis connectors, with output at left. Switches over four mike inputs at right are intended for input level matching.

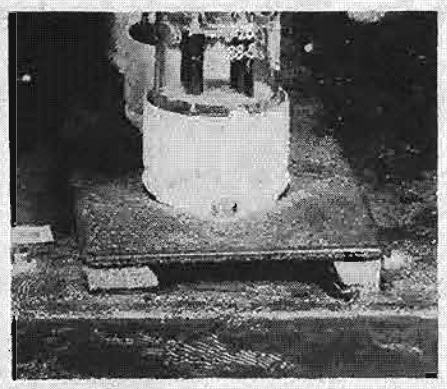


Fig. 14. Closeup of sponge-rubber shock mounts for preamp and mixer tube sockets.

| | |
|---|---|
| $C_{29}$, $C_{31}$, $C_{33}$ | .024 µf, 400 volts, paper |
| $C_{36}$ | 0.5 µf, 200 volts, paper |
| $C_{36}$, $C_{37}$, $C_{38}$, $C_{39}$ | 20 µf, 450 volts, electrolytic |
| $T_1$ | Midget output transformer, universal type |
| $Rect_1$ | Conant Instrument rectifier, HS type |
| $M$ | 0-1 milliammeter |
| $J_1$ | Phone jack |
| $S_1$ | Mike-film slide switch, spdt |
| $S_2$ | Expand-compress switch, toggle, dpdt |

**Power Supply**

| | |
|---|---|
| $T_2$ | Power transformer: 115-v. primary; secondary—470 v. c.t., 40 ma; 5 v. 2 a.; 6.3 v. 2 a. (Stancor PM8401 or equivalent) |
| $T_3$ | Isolation transformer, 115/115 v, 35 volt-ampere (Triad N51-X or equivalent) |
| $S_3$ | Slide switch, spst, on top panel |
| $CH_1$ | 2.3 H, 150 ma (minimum), 60 ohms or less (Stancor C2304 or equivalent) |
| $CH_2$ | 8.5 H, 50 ma (minimum), 400 ohms. (Stancor C1279 or equivalent) |
| $C_{40}$, $C_{41}$ | .01 µf, 600 volts, paper |
| $C_{42}$, $C_{43}$, $C_{44}$ | 40 µf, 450 volts, electrolytic |
| $C_{45}$, $C_{46}$ | 40 µf (minimum), 150 volts, electrolytic |
| $R_{61}$ | 1000 ohms, 2 watts |
| $R_{62}$ | 5 ohms, 2 watts |
| $R_{63}$ | 200 ohms, 25 watts, wirewound, adjustable |
| $Rect_2$ | Selenium rectifier, 150 ma, 150 volts. |
| Power plug | Cinch-Jones P306AB male, chassis mount |
| Power socket | Cinch-Jones S306CCT, female, cable type |

**Tone Control Circuit**

| | |
|---|---|
| $R_{64}$ | 500k ohms, audio taper potentiometer |
| $R_{65}$ | 5600 ohms, ½ watt |
| $R_{66}$ | 47,000 ohms, ½ watt |
| $R_{67}$, $R_{70}$ | 22,000 ohms, ½ watt |
| $R_{68}$ | 220k ohms, ½ watt |
| $R_{69}$ | 1000 ohms, ½ watt |
| $R_{71}$ | 470k ohms, ½ watt |
| $(R_{72}, R_{73})_1$ $(R_{74}, R_{75})$ | Thordarson dual tone control, R1068X, (2 required) |
| $CH_3$ | Thordarson tone control choke, 20C74 |
| $C_{47}$ | 10 µf, 25 volts, electrolytic |
| $C_{48}$, $C_{52}$ | .05 µf, 400 volts, paper |
| $C_{49}$ | 1 µf, 200 volts, paper |
| $C_{50}$ | .04 µf, 400 volts, paper |
| $C_{51}$ | .01 µf, 400 volts, paper |
| $C_{53}$ | 20 µf, 450 volts electrolytic |

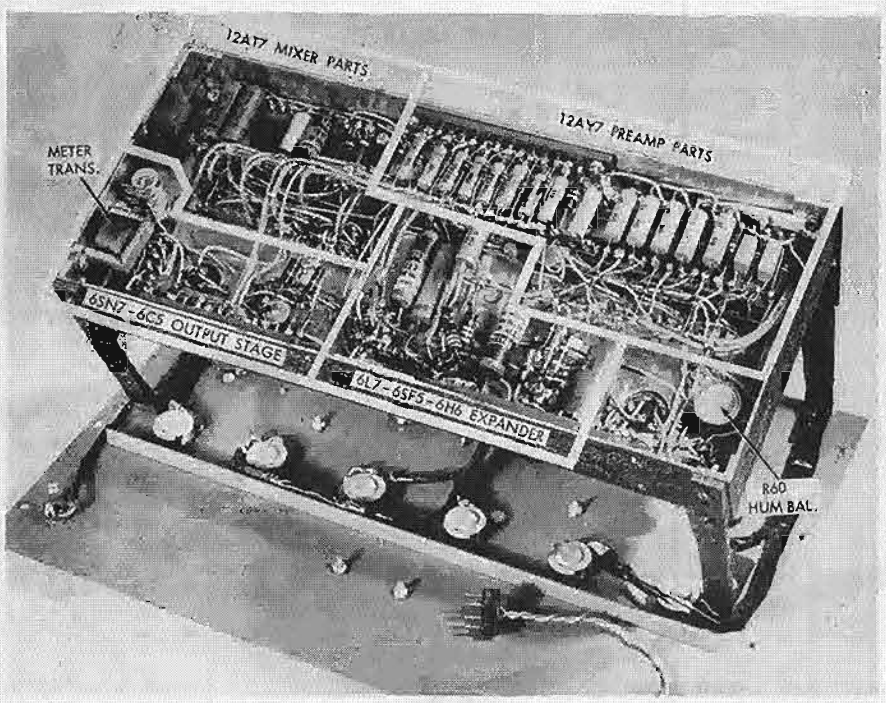



Fig. 15. Under side of chassis showing arrangement of components made to facilitate servicing. Terminal strips hold components in place.

# the AUDIO bookshelf

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**IMPORTANT ANNOUNCEMENT**

**Bound Volume of AUDIO Magazine Jan.-Dec. 1958 is ready for delivery.**

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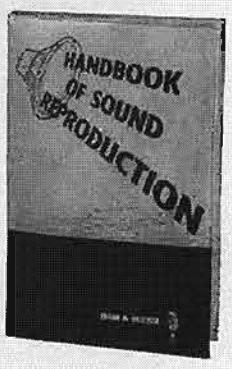


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**HANDBOOK OF SOUND REPRODUCTION**
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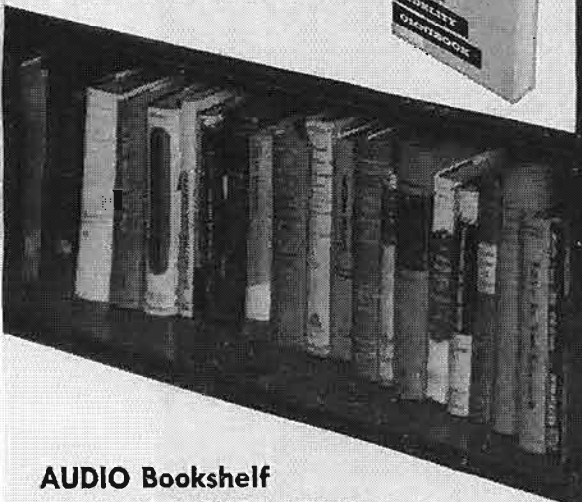
Prepared and edited by C. G. McProud, publisher of Audio and noted authority and pioneer in the field of high fidelity. Contains a wealth of ideas, how to's, what to's and when to's, written so plainly that *both* engineer and layman can appreciate its valuable context. Covers planning, problems with decoration, cabinets and building hi-fi furniture. A perfect guide. *$2.50 Postpaid.*



*NEW!*

**No. 119**
**HIGH FIDELITY AND THE MUSIC LOVER**
by Edward Tatnall Canby
An up-to-the-minute guide that shows you how to get the best out of your hi-fi records and tape recorder. Mr. Canby discusses in detail the speaker, the amplifier, the radio tuner, the record player and the tape recorder. He shows you how to save time and money, and get the hi-fi equipment that suits your particular needs. Illustrated with line drawings. $4.95



**No. 118**
NEW! *How-to Book on Hi-Fi Repair*
**CARE AND REPAIR OF HI-FI—Volume I**
by Leonard Feldman
Latest information on hi-fi components for efficient repair and maintenance. Complete, down-to-earth information that is not punctuated with complicated mathematics. Helpful to the hi-fi enthusiast, technician or engineer, this first volume includes many important features: Example schematics with tube layouts, descriptive illustrations and hook up diagrams, buyers' guide. *156 pages profusely illustrated. $2.50 Postpaid.*

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**RADIO MAGAZINES, INC., Dept. A**
**P.O. Box 629, Mineola, New York**

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## CROSSOVER

(*from page 24*)

cps to avoid splitting the all important formant band between two speakers.

An open-cone-type H.F. unit placed in the center of the L.F. cone, a cheap and popular solution of the problem, must be of limited size if it is not to mask off too great a fraction of the L.F. cone. With a crossover frequency in the vicinity of 2000 cps or higher, only the center section of the L.F. cone is effective as a radiator near the crossover, a point that can easily be lost sight of when choosing a unit to mount in the center of the L.F. cone.

Crossover frequencies above 1500–2000 cps make it necessary to look more carefully at the high-frequency performance of the L.F. cone. A good low-frequency performance with adequate power handling capacity and low values of distortion requires a heavy and rather soft cone but cones that give a satisfactory performance in these respects generally exhibit a rather marked rise in response and distortion in the 1500–2000 cps region. This often results in a harsh tonal characteristic and lack of middle range definition, defects that require great care in selecting the cone material and cone curvature if acceptable performance is to be obtained.

Frequencies appreciably higher than 2000 cps have to be avoided with a coaxial speaker system for the H.F. unit diaphragm is inevitably several inches behind the L.F. cone and thus some interference due to the relative displacement of the two speakers cannot be avoided.

It is difficult to attach relative weights to each of these factors but in general a crossover frequency in the region of 1700–2000 cps is about the optimum. Crossover frequencies above this figure generally result in trouble due to inadequate performance of the L.F. cone and to interference troubles due to the spatial displacement of the H.F. and L.F. cones. Crossovers below about 1500 cps result in inadequate control of the polar diagram because of the limitation on the size of the H.F. horn and to trouble due to division of the formant bands between two speakers.

Speaker systems with crossover frequencies in the region of 5000 cps are often used but almost always with separate H.F. units. Some interference due to displacement of the two speaker diaphragms may then be avoided by careful positioning of the H.F. speaker but if great care is not taken it is perilously easy to recognize the H.F. unit as a source of "H.F. twitterings" when listening within ten feet of the speaker.

With both domestic and professional speaker systems a choice of a high cross-

over frequency reduces the size and therefore the cost of the components in the actual dividing network. Typical values for a simple series dividing network operating at 500 and 5000 cps are shown in Table I from which it will be seen that the adoption of the higher crossover frequency allows the size of the chokes and capacitors to be reduced by a factor of ten times, a substantial saving in cost in a competitive market.

My thanks are due to The Macmillan Company for their permission to use diagrams and material from my book *High Quality Sound Reproduction.*

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## AUDIO ETC

(*from page 14*)

three weeks from now, to launch some fine new hi-fi product or a new recording, please DON'T TELEGRAPH. That's the rottenest old peach of all. I have no gripe against Western Union, but you really ought to remember that telegrams still tend to foretell either hideous doom or something personal and marvelous. A telegram tends to make the heart pound, either way.

When Western Union, that kindly guardian of the nation's wire communications, gently wakes me from a sound sleep at six in the morning with a blast of the doorbell—to invite me (100 words) to a party that is weeks away, or even three days away, I'm apt to get sore. I tend to throw things, and that isn't good. Sure, the telegram looks urgent and very impressive. But I don't like that kind of telegram and I don't like you, either, when you send it.

Maybe the trick would be to offset the heart-pounding and the anxiety by making it a singing telegram. After all, Western Union has been purveying that sort of good cheer for a long time. But if you send me one, be sure the tune is by Beethoven, or I won't listen.

5. This borders on the absurd, but it does happen. If you want to launch a party, you people with new products to introduce to the press, why not get around to it a bit ahead of time? I don't know how often I've had urgent telegrams to come to a Grand Reception that very afternoon. And surprisingly often it turns out that the invitation—via telegram—is for yesterday.

This, you see, is not only frustrating (since I do like parties, publicity or no) but it somehow casts a bilious light upon the organization that has done the last-minute job. And too, of course, it assumes that we of the "pross" can drop everything else and rush off to imbibe liquor and Information at a moment's notice.

We usually do, I'll admit. Especially when the locale is plush and the drinks are fabulous. But nevertheless . . .

I'll never forget, speaking under this heading, about one great, big, wordy telegram that asked me to a very plush press party and forgot to say where it was. Straight from the President's office, too. As I say, I'm not one to miss a shindig and so I telephoned in, but quick.

I should've sent a telegram.

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## CLASSIFIED

**Rates: 10¢ per word per insertion for noncommercial advertisements; 25¢ per word for commercial advertisements. Rates are net, and no discounts will be allowed. Copy must be accompanied by remittance in full, and must reach the New York office by the first of the month preceding the date of issue.**

TRADE UP TO STEREO: Largest selection of new, used Hi-Fi components. Write Dept. AE for trading information. 153-21 Hillside Ave., Jamaica 32, N. Y. Branches in Brooklyn, White Plains, Manhasset.

HIGH FIDELITY SPEAKERS REPAIRED
Amprite Speaker Service
70 Vesey St., New York 7, N. Y. BA 7-2580

ENJOY PLEASANT SURPRISES? Then write us before you purchase any hi-fi. You'll be glad you did. Unusual savings. Key Electronics, 120 Liberty St., New York 6, N. Y. EVergreen 4-6071.

WRITE for confidential money saving prices on your Hi-Fidelity amplifiers, tuners, speakers, tape recorders. Individual quotations only; no catalogs. Classified Hi-Fi Exchange, AR, 2375 E. 65 St., Brooklyn 34, N. Y.

INDUCTORS for crossover networks. 118 types in stock. Send for brochure. C & M Coils, 3016 Holmes Ave., N. W., Huntsville, Ala.

UNUSUAL VALUES. Hi-Fi components, tapes and tape recorders. Free catalogue A. Stereo Center, 51 W. 35th St., N.Y.C.

PROFESSIONAL HI-FI REPAIRS. New precision method restores peak performance inexpensively. Laboratory test report included. Bring or ship defective components to Bremy Electronics, 394 East 18th Street, Paterson 4, N. J. LAmbert 5-1191.

SELL: Revere Model T-11 professional tape recorder, portable case, stacked stereophonic playback heads, $350 investment, new condition; $175; Wagner-Nichols disc recorder—$50; Bogen 5-station master intercom—$15. V. F. Hein, 418 Gregory, Rockford, Ill.

RECORDS FROM YOUR FAVORITE TAPES—Tape Duplication, custom labels and other services. Prices tailored to your specific needs. Merle Enterprises, Box 145, Lombard, Illinois.

FREE Anti-Static Record Cleaning Cloth in handy case. $1.00 seller in stores. Please send 25¢ for postage and handling. Leslie Creations, Dept. A-1, Lafayette Hill, Pa.

CROSSOVER NETWORK KITS. Write Watson Industries, 110 Mildred, Venice, California.

FOR SALE: Mixing panel, custom made, six-position, two microphone inputs, four high-level inputs, two of which are bridging. Cinema amplifiers, separate power supply, rack mounting 19" x 10½" stainless steel panel. Excellent condition, $500. A. C. Smrha, 12 Mountainview Drive, Westfield, N. J.

TWO Pultec equalizers, like new, $200 each. H. White, 2123 Kenmore Ave., Bethlehem, Pa.

CONCERTONE 21-1 (half-track) tape recorder, with case and large tape collection. 1st class condition, only $475. B. K. Balch, 611 Livingston Rd., Linden, N. J.

WANTED: Transcript of television interview with General Gruenther on his return from Europe, middle of December, 1956. Write AUDIO, Box CD-1, P. O. Box 629, Mineola, N. Y.

FOR SALE: Wharfdale 12 FS/AL speaker, $40; Gray Broadcast viscous-damped arm, $20 or best offers. D. Ross, 55 Lenox Rd., Brooklyn 26, N. Y.

WANTED: REL Precendent tuner. David Hauser, 2403 Glen Place, Davenport, Iowa.

# PROFESSIONAL DIRECTORY



# *Industry Notes...*

**M.E.I.A. MEETING.** In a meeting held in Chicago specifically to raise funds for promoting the use of magnetic tape recording, the **Magnetic Recording Industry Association** digressed long enough to make a policy decision on the subject of reel-to-reel vs. cartridge recording equipment. General theme of the decision was that the industry should concentrate on the former and forget about cartridge equipment for the time being. A prime problem facing the industry, it was stated, is to reassure dealers who have lost confidence in reel-to-reel machines in the face of premature cartridge promotion. Irving Rossman, president of the Association, who is also president of Pentron Corporation, stated that his company would not introduce a cartridge-type recorder until RCA had marketed one. Previously Pentron had said that it would use the RCA-developed cartridge. So far RCA has not announced a specific date for commercial introduction of its cartridge recorder, although it has been shown at a number of trade exhibitions.

**BRITISH STEREO CONVENTION.** March 19 and 20 were the dates of a stereophonic sound convention held in London by the **Institution of Electrical Engineers.** The problem of adding "dimension" to other factors creating a high quality sound image were discussed. Stereo tape, disc recording, broadcasting techniques, and pyscho-acoustic considerations were dealt with in separate sessions.

**AMPEX STOCK OFFER.** Stockholders of **Ampex Corporation** will be offered rights to subscribe to additional common stock. Directors have approved the issuance of rights to holders of record April 1 to subscribe to additional common stock at the rate of one new share for each ten now held. Offering price had not been determined at time of publication. Proceeds from the offering will be used for general corporate purposes and are not earmarked for any special project.

**THREE HI-FI SHOWS.** In the face of two days of heavy rains, the **San Francisco Hi-Fi Music Show,** held this year in the famed Cow Palace, drew a paid attendance of 24,000, compared with 18,000 at last year's event held in the Whitcomb Hotel. Interest of the general public was heightened by a 44-page special stereo section in the Chronicle and a 16-page section in the Examiner promoting the event.

With an exceptionally high percentage of women in atendance, the 1959 **Los Angeles High Fidelity Show** opened in the Hotel Biltmore with 94 manufacturers displaying their equipment in 111 showrooms. Factory representatives who were there primarily to discuss such mundane items as frequency response, distortion, and the like, found themselves deeply involved in discourses on wood finishes, styling and other subjects which milady finds so fascinating about high fidelity.

Crowds were so intense at the annual Washington, D. C., **Hi-Fi Festival,** held in the Shoreham Hotel, that ticket sales had to be halted several times due to overcrowding. By far the most successful of the five festivals held there to date, it played host to 300 high fidelity exhibits. The show was opened by Vice-President Richard Nixon in the presence of several hundred guests, including dignitaries from more than 20 foreign countries.

# LETTERS

*(from page 6)*

Assume identical suspension linearity and equal final system resonances. Hence the speaker in the small box is more compliant. Distortion from the small box might well be less since the total elastic restraint which it sees is to a larger extent due to a linear air-spring. If one box is vented the distortion question becomes one of balance between small cone movement with mechanical suspension *vs.* larger cone movement with air suspension. This question must be decided on the merits of the particular systems involved.

GEORGE O. ADKISSON,
306-1 Third St.,
Fort Leavenworth, Kansas

## ADVERTISING INDEX

*"...approaches the authenticity of concert hall performance," says famed violinist Mischa Elman about his TMS-2, shown with deflectors opened for full stereo.*

The TMS-2 marks the most significant loudspeaker achievement since the advent of popular stereo. Combining two complete multi-speaker systems in one compact enclosure only 30" wide, it solves for the first time all the problems of placement, space limitations, decor and cost inherent in conventional stereo systems. Most important of all, the TMS-2 literally adds a third dimension to stereophonic sound... the perception of *depth*.

This is accomplished by its unique acoustic design that recreates multiple sound sources by utilizing the walls of the room similar to the way sound is transmitted in the concert hall. The bass emanates from the rear of the enclosure, the mid and treble ranges from the sides. Adjustable deflector doors increase or decrease the amount of stereo spread, as desired, according to the program material, room acoustics, etc.

The TMS-2 can be placed in a corner or anywhere along a wall, and since with this system there are no critical listening positions, any number of listeners can enjoy stereo from most anywhere in the room. Even with monophonic equipment and program material, the TMS-2 provides a very pleasing stereo-like effect. It looks more like a piece of fine furniture than a speaker cabinet, and will harmonize with any decor—modern or traditional. (Full details in catalog—see below.) *In Mahogany $258, Blond or Walnut $263, user net.*

*With deflector doors closed for monophonic use, the incredibly compact TMS-2 is only 30" wide, 25" high, 12½" deep.*

IMPORTANT NOTICE FROM University®

# TMS-2*

## ~~IN SHORT SUPPLY~~ NOW BEING DELIVERED!

We regret any delay you may have experienced in receiving your TMS-2 'Trimensional' system. The unprecedented consumer demand for this remarkable new stereo speaker system has sold out the initial production runs. But with our production facilities now trebled, these delays ~~are rapidly being~~ HAVE BEEN overcome. ~~If your~~ YOUR dealer ~~cannot~~ can give you immediate delivery, ~~please be patient.~~ THANK YOU FOR YOUR PATIENCE.

## *Other University approaches to stereo... for every space, budget and decor requirement*

**Leading Metropolitan Opera Star Leonard Warren converted to stereo easily and inexpensively . . . using a compact Stereoflex-2* "add-on" speaker with his full-range "Troubadour" speaker system.**

For those with a full-range monophonic system or planning to buy one now with an eye to stereo later, University offers three different "add-on" speakers. Choose the one that suits you best —for bookshelf, wall, or "litepole" installation—or as an end table.

**Discriminating music lovers may enjoy magnificent stereo by simply connecting two University "add-on" speakers to one dual-voice-coil-woofer in a suitable enclosure.**

This approach offers great versatility. The woofer may be installed wherever most convenient† . . . either in a small, suitable enclosure, or concealed in a wall, closet, etc. The two "add-on" speakers can then be placed to provide optimum stereo reproduction without upsetting room decor.

**Noted choral and orchestra conductor Fred Waring chose a pair of University RRL* Ultra Linear Response speakers for *his* system.**

Two such identical speakers are an excellent stereo solution in rooms where they can be placed in reasonably symmetrical positions, far enough apart to provide sufficient stereo separation. All University systems are ideally suited for this purpose, because they are stereo-matched in production to within one decibel.


WHICH WAY TO STEREO IS IDEAL FOR YOU?

Send for FREE *Informative Guide to High Fidelity Stereo and Monophonic Speaker Systems and Components.* Complete information on the TMS-2 and other stereo speaker systems...how to adapt your present system to stereo...how to choose a monophonic system *now* for most efficient conversion to stereo *later* ...how to "do-it-yourself" economically, etc. See your dealer or write Desk R-12, University Loudspeakers, Inc., White Plains, N. Y.

* *Trade-mark. Patent Pending.*

† *Bass frequencies below 150 cycles do not contribute to the stereo effect.*

*the case of the stereo*

# HUMMMMMMINGBIRD

# *or* MAGNETIC *vs* CERAMIC

You may have been reading many controversial advertisements as to the merits of various stereo cartridges . . . namely, the magnetic version vs. the ceramic version. Qualified claims are made by their manufacturers . . . and most are accurate. But how a specific cartridge *sounds* in your stereo system is really the criterion. Let's consider the real facts:

**IT'S A FACT!** Audio Engineers agree that magnetic stereo cartridges are excellent, costly . . . but burdened with *hum*. Tests prove that the new Electro-Voice Magneramic cartridge is completely hum-free. No motor or line hum can possibly be introduced to mar soft record passages, because the Magneramic is *non-inductive*.

**IT'S AN ENGINEERING AXIOM!** The simpler the design of a precision product, the less chance there is of manufacturing defect. Magnetic stereo cartridges are far more complicated than the comparable Electro-Voice Magneramic stereo cartridge. With E-V, you are assured years of trouble-free, high fidelity stereo performance.

**IT'S POSITIVE!** When the Electro-Voice corps of 60 engineers began intensive scientific stereo studies, they had the choice of either designing a magnetic or a ceramic cartridge. Knowing that two of the most vital factors for true audio reproduction were lack-of-hum and trouble-free performance, they took the positive approach and produced a stereo cartridge incorporating simple elements permitting positive, stable control for uniform output.

And so, with the advent of stereo, Electro-Voice introduced an entirely new concept in ceramic cartridges . . . a true high-fidelity series . . .

## THE E-V MAGNERAMIC

which will consistently outperform the best magnetics and do away with the "hummingbird" in your stereo system.

**Choose the Magneramic . . . a new improved E-V stereo cartridge which plugs directly into magnetic inputs. See why it's the choice of so many FM stations for critical stereo broadcasts:**

- ✓ NO HUM
- ✓ BEST CHANNEL SEPARATION
  *Over 25 db isolation between channels*
- ✓ HIGHEST COMPLIANCE
  *Horizontal and vertical compliance equal to or surpasses the best magnetic cartridges*
- ✓ WIDEST RANGE FREQUENCY RESPONSE
  *Far in excess of any monaural (monophonic) or stereo record*
- ✓ FLATTEST RESPONSE TO WESTREX 1A VELOCITY CURVE
  *From 20 cps to beyond audibility*
- ✓ HIGH 20 MILLIVOLTS OUTPUT
  *All the voltage you need . . . and then some*
- ✓ PROVEN SUPERIOR
  *for conventional monophonic records as well as stereo records*
- ✓ SOLD ON MONEY-BACK GUARANTEE
  *We invite you to try an E-V Magneramic, with E-V's unqualified guarantee backed by over 30 years as a manufacturer.*

Give the Magneramic a thorough listening test. If for any reason you aren't completely convinced of its superiority, your FRANCHISED Electro-Voice dealer is authorized to give you a full refund.

Step up to the excitement of stereo . . . step up to Electro-Voice Stereo . . . the industry's standard. Over a half-million in use, more than the total of all other stereo cartridges combined, attest to its acceptance as stereo's standard. Choose either the E-V *Magneramic* for magnetic inputs or the E-V *Standard* Stereo Cartridge for non-magnetic inputs.

21 MD with 0.7 Mil Diamond Stylus, net $19.50; 26 MDST Turnunder with 0.7 Mil Diamond Stylus, and 3-Mil Sapphire Stylus for 78 R.P.M.'s, net $22.50; 21 MS with 0.7 Mil Sapphire Stylus, net $9.90; 26 MST Turnunder with 0.7 Mil Sapphire Stylus, and 3-Mil Sapphire Stylus for 78 R.P.M.'s, net $12.90.

GOOD STEREO DEPENDS ON THESE VITAL FEATURES: FREQUENCY RESPONSE, 20-16,000 cps flat (Westrex 1A); ELEMENTS, 2 PZT Ceramic; OUTPUT VOLTS, 20 mv. Nominal; COMPLIANCE, 2 x $10^{-6}$ cm/dyne; WEIGHT, 3.4 Grams; TRACKING FORCE, 4-6 Grams; CHANNEL SEPARATION, 25 db at 1 KC; MOUNTING, EIA (RETMA) Standard, 1/2"-7/16" Center; STYLUS, .7 Mil (Diamond or Sapphire); OUTPUT TERMINALS, Standard .050 Connectors; IMPEDANCE OR LOAD, 22,000 ohm or higher magnetic input.

*See your High Fidelity Specialist or write Dept. AD-2*

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**Electro-Voice®**

**INC., BUCHANAN, MICHIGAN**

Over ½ Million in Use . . .
MORE THAN ALL OTHERS COMBINED