AUDIO

OCTOBER, 1959
50¢

...the original magazine about high fidelity!

OCTOBER, 1959 VOL. 43, No. 10

Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

COVER PHOTO: Installation in the home of Karl Kramer, manager of technical services, Jensen Manufacturing Company, showing application of Galaxy II speaker system. Bass-center unit is at lower right, with Satellites—mid- and high-frequency units—on shelf at right and mounted on light pole at left. Wall-mounted cabinets are "Omnibus" line (Richards Morgenthau & Co., 225 Fifth Ave., New York 10, N. Y.) and contain a Rauland-Borg model HF 1531 stereo amplifier and a Concertone model 1501 tape recorder which has been converted to stereo playback operation. Records are stored in the right cabinet unit.

AUDIO (title registered U. S. Pat. Off.) is published monthly by Radio Magazines, Inc., Henry A. Schober, President; C. G. McProud, Secretary. Executive and Editorial Offices, 204 Front St., Mineola, N. Y. Subscription rates—U. S. Possessions, Canada and Mexico, $4.00 for one year, $7.00 for two years, all other countries, $5.00 per year. Single copies 50¢. Printed in U.S.A. at Lancaster, Pa. Entered as Second Class Matter February 9, 1950 at the Post Office, Lancaster, Pa. under the act of March 3, 1879.

RADIO MAGAZINES, INC., P. O. Box 629, MINEOLA, N. Y.
Postmaster: Send Form 3579 to AUDIO, P. O. Box 629, Mineola, N. Y.

AUDIOclinic

JOSEPH GIOVANELLI*

Balancing Stereo Channels

Q. My stereo sound system has two identical loudspeakers, two identical preamplifiers, but the amplifiers are different. The inequality of the two amplifiers creates a balancing problem.

1. A New York outlet has introduced a stereo balance meter which appears to be two VU meters in one case. On the face of the case are two range controls. What are these for?

2. Am I correct in assuming that these meters should be connected at the output of the amplifier for proper stereo balance? Because my two amplifiers are different, their outputs are unequal when the signals from the preamplifiers are equal. For balancing purposes, therefore, a twin meter such as this seems ideal.

3. Since not all programs contain equal volume in each channel, am I correct in assuming that the use of this meter in conjunction with a sine-wave tone signal on each channel would be an ideal method of balancing my stereo channels? James C. Valestin, St. Louis, Mo.

A. 1. This meter can be a very nice piece of equipment to have around. The range switches are intended to keep the peak voltage from driving the meter off scale.

2. The meter should be connected across the speaker terminals of the amplifier.

3. Yes, the use of this meter in conjunction with a sine-wave tone signal on each channel would be an ideal method of balancing stereo channels. In actual practice, however, this method is not always used in stereo recordings. Even when it is used, a false balance may result. I refer now to a particular recording which attempted to use this method. The levels of the two sine-wave tones did not correspond to the levels of the two channels. Therefore, the tones could not serve as a balance indicator. It was not the fault of the system, but rather, the fault of this particular recording.

The use of this system is a good basis for balancing. Just keep in mind that there may be occasions when disparities will be encountered.

Most of the time the two channels must be balanced during the stereo performance.

This can usually be accomplished by setting the volume controls of the preamps to positions which give equal readings on the two scales of the instrument.

Even this procedure is not uniformly reliable. One instance wherein this latter system does not yield adequate results is the stereo installation in which the speaker systems are of unequal efficiencies. For proper balance, the channel feeding the less efficient speaker will require a greater power level and, hence, a higher meter reading then will be true of the channel feeding the more efficient system.

You cannot always balance your signals once the program has started. Let us assume that the material to be balanced is a symphony orchestra. Let us assume also that, at the time the balance attempt was made, only a small group of instruments in the orchestra was playing. This group might well be located on one channel only, or nearly so. Clearly, if you brought the off channel up to match the level of the stronger one, you would be less balanced than you would be if you balanced it by ear. Imagine what happens when the full orchestra plays! Further, some recordings are made off center. When these are balanced properly in playback, the room echo is round and normal. The microphone placement, however, is such that all the instruments were more on one channel than on the other. The mikes were simply in the wrong places. This is similar to sitting on a side aisle of a concert hall, rather than sitting center aisle. To avoid this, I suggest that you switch to mono, thus coupling the two channels together with the same program on both. Then you can balance easily by meter.

Only through the knowledge of the pitfalls of the use of the meter can the advantages of its application be thoroughly explored, and it is for this reason that I dwelt on them at such length here.

IM and Detectability

Q. In terms of your own experience, what is the point at which amplifier distortion becomes so negligible that a further reduction would make no difference in listening quality as determined aurally? As an arbitrary example, would a reduction of IM distortion from 0.5 per cent to 0.1 per cent make any audible difference? John Kelly, Chicago, Ill.

I believe that once an IM distortion of less than 1 per cent is reached, it is virtually impossible to detect any further improvements. This is largely because our program sources rarely run lower in distortion than 1 to 2 per cent IM. Also, the distortion levels of mechanical and electrical transducers run above this level in most cases. This distortion serves to over-

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

"Our tests prove that Garrard Changers deliver the peak stereo performance built into the new FAIRCHILD SM-1 Cartridge,"

says Mr. George G. Cohen, Marketing Manager, Fairchild Recording Equipment Corporation.

"We pioneered in the development of stereo cartridges. From the very beginning we have used Garrard Changers in our testing laboratories. We are pleased to report that, thanks to the complete absence of any disturbing or distorting factors such as rumble or wow, the Garrard has met every requirement of our highly sensitive and compliant rotating magnet and moving coil type cartridges."

We are grateful for Mr. Cohen's and Mr. O'Shaughnessy's comments which reflect the actual experience of the discriminating owners of Garrard Changers with Fairchild Stereo Cartridges. This kind of superior performance is the reason why more Garrard Changers are sold as components for the finest stereo systems than all other changers and turntables combined.

"Our service records show that the Garrard Changer and Fairchild Cartridge make a perfect team for stereo"

says Mr. George O'Shaughnessy, Service Manager, Fairchild Recording Equipment Corporation.

"With us Garrard has an outstanding record of performance. We are gratified at how few complaints there are from owners of Garrard Changers with Fairchild Stereo Cartridges. That is due to Garrard's non-resonant aluminum tone arm and its precise tracking characteristics."

Here are the reasons why Garrard Changers are endorsed for stereo not only by Fairchild, but by all other manufacturers of fine stereo cartridges such as Pickering, Electro-Voice, Shure, General Electric, etc.

- Vertical and lateral rumble completely inaudible. Wow and flutter far below exacting "broadcast tolerance" standards.
- Exclusive aluminum tone arm, precision-mounted at engineering works for optimum tracking angle, perfect sound reproduction.
- Unrestricted choice of stereo cartridges—any of them will track at the manufacturer's lightest specified weight.
- Record handling gentler than the surest human hand.
- The important convenience of manual play plus completely automatic operation without compromise in performance.

These are the FACTS, no one can deny them with authority—and they are backed by the 36 years of experience that have created Garrard's unique reputation for unsurpassed quality.

For the best in Stereo... Insist on a

Garrard

CHANGER

The World's Finest!

Send for free Garrard Comparator Guide

Your Name: _____

Address: _____

City: _____ *State:* _____

Mail to Dept. **GR-19** *at address below.*

There's a Garrard for every high fidelity system...all engineered and wired for Stereo and Monaural records.

BIC ENDORSED QUALITY

RC93 Super Changer **$69.50**

RC88 Deluxe Changer **$59.50**

Model 210 Deluxe Intermix Changer **$49.50**

RC121/II Intermix Changer **$42.50**

TPA/12 Stereo Tone Arm **$19.50**

301 Transcription Turntable **$89.00**

4HF Transcription Manual Player **$59.50**

Model T/II Manual Player **$32.50**

GARRARD SALES CORPORATION, Division of British Industries Corporation, PORT WASHINGTON, N.Y.

Canadian inquiries to Chas. W. Pointon, Ltd., 66 Racine Road, Rexdale, Ontario

Territories other than U.S.A. and Canada to Garrard Engineering & Mfg. Co., Ltd., Swindon, Wilts., England

ride any improvements in amplifier distortion. I believe, therefore, that it would be very, very difficult to detect a change in IM distortion from 0.5 to 0.1 per cent.

The foregoing should not be construed to indicate that I believe that the industry can rest here. Improvements are always welcome even though we have reached a surprising state of realism with our present knowhow and equipment. A single attendance at a live concert will demonstrate that we still have considerable progress to make.

An FM Tuning Indicator

Q. I have an FM tuner in which I wish to incorporate a "Magic Eye" to indicate the "on-carrier-center position". My tuner uses a discriminator circuit. Is it possible to incorporate this feature? How can I do so? N. Kotik, Elmhurst, N.Y.

A. *Figure* 1 shows a typical discriminator circuit with the necessary tuning eye connections. The indicator employed is a 6AL7.

The major problem to be solved is whether there is room on the chassis to mount the tuning-eye bracket. If lack of space prohibits mounting the bracket on the chassis, the leads can be extended and the tuning eye can be mounted in a convenient spot on the front panel of the equipment cabinet.

This circuit will have some slight effect on the discriminator's alignment. It will probably be too slight to notice; should you have a great enough effect to cause distortion and lopsided tuning, align the secondary of the discriminator coil for minimum hiss, and align the primary of that same coil for maximum hiss. The receiver should be tuned to a free spot on the dial during the alignment process.

Loudspeaker Protection

Q. I have a 40 watt amplifier driving a speaker whose maximum power-handling capacity is only 12 watts. What size fuse should I use in order to safeguard my speaker system? The impedance of the speaker is 16 ohms. Michael S. Favore, Chicago, Ill.

A. From the formula $W = I^2R$ we can easily determine the current taken by the

(*Continued on page 12*)

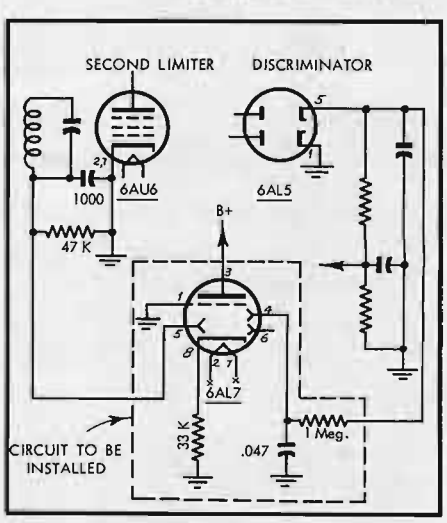
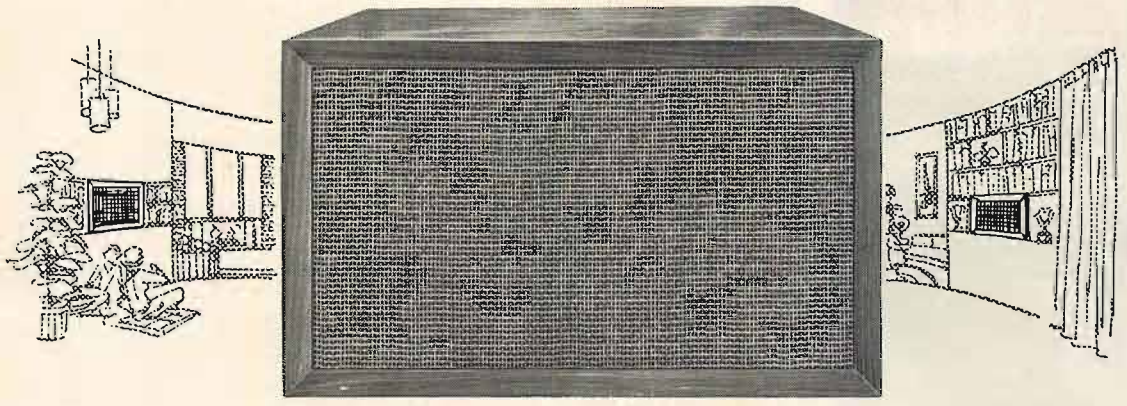


Fig. 1

NEW SOUND EXCITEMENT FOR THE HI-FI STEREO AGE!

Kingdom LORENZ An IT&T Associate

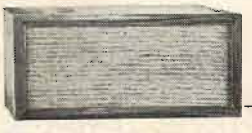


All-New and Incomparable
OMEGA I

NEW! KAL Audette

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

Brown or Blond Leatherette $49.50
Matching Brass Legs 5.95



NEW! Audette III

Big performance in small space! Use singly or pair for stereo. Completely finished on 4 sides for use horizontally or vertically. Features Lorenz 8" woofer with matched quality tweeter and high pass crossover. Frequency response: 30-18,000 cps. Impedance: 8 ohms. Power rating: 18 watts peak. Size: 11" x 23¾" x 10". Gross weight: 20 lbs.

Unfinished Birch (sanded, ready for finishing) $57.50
Oiled Walnut, Mahogany, Walnut, Blond or Ebony 64.50
Matching Brass Legs 5.95

NEW! Audette SENIOR

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

Satin Mahogany $69.50
Blond or Walnut 74.50

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

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

Inside the OMEGA I is a brilliantly matched combination of advanced Lorenz speakers: a full-spectrum 12" woofer with two quality tweeters and high pass crossover. The "infinite baffle" principle provides a thrilling realism found only in the largest most expensive systems.

• 18 to 18,000 cps • 16 ohms • 40 watts peak • 27" x 14¾" x 11½" • 46 lbs. • At any price, you simply can't buy better!

Unfinished Birch (sanded, ready for finishing) $109.50
Oiled Walnut, Mahogany, Walnut, Blond or Ebony 119.50

Never before, so many quality features in loudspeakers—yet priced for the modest budget! Dual cones for breathtaking wide range performance! Twin voice coils in 12" loudspeakers, with flexible impedances of 4, 8 or 16 ohms, enabling you to select the impedance you require! Non-resonant cast aluminum girder constructed frames! Fully tropicalized for finest operation in any climate. For stereo or monaural—singly or in matched pairs.

NEW! Lorenz S-1288

Value-packed basic 12" loudspeaker of advanced design, with dual cones and twin voice coils. Choice of impedances of 4, 8 or 16 ohms on one speaker! • 18 to 15,000 cps. • Magnet assembly weight: 61.5 oz. • 30 watts peak. $44.50

NEW! Lorenz S-1288 II

A complete system—consists of Lorenz S-1288 with twin tweeters on rigid metal bracket and high pass crossover. Dual cones and voice coils with 4, 8 or 16 ohm impedances. • 18 to 18,000 cps. • 35 watts peak. A "system" in itself! $67.50

NEW! Lorenz S-888

Spacious sound with real economy! Outstanding 8" speaker with dual cones and high efficiency 8 ohm voice coil. • 30 to 14,500 cps. • 18 watts peak. • Magnet assembly weight, 28.5 oz.

$21.50

NEW! Lorenz S-388

Armored horn-type 2½" tweeter with plastic cone for 120-degree high frequency sound dispersion. New ferrite magnet hermetically sealed.

• 2,000 to 18,000 cps. • 5.5 ohms. • 2 watts peak. The perfect mate for Lorenz 12" or 8" speakers. $8.50

HP-1 High Pass Crossover

Crosses over at 2,000 cps. at rate of 3 db per octave—feeds highs to tweeters, lows to woofer. Extends speaker system range to limit of audibility. For use with 2 or 3 way systems. $4.95

At High Fidelity Dealers Everywhere. FREE Catalog. Write Dept. A.

Kingdom PRODUCTS, Ltd. 514 Broadway, New York 12, N. Y. • WOrth 6-0800

Exclusive U. S. Distributors for Lorenz High Fidelity Loudspeakers

LETTERS

The Case for Stereo Tapes

SIR:

In the frantic rush to get aboard the stereo disc bandwagon, a sad and disastrous thing is happening.

Your magazine, and others in the same field, have stopped reviewing stereo tapes, and of late refrained from any mention of stereo tapes whatever. At the same time, several prominent manufacturers have stopped releasing them, they are no longer advertised, and most dealers have stopped stocking them. The general impression would seem to be that recorded stereo tape is a thing of the past and has been completely superseded by the stereo disc.

I say this is a sad thing because it comes at a time when at long last some stereo tapes* have appeared on the market which in my opinion have reached for the first time a degree of excellence in music reproduction which might be called perfection.

They have a wide frequency and dynamic range and set a new standard for absence of noise and distortion. With the fine music and performance on some of these reels they bring a new and refreshing sense of pleasure to the discriminating listener which is unattainable by other means. The discs of the same recordings are superlative in their category, but it is unnecessary to go into the technical reasons why any good tape is better than the same recording on a disc. Anyone who doesn't understand the whys and wherefores need only make a listening comparison of tape and disc versions of the same recording, played on equally top-notch equipment, to appreciate the tape's superiority.

The disastrous part of this apparent abandonment of the best thing that audio has to offer is that there will be no reason for even the best producers to go on making stereo tapes if everyone continues to discourage their sale. If this backward step is successful, it will be not only disaster to the industry, but to all discriminating listeners.

What I want to know is, Why this evident conspiracy to eliminate stereo tape in favor of the stereo disc?

There seems to be only one answer: the comparative cheapness and ease of mass production of the disc, a quick shot in the arm for the industry, and the pursuit of the fast buck. This is a shortsighted policy.

I think that this argument, based only on the cheapness of the disc, is essentially spurious. The fact that discs cost a little less than half as much as tapes for their running time tends to make the average buyer less selective, with the result that many records are discarded or forgotten after being run a couple of times, while the carefully selected tape finds a permanent place in the library.

The disc starts to deteriorate with its first playing; a well-cared-for tape lasts indefinitely. The stereo disc inherits, often in multiplied form, all the ills of groove reproduction, of which the stereo tape has none.

Now for the comparative cost of disc and tape equipment. In either case, there must be duplicate amplifiers and speaker systems, which cost quite a bit of money. These components have reached a stage of development where they are not likely to be much improved in the foreseeable future. So there is nothing left to improve but the original sound source or signal, and it is false economy not to do so, for you can't get anything better out of an audio system than that which you put into it. When the cost of a good turntable, stereo arm, and cartridge, plus a first-class stereo preamplifier are added up, they probably won't cost much less than a good tape player. None of the aforementioned items is necessary if the tape player has its own preamplifier, with balance and volume controls, as most do. If a system which will play both discs and tapes is wanted, then the extra cost of a tape deck is well worth while.

Of course, not all stereo tapes are good, nor all stereo discs bad—far from it. But I am only concerned with the best, which I assume is the object of all true audiofans.

Naturally the lower priced components and the cheaper mass-produced discs will remain the financial mainstay of the indnstry, but is that the reason for this apparent drive to put the stereo tape off the market by giving it the silent treatment?

I believe there are plenty of people who own stereo tape equipment who would buy many more tapes if they could hear the kind of sound I have been hearing lately, and many more who would purchase tape equipment if they could have the same experience and were assured of a continuing supply of stereo tapes of such high quality.

I am starting a campaign with the object of establishing the stereo tape in its rightful position by acquainting the discriminating listening public with its vast superiority, and thus encourage the manufacture and distribution of a continuing flow of tapes of the same high quality as some of those now available.

This one-man effort is small. Is there anyone interested in joining this crusade for better music?

Audiofans of the World, arise! You have nothing to lose but your rumbles, pops, and scratches, plus a lot of irritating distortion.

ERNEST B. SCHOEDSACK,
370 Twentieth St.,
Santa Monica, California.

(*We would like to add our comments on this subject, and, perhaps, a refutation or two. If anyone is interested, please turn to page 18.* ED.)

* Produced by Everest, of Belock Instrument Corp.

Doppler Effect

SIR:

Browsing through your July issue, I was pleased to see a letter from Mrs. Jane M. Hall and an excellent technical article by Virginia Rettinger, which seems to indicate that ladies are now taking a serious and welcome interest in the subject of audio. (At our demonstration in the Royal Festival Hall last May, out of forty people on the front row, no less than ten were members of the fair sex.)

Now although I agree with Virginia Rettinger's views on the value of avoiding distortion by using two or more loudspeakers, I do not think it is valid to attribute such distortion to Doppler effect. In fact, I would say that Doppler has had no more to do with loudspeaker distortion than I have had to do with the Leaning Tower of Pisa. I thought I had laid Doppler to rest forever in my first little book on Loudspeakers more than ten years ago, but no doubt your authoress would be too young to have read it.

Doppler effect is change of pitch due to high speed—say half a semitone at 60

(*Continued on page 10*)

Easy-to-build

HEATHKIT®

- style
- performance
- quality

costs you less!

STEREO EQUIPMENT CABINET KIT

MODEL SE-1 (center unit) **$149.95**
Shpg. Wt. 162 lbs.

MODEL SC-1 (speaker enclosure) **$39.95** each
Shpg. Wt. 42 lbs.

Superbly designed cabinetry to house your complete stereo system. Delivered with pre-cut panels to fit Heathkit AM-FM tuner (PT-1), stereo preamplifier (SP-1 & 2) and record changer (RP-3). Blank panels also supplied to cut out for any other equipment you may now own. Adequate space also provided for tape deck, speakers, record storage and amplifiers. Speaker wings will hold Heathkit SS-2 or other speaker units of similar size. Available in unfinished birch or mahogany plywood.

MONAURAL-STEREO PREAMPLIFIER KIT (Two Channel Mixer)

MODEL SP-2 (stereo) **$56.95** Shpg. Wt. 15 lbs.
MODEL SP-1 (monaural) **$37.95** Shpg. Wt. 13 lbs.
MODEL C-SP-1 (converts SP-1 to SP-2) **$21.95** Shpg. Wt. 5 lbs.

Special "building block" design allows you to purchase instrument in monaural version and add stereo or second channel later if desired. The SP-1 monaural preamplifier features six separate inputs with 4 input level controls. A function selector switch on the SP-2 provides two channel mixing. A 20' remote balance control is provided.

World's largest manufacturer of electronic instruments in kit form

HEATH COMPANY
Benton Harbor, 25, Michigan

a subsidiary of Daystrom, Inc.

HIGH FIDELITY RECORD CHANGER KIT

MODEL RP-3 **$64.95**

Turntable quality with fully automatic features! A unique "turntable pause" allows record to fall gently into place while turntable is stopped. The tone arm engages the motionless record, and a friction clutch assures smooth start. Automatic speed selector plays mixed 33⅓ and 45 RPM records regardless of sequence. Four speeds available: 16, 33⅓, 45 and 78 RPM. Changer complete with GE-VR-II cartridge with diamond LP and sapphire 78 stylus, changer base, stylus pressure gauge and 45 RPM spindle. Shpg. Wt. 19 lbs.

PROFESSIONAL STEREO-MONAURAL AM-FM TUNER KIT

MODEL PT-1 **$89.95**

The 10-tube FM circuit features AFC (automatic frequency control) as well as AGC. An accurate tuning meter operates on both AM and FM while a 3-position switch selects meter functions without disturbing stereo or monaural listening. Individual flywheel tuning on both AM and FM. FM sensitivity is three microvolts for 30 db of quieting. The 3-tube FM front end is prewired and prealigned, and the entire AM circuit is on one printed circuit board for ease of construction. Shpg. Wt. 20 lbs.

"EXTRA PERFORMANCE" 55 WATT HI-FI AMPLIFIER KIT

A real work horse packed with top quality features, this hi-fi amplifier represents a remarkable value at less than a dollar per watt. Full audio output at maximum damping is a true 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Featuring famous "bas-bal" circuit, push-pull EL34 tubes and new modern styling. Shpg. Wt. 28 lbs.

MODEL W7-M **$54.95**

NEW

NOTE THESE OUTSTANDING SPECIFICATIONS: Power Output: 14 watts, Hi-Fi; 12 watts, Professional; 16 watts, Utility. **Power Response:** ± 1 db from 20 cps to 20 kc at 14 watts output. **Total Harmonic Distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation Distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1 **Hum and Noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts.

14-WATT HI-FI ECONOMY AMPLIFIER KIT

MODEL EA-3 **$29.95**

From HEATHKIT audio labs comes an exciting new kit . . . New Styling, New Features, Brilliant Performance! Designed to function as the "heart" of your hi-fi system, the EA-3 combines the pre-amplifier and amplifier into one compact package. Providing a full 14 watts of high fidelity power, more than adequate for operating the average system, the EA-3 provides all the controls necessary for precise blending of musical reproduction to your individual taste. Clearly marked controls give you finger-tip command of bass and treble "boost" and "cut" action, switch selection of three separate inputs, "on-off" and volume control. A hum balance control is also provided. The convenient neon pilot light on the front panel shows when instrument is on. Styled to blend harmoniously into any room surroundings, the handsome cover is of black vinyl coated steel with gold design and features the new "eyebrow" effect over the front panel to match the other new Heathkit hi-fi instruments. The panel is satin black with brush-gold trim strip, while the control knobs are black with gold inserts. Shpg. Wt. 15 lbs.

HIGH FIDELITY AM TUNER KIT

MODEL BC-1A **$26.95**

Designed especially for high fidelity applications this AM tuner will give you reception close to FM. A special detector is incorporated and the IF circuits are "broadbanded" for low signal distortion. Sensitivity and selectivity are excellent and quiet performance is assured by a high signal-to-noise ratio. All tunable components are prealigned before shipment. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

MODEL FM-4
$34.95
(with cabinet)

HIGH FIDELITY FM TUNER KIT (FM-4)

The all new model FM-4 incorporates the latest advancement in circuit design. Features include better than 2.5 microvolt sensitivity for 20 db of quieting, automatic frequency control (afc) with defeat switch, flywheel tuning and prewired, prealigned and pretested tuning unit. Prealigned IF transformers and prewired tuning unit assure easy assembly with no further need of alignment after unit is completed. The five tube circuit features a generous power supply utilizing a silicon diode rectifier. Shpg. Wt. 8 lbs.

"MASTER CONTROL" PREAMPLIFIER KIT

MODEL WA-P2 **$19.75** **(Not Illustrated):**

All the controls you need to master a complete high fidelity system are incorporated in this versatile instrument. Features 5 switch-selected inputs each with level control. Provides tape recorder and cathode-follower outputs. Full frequency response is obtained within ± 1½ db from 15 to 35,000 CPS and will do full justice to the finest available program sources. Equalization is provided for LP, RIAA, AES, and early 78 records. Shpg. Wt. 7 lbs.

"UNIVERSAL" 12 WATT HIGH FIDELITY AMPLIFIER KIT

MODEL UA-1 **$21.95**

Ideal for stereo or monaural applications, this 12-watt power package features less than 2% total harmonic distortion throughout the entire audio range (30 to 15,000 CPS) at full 12-watt output. Use with preamplifier models WA-P2 or SP-1 & 2. Taps for 4, 8 and 16 ohm speakers. Shpg. Wt. 13 lbs.

NEW!

MODEL TR-1A: Monophonic half-track record/playback with fast forward and rewind functions. Shpg. Wt. 24 lbs. **$99.95**

MODEL TR-1AH: Half-track monophonic and stereo record/playback with fast forward and rewind functions. Shpg. Wt. 35 lbs. **$149.95**

MODEL TR-1AQ: Quarter-track monophonic and stereo with record/playback fast forward and rewind functions. Shpg. Wt. 35 lbs. **$149.95**

NOW! TWO NEW STEREO-MONO TAPE RECORDERS IN THE TR-1A SERIES

Offering complete versatility, the model TR-1A series tape recorders enable you to plan your hi-fi system to include the functions you want. Buy the new half-track (TR-1AH) or quarter-track (TR-1AQ) versions which record and playback stereo and monophonic programming, or the half-track monophonic record-playback version (TR-1A).

Precision parts hold flutter and wow to less than 0.35%. Four-pole, fan cooled motor. One control lever selects all tape handling functions. Each tape preamplifier features NARTB playback equalization, separate record and playback gain controls, cathode follower output, mike or line input, and two circuit boards for easy construction and high stability. Complete instructions guide assembly.

HEATHKIT®

YOU'RE NEVER OUT OF DATE WITH HEATHKITS

Heathkit hi-fi systems are designed for maximum flexibility. Simple conversion from basic to complex systems or from monaural to stereo is easily accomplished by adding to already existing units. Heathkit engineering skill is your guarantee against obsolescence. Expand your hi-fi as your budget permits . . . and, if you like, spread the payments over easy monthly installments with the Heath Time Payment Plan.

CONTEMPORARY
Model CE-1B Birch
Model CE-1M Mahogany

TRADITIONAL
Model CE-1T Mahogany

- No Woodworking Experience Required For Construction.
- All Parts Precut & Predrilled For Ease of Assembly.
- Maximum Overall Dimensions: 18" W. x 24" H. x 35½" D.

CHAIRSIDE ENCLOSURE KIT

MODEL CE-1 **$43.95** each

Control your complete home hi-fi system right from your easy chair with this handsome chairside enclosure in either traditional or contemporary models. It is designed to house the Heathkit AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier, along with the RP-3 or majority of record changers which will fit in the space provided. Well ventilated space is provided in the rear of the enclosure for any of the Heathkit amplifiers designed to operate with the WA-P2. The tilt-out shelf can be installed on either right or left side as desired during the construction, and the lift-top lid in front can also be reversed. All parts are precut and predrilled for easy assembly. The contemporary cabinet is available in either mahogany or birch, and the traditional cabinet is available in mahogany suitable for the finish of your choice. All hardware supplied. Shpg. Wt. 46 lbs.

IT'S EASY . . . IT'S FUN AND YOU SAVE UP TO ½ WITH DO-IT-YOURSELF HEATHKITS

Putting together your own Heathkit can be one of the most exciting hobbies you ever enjoyed. Simple step-by-step instructions and large pictorial diagrams show you where every part goes. You can't possibly go wrong. No previous electronic or kit building experience is required. You'll learn a lot about your equipment as you build it, and, of course, you will experience the pride and satisfaction of having done it yourself.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

MODEL SS-2 **$39.95**
Legs: No. 91-26 Shpg. Wt. 3 lb. $4.95

The modest cost of this basic speaker system makes it a spectacular buy for any hi-fi enthusiast. Uses an 8" mid-range woofer and a compression-type tweeter to cover the frequency range of 50 to 12,000 CPS. Crossover circuit is built in with balance control. Impedance is 16 ohms. Power rating 25 watts. Tweeter horn rotates so that the speaker may be used in either an upright or horizontal position. Cabinet is made of veneer-surfaced furniture-grade plywood suitable for light or dark finish. All wood parts are precut and predrilled for easy assembly. Shpg. Wt. 26 lbs.

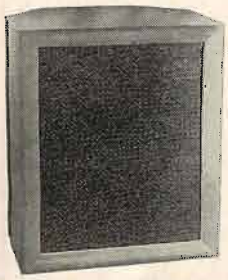
DIAMOND STYLUS HI-FI PICKUP CARTRIDGE

MODEL MF-1 **$26.95**

Replace your present pickup with the MF-1 and enjoy the fullest fidelity your library of LP's has to offer. Designed to Heath specifications to offer you one of the finest cartridges available today. Nominally flat response from 20 to 20,000 CPS. Shpg. Wt. 1 lb.

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

The SS-1B employs a 15" woofer and super tweeter to extend overall response of basic SS-2 speaker from 35 to 16,000 CPS ±5 db. Crossover circuit is built in. Impedance is 16 ohms, power rating 35 watts. Constructed of ¾" veneer-surfaced plywood suitable for light or dark finish. Shpg. Wt. 80 lbs.



MODEL SS-1B
$99.95

SEND FOR FREE CATALOG

Describing over 100 easy-to-build kits in hi-fi, test, marine and ham radio fields. Also contains complete specifications and schematics.

LEGATO HI-FI SPEAKER SYSTEM KIT

MODEL HH-1 **$299.95**

The startling realism of sound reproduction by the Legato is achieved through the use of two 15" Altec Lansing low frequency drivers and a specially designed exponential horn with high frequency driver. The special crossover network is built in. Covers 25 to 20,000 CPS within ±5 db. Power rating 50 watts. Cabinet is constructed of ¾" veneer-surfaced plywood in either African mahogany or white birch suitable for the finish of your choice. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

HEATH COMPANY · BENTON HARBOR 25, MICH.

pioneer in "do-it-yourself" electronics

a subsidiary of Daystrom, Inc.

☐ Please send the Free Heathkit catalog.

Enclosed find $.....
Please enclose postage for parcel post—express orders are shipped delivery charges collect. All prices F.O.B. Benton Harbor, Mich. A 20% deposit is required on all C.O.D. orders. Prices subject to change without notice.

name _____

address _____

city & state _____

QUANTITY	ITEM	MODEL NO.	PRICE

LETTERS

(*from page 6*)

m.p.h.—and such a velocity is never reached in speaker-cone movement. Mrs. Rettinger cites an extreme case at 40 cps where deflection in an 8-in. cone would be 0.58 in. (Heaven help it!) But this represents a speed of not more than 3 m.p.h. so any Doppler effect can be ruled out. Furthermore, violinists prove that wobbling the pitch above and below a well chosen centre note does not cause distortion; it warms up the tone.

The intermodulation distortion to which the authoress rightly draws attention is due to non-linearity in cone movement at low frequencies, which is actually a form of overloading, and is usually most readily produced and heard on loud organ passages. Avoid non-linearity and you avoid the distortion at all frequencies.

And so once again let us say goodbye to dear old Doppler—may he rest in peace!

G. A. Briggs, Managing Director,
Wharfedale Wireless Works, Ltd.,
Idle-Bradford, Yorks., England.

Damping Materials

Sir:

In the article by Huff on damping materials in the August issue, a number of peculiar results were obtained which run counter to accepted theory and practice in acoustics and transducer work. Perhaps the author could help by explaining:

1. How sound output outside the cabinet can be increased, and up to 15,000 cps, by decreasing the sound pressure inside the cabinet.
2. Why sound at high frequencies, 1000 to 15,000 cps, inside the cabinet, affects external radiation when even very thin walls constitute solid barriers to high-frequency sound.
3. How does the 15,000 cps sound get inside the cabinet? The author's speaker generates high frequencies in tweeters mounted in front of the woofer cone.
4. How the author's test data checks with data from acoustical materials testing laboratories whose business it is to evaluate sound absorption of materials.

Also, the tired old canard about "the speaker being the weakest link" now needs to be proved or laid to rest. The vast difference in sound quality of different records convinces us that the speaker can now shed its old-time inferiority complex.

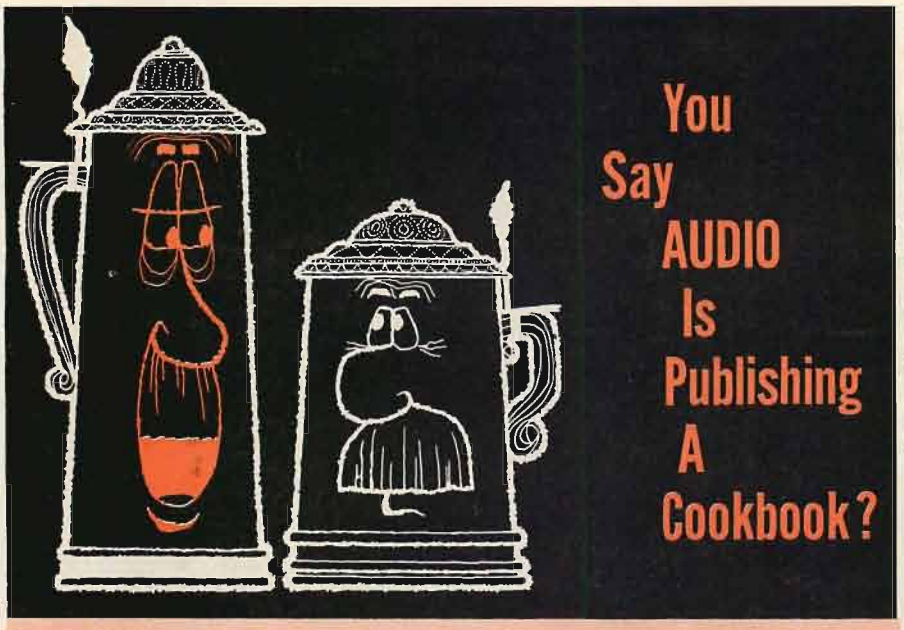
Philip B. Williams, Chief Engineer,
Jensen Manufacturing Co.,
6601 S. Laramie Ave.,
Chicago 38, Ill.

Stolen Tape Recorder

Sir:

While I was away on a vacation, a thief entered my apartment and stole my Ampex 600 tape recorder, Serial No. 5I-1324. Anyone who might come in contact with this machine is requested to communicate with me. I will pay an ample reward for any information leading to the recovery of the machine.

R. G. Chaplick,
10001 McKinney Ave.,
Silver Spring, Maryland.



Yes, AUDIO is publishing a cookbook—not that we intend to extend the subject of gastronomy to include recipes in future pages of AUDIO.

You may ask...why?

And we would answer—Simply because we feel that people who read AUDIO, and enjoy the finest quality music reproduction also enjoy really good food on their tables.

Your next question may be...Is it a different kind of cookbook?

Of course our reply would be—Yes! Oh, it doesn't have a revolutionary format and it appears to look like any ordinary cookbook. But, the secret of its goodness is the recipes that fill its 148 pages... recipes responsible for the heart warming, flavorsome, homespun aromas experienced only in the kitchen of an Adirondack country home.

The name of the book is PLACID EATING, and it is chock full of palate-tempting recipes compiled by Climena M. Wikoff, owner of the Mirror Lake Inn ...at (you guessed it) Lake Placid, New York.

Actually, the first edition (now out of print) was discovered by Mr. AUDIO (C. G. McProud) during his stay at Mrs. Wikoff's Mirror Lake Inn, where, in Mr. McProud's own words—"*...every meal is so tasty that eating becomes a real joy, where each night's dessert excels the one from the night before, where one has to push himself away from the table before upsetting the daily calorie count.*"

Here is a cookbook that will enable you to recreate in your own homes superb dishes experienced only at the Mirror Lake Inn—dishes like *Lake Trout Baked In Wine* and *Adirondack Apple Pie*, recipes for which are reproduced below—

LAKE TROUT BAKED IN WHITE WINE

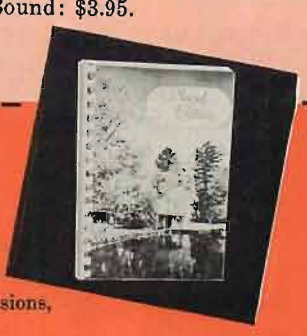
Remove heads and tails from a 2-pound fish. Split open down back and rinse well. Remove backbone and rub inside with lemon, salt, pepper and thyme to taste. Knead 1 tablespoon of butter and anchovy paste the size of a large pea; placing mixture inside fish. Place fish in a greased baking pan and cover with ½ cup of white wine. Bake 25 to 30 minutes in moderate oven, 350 degrees. Baste frequently. Garnish with parsley and lemon and serve with plain boiled potatoes.

ADIRONDACK APPLE PIE

1 c. sugar
2 tbsps. sifted flour
½ tsp. grated nutmeg
½ c. orange juice
⅓ c. melted butter
3 tbsps. white corn syrup
6 to 8 tart apples, thinly sliced
pastry

Mix together the sugar, flour, nutmeg, orange juice, corn syrup and melted butter. Add the sliced apples and mix thoroughly. Butter a pie pan heavily before putting in your pastry. Fill the pie shell with the apple mixture and make pastry strips for the top which should be dipped in melted butter before putting on the pie. Bake in 400 degree oven for 15 minutes: reduce heat to 250 degrees and bake 35 to 40 minutes longer.

This colorful book, plastic bound for easy handling, will contribute many wonderful adventures in food for everyone in the family. Order a copy today, the Lady-of-the-house will adore you for it. Incidentally...it makes a wonderful gift for anyone. PLACID EATING, 152 pages, Plastic Bound: $3.95.



RADIO MAGAZINES, INC., Dept. K99
P.O. Box 629, Mineola, New York

Enclosed is my remittance of .....,
please send me ..... copies of
PLACID EATING @ $3.95 each.
(No C.O.D., all books sent postpaid in U.S.A. and possessions, Canada, and Mexico. Add 50¢ for Foreign orders.)

NAME _____ ADDRESS _____

CITY _____ ZONE ____ STATE _____

COMING HI-FI SHOWS

Oct. 5–10—New York, High Fidelity Music Show, New York Trade Show Building. Presented by the Institute of High Fidelity Manufacturers with "Decorate your home with music" as the theme (*IHFM*)
Oct. 5–9—New York, Audio Engineering Society Convention and Professional Equipment Exhibit, Hotel New Yorker. (*AES*)
Oct. 15–18—Kansas City, Mo., Hotel Bellerive. (*Hi-Fi Music Guild of Greater Kansas City*)
Oct. 16–18—Detroit, Statler Hotel. (*RIGO*)
Oct. 28–31—Toronto, Ont., Canada, Park Plaza Hotel. (*Dominion High Fidelity Association*)
Oct. 30–Nov. 1—Buffalo, N. Y., Statler Hotel. (*Rigo*)
Nov. 6–8—Seattle, Wash., New Washington Hotel. (*Rigo*)
Nov. 13–15—Portland, Ore., New Heathman Hotel. (*Rigo*)
Nov. 20–22—Philadelphia, Pa., Benjamin Franklin Hotel. (*Rigo*)
Dec. 4–6—Minneapolis, Minn., Hotel Leamington. (*Audio Div., Paul Bunyan Chapter, ERA*)

AUDIOCLINIC

(*from page 4*)

speaker at 12 watts. We find that the current is just under 0.9 ampere. However, there are complicating aspects to this problem. The power pulses which damage loudspeakers are of extremely short duration. This time interval is usually much too short to blow the fuse. Bear in mind that there is a thermal delay in fuses; they cannot blow until they are heated sufficiently to melt their elements, and this takes a measureable amount of time. What is needed is a fuse whose value is somewhat below that calculated from application of the above formula. In this case a 0.75 ampere fuse, or even a 0.6 ampere fuse may be tried. Along with this precaution you should use a fast-acting instrument fuse. Should you use this type of fuse it may be necessary to increase the current rating used since such a fuse has a considerably shorter thermal delay. If you use an instrument fuse be sure to obtain the correct holder for it. It is somewhat longer than the standard type seen on most high fidelity equipment.

Bypassing the Output Wattages

Q. I have noticed that in the output stages of amplifiers there are sometimes individual cathode resistors and sometimes a single resistor. In the latter cases, the common resistor is sometimes bypassed with a capacitor, and sometimes not. What are the relative merits and drawbacks of bypassing the output tubes? John Kelly, Chicago, Ill.

A. The controversy over the merits and demerits of common versus separate cathode resistors in output stages, and whether these elements should or should not be bypassed has gone on for some time and has not yet been resolved. The answer seems to depend upon the actual characteristics of a particular piece of equipment or circuitry in which the resistors are to be used. The differences are slight indeed. Æ

AUDIO ETC.

Edward Tatnall Canby

FOUR-TRACK POINTERS

FOUR-TRACK STEREO is here! So the ads would put it, but I can go further and be more specific.

Quarter-track (to use the alternative term) has bowled *me* over in person, after a summer's worth of direct experience with it. I have so much to say on various aspects of this subject that I'm sort of sputtering, right now, and will have to spread myself out over several issues.

I haven't had such a profitable time trying out a new home sound development since LP came in, or maybe since stereo tape. (Stereo disc was too hectic to be enjoyable, most of the time.) I'm sold on quarter-track, for a great many varied and interesting purposes not including (of course) strictly professional work, where it is pointless, but definitely reaching out into all aspects of home hi-fi, semi-professional, and specialized recording and on into a batch of newly practical types of recording that are going to open up soon, thanks to this sudden availability of low-cost, relatively simple two-channel tape. (Four-track, two channels each way.)

Pending further discussion, here are my major conclusions, in a cartridge shell.

1. I am astonished at what four-track can do already, so soon after its official launching. I am impressed at its reliability, its lack of serious bugs. For example, its excellent performance in respect to cross-talk between channels—there simply is none—and the easy accuracy of its channel tracking, or the already strikingly low background noise level attainable. See Tandberg, below.

2. I am highly pleased at four-track sound quality, to date, but I'm especially and deeply impressed by what can now be done at the crucial speed of 3¾ ips.

Arguments rage—I had to try for myself. I deliberately did most of my four-track recording work at this speed, to find out what its virtues and faults might be in strenuous practice. For most intentions, I find that 3¾ ips can do me so well that the higher speed of 7½ ips is mainly useful as a sort of margin-of-safety extra. I honestly can't tell the two apart, as I play back the tapes I made. There are differences, measurable ones, but they most certainly do not jump at you in the listening.

3. Extrapolating for likely improvement —remember the LP after one year?—I can't help but suspect that 3¾ ips is on the way to becoming the standard hi fi speed, replacing 7½ ips as that speed in turn replaced 15 ips. My remarks of July seem to have been confirmed, so far, by my own experience to date.

4. A startling change of attitude on my part was one unexpected result of all this experimenting. I suspect that—far from the common expectation — two-channel home-style recording is going to be the biggest boon to home recording, and to various semi-professional types of recording, since tape itself came in.

Even as late as last spring I probably would have scoffed at home two-track as a waste of energy—but I was going to try it anyhow, if only to learn how to make stereo recordings myself. It turned out to be more than merely feasible. I quickly found that *two* mikes, *two* channels, *two* speakers, make good recording, entertaining, intelligible, lively effects, much more sure fire than with standard mono recording. It's a cinch and you can't go wrong! Almost anywhere you put your two mikes is OK, so long as they aren't right together in one spot. There are a million tricks to play, a thousand ways to exploit the "twoness" of those two mikes. Practically everything goes and literal realism is the last thing that matters.

And don't forget that you can record "binaural" for earphones, with close-together mikes, and produce an uncanny recorded realism out of the most ordinary sounds. Ampex is definitely on the right track with its present ads for home earphone listening (though I am against earphones for true *stereo* recordings—that doesn't work at all). Make your own "binaural" and see what I mean. It's terrific.

As for the great schism of the moment, reel-to-reel quarter-track *vs.* cartridge (magazine) tape, my recent experience with both types leads me to think it likely both kinds will survive and grow, aided of course by relentless promotion in each camp.

The thing is, that the two systems are more than just mechanically different. They have inherently different appeals, are useful to such utterly different groups of potential buyers, that there will undoubtedly be a place for both in the coming scheme of htings. More on this subject in connection with the RCA Victor tape cartridge machine, which I've been using lately. But I should point out right here that a similar earlier rivalry, between 33 and 45, ended up with both systems in use and for similar reasons—not only the pressure of promotion, but the fact that there was a different need for each, in different areas.

There's a need for reel-to-reel tape, and there's also a big field for sheer pushbutton tape operation. Wasn't it Kodak that said, you push the button and we do the rest? Well, more or less. It was a good idea and it still is, practically speaking.

TANDBERG MODEL 500

I tried out two utterly unlike four-track recorders last summer, each representative of a particular approach and way of thinking, the two differing in a great deal more than the fact that one was reel-to-reel and the other a cartridge machine. My main work was done on the Tandberg 500, latest modification of that well-known Norwegian line, and I owe first consideration to Tandberg, too, since I've kept it waiting longest. I'll get to the RCA Victor SCP-2 tape cartridge recorder shortly.

The Tandberg 500 is a compact, complex, ingenious, high-quality four-track recorder that plays stereo, and will record on two tracks as well via an added (separate) preamplifier-control unit for the second track, which I used. The machine is small, but heavy—and no wonder, considering the fabulous amount of gear crammed inside its little frame. It has a single built-in monitor speaker that will play either channel; but stereo playback is via external speakers. Two small power amplifiers of a few watts are included, good enough to drive a set of speakers in a small room or for monitor playback. A cathode follower dual output (via a rear switch, added for the American market) allows playback via your own amplifiers and speakers—the main intent of the machine in view of its high quality performance. This approach is not unlike that of the semi-pro Ampex 600 line (though the Ampex has no speaker at all and uses three heads, to Tandberg's two-head arrangement) and in both the reasoning is good: for optimum results at the various given speeds, it is best to concentrate on the recording itself and on the basic playback, minus built-in power amplifiers and speakers—which inevitably must be compromised for space. You provide your own playback equipment, of the properly large and uncompromised sort that will accommodate the tape machine's sound quality.

This, obviously, is the only approach for the man who wants to get the best he can out of a given type of recording, from the tape recorder itself and in the playback system that is used with it. The Tandberg's built-in monitor speaker is fine for field checking, on the spot, and two small portable speakers will give you adequate stereo effect, if you need a stereo field check as well. For hi-fi playback you use your regular home stereo equipment.

I do have some reservations in detail concerning this Tandberg 500, which is in some ways an interim adaptation to the new four-track stereo needs and suffers from a consequent clumsiness in operation. I know all about these minor troubles—from vivid experience. But for this very reason, let me first praise its basic ability in the very highest terms I can.

This Tandberg 500 turns out really amazing recordings. I have not yet stopped marvelling at the clarity, naturalness and, above all, the astonishing *quietness* (low background noise) of its tapes—I still can't believe they're true. Granted that,

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

for high-hearing ears, there is a very slight frequency limitation at the top in the 3¾ ips speed; but I still think that most of the tapes I made in this fashion—four-track, 3¾ ips, two hours of stereo per normal roll—could not be distinguished by most musical listeners from top-quality *full-track* professional work.

This goes beyond the mere specs, though they look pretty goood. As we all know, there are specs and specs. Flat within this or that tolerance or such-and-such frequency range, distortion at thus-and-so percentage, and so on. With all due deference to the industry's measuring instruments and to its official standards, I still prefer to cross my fingers until I've put my good ears to work. Whatever the specs, my ears say immediately that the Tandberg sound is just plain extraordinary, that the low quarter-track noise level (and consequently wide dynamic range) is fabulous—and this is a crucial factor in four-track recording, as we all know.

Crickets and Cowboys

The biggest complaint about the change to quarter-track has been the increased likelihood of a less favorable signal-to-noise figure, the likelihood of objectionable hiss and noise in the background. I've heard that very thing in other quarter-track tape and I would have been pretty disturbed, too, if it hadn't been for my experience with Tandberg. A half minute of listening to a Tandberg tape will convince anybody that it *can* be done, the really noiseless quarter-track recording, though how it is done is more than I know.

In this respect it was particularly delightful, for me, to do most of my recording in a large outdoor tent in Tennessee where the musical rehearsals and concerts took place. The background noise in that location varied from annoying to just plain charming! There were crickets and birds galore, for one thing, and little children playing cowboys and Indians in a nearby house. (*Got'im! You're dead! Pow-pow, bang-bang,* right in the middle of a Debussy string quartet). Also dogs and, several times, dog fights in the midst of the audience. A half-hour chime broke in periodically from a nearby tower and trucks rolled by in the distance, people talked faintly, a block or so away. Then there were the thunderstorms and the roar of rain on the canvas roof—one cloudburst completely drowned out a full orchestra except for the single triangle, which could be heard, *ting,* faintly over the noise.

The Tandberg picked up every detail—*every* detail—down to the last cricket. The low-level sounds that came through on some of my tapes are absolutely fascinating, as well as impressive. If you can hear birds, crickets, distant people, rustling clothing, faint ticks as music stands are rattled, tiny coughs and whisperings, all without any audible hum or background noise, if the normal volume of the playing orchestra follows upon these faint sounds and practically knocks you flat—then you know that you have a fine signal-to-noise ratio! I still can't get over it, and I give all the credit to Tandberg, for it takes high quality over-all design to come out with that sort of performance. (It also takes a fine playback system, which I had—but that'll have to wait. It was a Fisher 400 system that did it for me first, stereo preamp and stereo main amplifier, hooked up to AR-3's.)

Ceramics

There's more to this tale of perfection. I made many of my tapes via a pair of ceramic mikes, of a new type, furnished by Tandberg with its recorder. They in themselves were so good that I kept thinking, "there must be something wrong here," but there wasn't. Yes, I can tell their sound from that of a high-quality professional mike. There *is* a difference. But it isn't great and few people have the ears to notice it. Other ceramics I have tried are variously harsh, strained, tinny, peaky, limited in frequency range at the top. Not these little feather-weight jobs, which go 'way up, are smooth and peak-free. (I suspect a bit of bass is sacrificed to give a higher top, which is OK with me and better than the other way around.)

They're indestructible into the bargain, these ceramics—I've practically played pingpong with them by accident on several occasions. They bounce quite nicely. And they'll do just about any job of quality recording the fussy home user is likely to want. The little things are circular, hardly bigger than a half dollar, sealed in white plastic with holes in front and a piece of green felt on the flat back for cushioning on tables. I held them in my hands, a lot of the time, or taped them to the mike stands with freezer tape. They're that light. I'm not ashamed to use these mikes, at 3¾ ips four-track, for tapes that will end up on the air, and with no explanations necessary. (They'll be copied on a full-track Ampex 350, mono.) Few FM listeners—nobobdy on AM—will hear any sort of sonic deficiency.

(Now don't misunderstand this, you professional men. I'm not claiming that this quarter-track 3¾ ips sound is technically the equal of professional recording at the customary higher speeds and wider tracks, nor that the ceramic mikes are a match for professional condensers of common usage. What is important to get straight, I think, is that the differences are for most ears so minute in view of the over-all sound quality from this equipment that its performance must be rated as extraordinary, and the sound itself rated well within the top area of quality for home performance.)

I should remark at this point that I am taking the Tandberg as a representative of its type, four-track reel-to-reel, and so far I have tried no other. Perhaps other competing machines can produce this sort of quality quarter-track sound. I suspect Ampex can do it (and with a wider frequency range on 3¾ ips, due to the ultra-narrow Ampex head gap); and, I suspect, the new Norelco from Philips in Holland can probably match Tandberg in essentials—it has a slightly smaller gap, too, for a few more highs at the very top. Other reel-to-reel four-track machines should offer similar new values. What I must make clear is that here is at least one machine that establishes a standard which is unmistakeably high enough to pin down four-track quality—this high or higher.

(*Continued on page 103*)

FILLS THE 20-30w HI-FI POWER GAP!

10-15 W	15-20 W	30-50 W
G-E 6BQ5 6DZ7	G-E 7189-A	G-E 6L6-GC

NEW

7355
BEAM POWER PENTODE

General Electric's new 7355 answers a hi-fi, stereo need that is felt sharply—for low-distortion power in the 20 to 30 watts range. Fast-selling "middle of the line" instruments require this output. Two 7355's provide it, with these advantages to the designer: (1) tube and circuit costs are economical. (2) Tube size is right—only 3″ high seated. (3) The tube quality is there—same 5-ply plate construction as the premium-performance G-E 6L6-GC. See ratings, at right, for power that is hand-tailored for medium-size hi-fi with superior tone! Further information about new Type 7355 available from any General Electric tube office below.

Max plate dissipation		18 w
Max screen dissipation, continuous		2.5 w
Max screen dissipation, peaks of speech and music		5 w
Power output for two tubes p-p Class AB_1 under following conditions:		20 w to voice coil, with only 1.8% distortion without feedback
	$E_b = 300$ v	
	$E_{c2} = 250$ v	
	$E_{c1} = -21$ v	
	$R_L = 4000$ ohms	

* * *

In addition to 5 power tubes that cover a wide output range, G.E. makes available these 4 high-quality types for other hi-fi, stereo applications:

5AR4	Rectifier tube
6CA4	Rectifier tube
7025	Low-noise twin triode for pre-amplifier use
7247	Utility low-noise double triode with dissimilar sections

200 Main Ave., Clifton, N. J.
(In Clifton) GRegory 3-6387
(In New York City)
WIsconsin 7-4065, 6, 7, 8

3800 N. Milwaukee Ave.
Chicago 41, Illinois
SPring 7-1600

11840 W. Olympic Blvd.
Los Angeles 64, Calif.
Phones: GRanite 9-7765
BRadshaw 2-8566

Progress Is Our Most Important Product

GENERAL ELECTRIC

2-211-103

EDITOR'S REVIEW

THE OUTLOOK FOR TAPE

AN INTERESTING LETTER from movie old-timer Ernest B. Schoedsack appears in the LETTERS column on page 6 of this issue. He accuses AUDIO —and other magazines as well—of conducting a campaign to discourage all interest in tape, tape recording, recorded tape, and everything pertaining to tape reproduction. Since this wasn't a form letter, we can only believe that Mr. Schoedsack has not followed our columns closely over the past few months. Our TAPE GUIDE section—started only last May—is well received, and is devoted entirely to tape.

To the charges that we have failed to review stereo tapes regularly we must admit we are guilty. On the other hand, Mr. S. will have to admit that with the introduction of the stereo disc there was a considerable reduction of interest in tape, since stereo tape was so much more costly than the newer and—let us admit it—easier-to-handle disc. However, a step forward in one field may inaugurate new developments in another in order for them to keep in step. Granted that 7½-ips tape is better than discs when played on a good machine—and we believe everyone will agree to that—few people are going to pay two or three times as much for tape as for discs, even though they all know that tape is better.

We do think that the recorded tape people did us an injustice in their pricing. Full 1200-foot reels of tape recorded monophonically on two tracks were put on the market at an average cost of about $7.95, with a playing time of one hour. The same 1200 feet of tape could provide only one-half hour of playing time with two-track stereo, and while we realize that there is more trouble in making the original recording and possibly in the duplicating process, we do not believe that a stereo tape 1200 feet long should cost around $14.95. Instead of a two-to-one price difference for stereo over mono, we were faced with almost four times the price, based on the playing time. For this reason, we believe that the recorded tape manufacturers priced themselves out of the market and that they have only themselves to blame for the slump that was caused.

Now, of course, the tape people have come up with the four-track machines, and anyone who has heard one of the later models at 7½ ips will agree that the quality compares with even the more recent 7½-ips two-track machines, and easily with older machines at 15 ips. If it is low price that the public wants—and we do not believe that price is entirely the governing factor—they can always go to the 3¾-ips four-track tapes, and price differentials between tape and disc have almost begun to favor the tape.

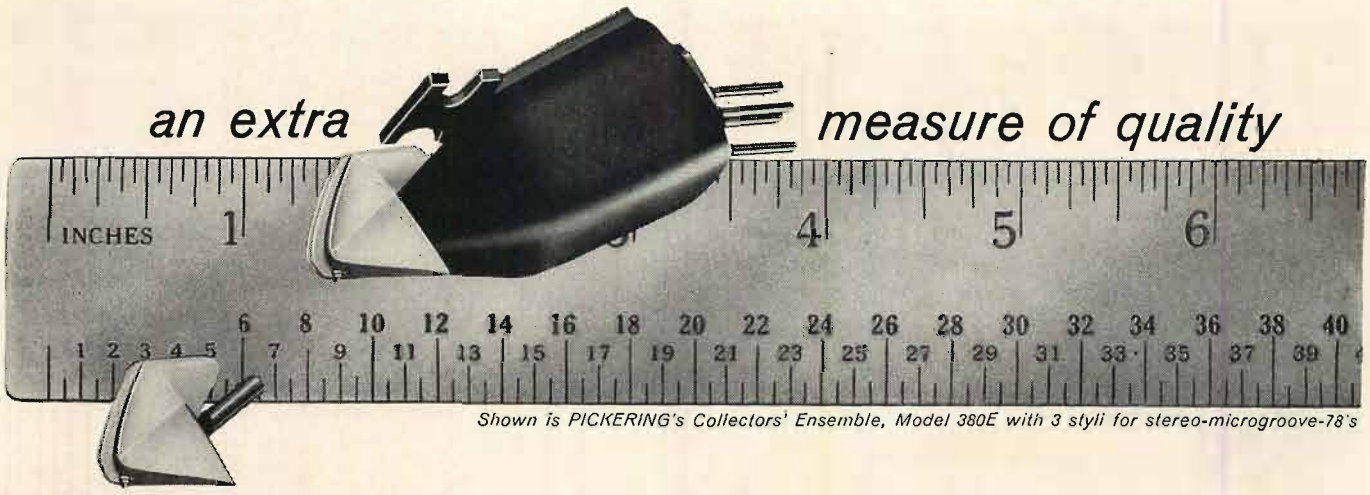
There is a lot of talk about how good the 3¾-ips tape is, and that it is "just as good" as 7½. Most certainly there have been improvements in the machines, both in respect to the mechanisms and in head construction, but we so often have to remind ourselves of what real high-quality reproduction sounds like. The LP microgroove record was a great improvement over the shellac 78's, but it was not entirely because the speed was lowered and the groove made smaller. The geometry of groove *vs.* speed favors the LP slightly, but as we have said before—and probably will again—keep at least one of Ewing Nunn's 78-microgroove Audiophile records around the house just so you can keep your feet on the ground as far as reproduction quality goes. There is as much difference between a 78 microgroove and an LP as there is between good FM reception and average AM reception —and by average we mean on the ordinary superheterodyne AM receiver, since it is not the transmitter that limits the frequency range but the narrow-band receiver.

After we were thoroughly conditioned by the jump from 78 to 33 LP, it began to be suggested that we could make the stylus still smaller and reduce the speed to 16⅔ *without any change in quality.* It may be so, theoretically, but we have not yet seen it in practice, and while the 16 did make a short introduction a year or so ago, where is it now?

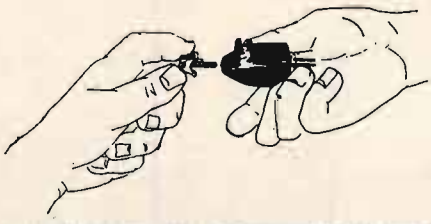
It is a human failing that one can become accustomed to a slight degradation in quality, and once accustomed to it we adopt a new standard. Another slight degradation comes along, and we become accustomed to that one, and reduce our standard just a little bit more. If this continues for awhile, we finally accustom ourselves to really poor reproduction, which is why we suggest setting up our own standard—even though it be as simple as just one 78-microgroove disc, or for the tape people (if your machine will do 15 ips) a good 15-ips original tape or a close copy of an original. As a matter of fact, it would seem likely that some of the recorded-tape companies could make a few extra dollars by providing top-quality 15-ips tapes for those who are willing to pay a little more just to have such a standard.

We hope that Mr. Schoedsack won't become too discouraged to the point where he stops looking for good tapes. We believe firmly that tape *will* come back, stronger than ever—if we admit that it ever went away, which we don't. The entire high-fidelity industry is based on quality of reproduction, not upon how fancy or how shiny the cabinet is. We think the claim for the smallest stereo "hi-fi" is nothing short of ludicrous. Not that everyone will insist upon the highest quality, but there are plenty who will, and who are willing to pay for it. Those of us who have a deep interest in audio must continue to demand quality, even if we have to eat a little less (which would probably be good for us anyway). It won't be cheap, necessarily, but it can be good.

an extra measure of quality



Shown is PICKERING's Collectors' Ensemble, Model 380E with 3 styli for stereo-microgroove-78's



Only the Stanton Stereo FLUXVALVE features the safe, comfortable, easily replaceable stylus assembly.

The extra measure of quality in every PICKERING product **adds extra value... extra convenience**...to any high fidelity system! The beautifully simple sculptured lines...the low, sleek profile...the **new** look in quality stereophonic pickups—this is the shape of good things to come—this is the PICKERING **Collectors' Series.**

Without question, the 380 is the **finest—** with more features and more flexibility than any other stereo pickup in the world. For example— the 380 is fully encapsulated in **precious mu-metal** for absolutely hum-free performance.

Visit your dealer for a demonstration today, you will love the **live, eager** response to every nuance in the record groove...you will find yourself listening to a **bright, delightful quality**...second only to the original live performance. The only true way to judge a high fidelity component is to compare it with another...measure its performance with the most vital instrument of all...the ear. Those who can **hear** the difference... choose PICKERING*.

COLLECTORS' SERIES

Totally new and unique to high fidelity is the "Collectors' Ensemble"...a complete quality "pickup-package" for reproduction of all records—stereo —microgroove—78's.

Model 380E—Collectors' Ensemble, includes the Stanton Stereo FLUXVALVE with 3 "V-GUARD" styli for stereo, microgroove and 78 rpm records **$60.00**

Model 380A—Includes Stanton Stereo FLUXVALVE with D3807A "V-GUARD" stylus for transcription arms **$34.50**

Model 380C—Includes Stanton Stereo FLUXVALVE with D3807C "V-GUARD" stylus for auto-changer arms **$29.85**

PRO-STANDARD SERIES

It may interest you to know that in one short year, PICKERING'S Pro-Standard Series has become an industry standard...the universal choice of professionals. Now, the new and revolutionary PAC* technique developed by PICKERING has effected economies in manufacture which permit a reduction in the price of the Pro-Standard Series.

Model 371A Mk II Stanton Stereo FLUXVALVE Pickup now **$26.40**

Model 371C Mk II Stanton Stereo FLUXVALVE Pickup now **$24.00**

Model 196 Mk II UNIPOISE Arm with integrated Stanton Stereo FLUXVALVE Pickup now **$49.50**

*PICKERING AUTOMATED CRAFTSMANSHIP

FLUXVALVE, "V-GUARD," "T-GUARD," UNIPOISE, PAC ®

PICKERING — for more than a decade— the world's most experienced manufacturer of high fidelity pickups... supplier to the recording industry.

FOR THOSE WHO CAN HEAR THE DIFFERENCE

Pickering

PICKERING & CO., INC., PLAINVIEW, NEW YORK

NEW EXPERIMENT IN TELEPHONY

It could speed up "dialing." Bell Laboratories people created it—and now it's being tested.

The telephone you see above embodies an important new concept. It "dials" by means of push buttons—promises more convenient telephoning. Bell System engineers are currently testing it for public reaction. Bell Telephone Laboratories developed it.

The Laboratories' invention of the transistor makes it possible. For the transistor permits a new kind of calling signal generator, mounted within the instrument.

To insure ease of operation, psychologists studied human reactions to various finger pressures and sizes and arrangements of buttons. All factors affecting speed and accuracy were thoroughly evaluated. Electrical and mechanical engineers brought together the human and physical factors, created a practical piece of apparatus. Industrial designers worked out the functional shape.

The new instrument sends a calling signal quite different from that of your present telephone. This poses a problem. Complex automatic switching must be changed to handle the new signals as well as the old ones. Switching engineers must devise ways to make this change in *thousands* of central offices—economically.

Most of the challenges have been met. Final judgment on this new concept depends on the outcome of field tests. Meanwhile, Bell Laboratories continues in its task of originating and developing devices to improve your Bell System telephone service.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

FM Commercial Eliminator for Fringe Areas

RONALD L. IVES*

Many FM stations are still simplexing background music programs with 20 k-c beep tones to kill announcements on their subscribers' leased sets. Here is a device which will work as an adjunct to any set.

MANY OF OUR FM stations broadcast a 20-kc "beep" signal along with commercials and pleas for subscriptions, so that receivers with selective relays emit only instrumental music, and are silent during chin music. As the commercials become more long-winded and offensive, their elimination becomes increasingly desirable.

Relatively simple circuits for eliminating commercials from the stations that broadcast "beep" signals have been published one by Stoner[1], being typical of the more practical. This type of circuit works very well in strong and moderate signal areas, for which it is designed, but is somewhat undependable in fringe areas, where signals tend to be weak.

Several highly sensitive selective amplifier-relay combinations are commercially available at relatively high cost, most of them using either complicated L-C filter combinations, or twin-T feedback amplifiers. Tests with several of these showed that, in addition to high cost and power consumption, they were too selective, so that they needed continual readjustment to follow the minor variations in the "beep" frequency put out by the FM station. Needed, for this application, was a selective amplifier capable of operating a relay when the input was about 50 mv at 20 kc ± 1 kc.

After some computation and experimentation, the amplifier of *Fig.* 1 was developed. This uses only two dual triodes, and develops an output of 55 volts negative with an input of only 40 mv from 19 to 21 kc. All parts are standard "over the counter" items, and construction is simple and straightforward. So that both speaker interruption, by use of a relay, and biasing off of the first a. f. tube could be used, as desired, dual outputs are provided on this chassis, which is considerably larger than is needed for either type of operation singly. Power supply used here is also much larger than is necessary.

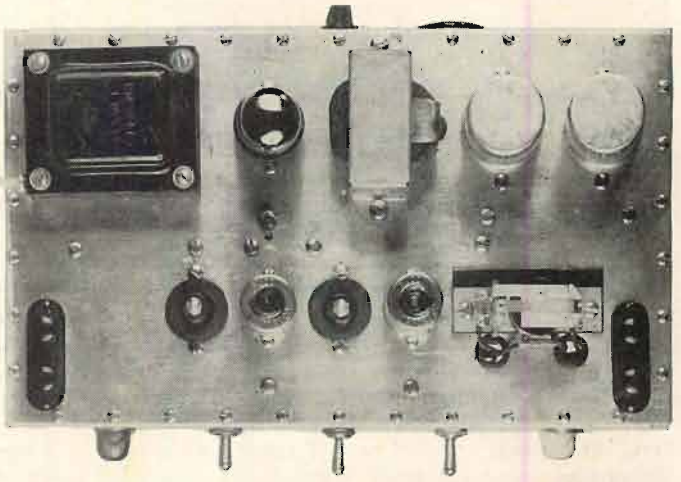


Fig. 1. Sensitive "beep" amplifier and relay, with power supply.

Circuit of this selective amplifier, with alternative output modes, and two alternative power supplies, is shown in *Fig.* 2. Several other rather obvious alternatives can be used without impairing operation of the device, which has no critical adjustments except tuning.

Operation of the selective amplifier is standard, and is much like that of an i. f. system less avc. Input, taken from the FM detector circuit ahead of the de-emphasis network, is applied across the first tuned circuit, through a 220-k resistor. At the frequency to which this circuit is tuned, 20 kc, a high voltage is applied to the grid of V_{1a}. At all other frequencies, a very much lower voltage is applied to this same grid.

Amplification of the signal applied to the grid occurs in the tube, and its output is applied across another tuned circuit, where the process repeats, energizes the grid of V_{1b} greatly if the signal is at 20 kc, and negligibly at all other frequencies. A third amplification takes place in V_{2a} in the same manner, and the amplified output of this tube is full-wave rectified by the two diodes in the output circuit. This is filtered by the .02 μf capacitor and 1-meg. resistor in the output, and regulated by the NE-51 lamp, which also serves as a "beep" pilot. If only a bias output (here −55 volts) is desired, output is taken from A-A, and V_{2b} can either be omitted or used for something else. If relay operation is desired, the bias voltage developed across the output of the rectifier is applied to the grid of V_{2b}, effectively cutting it off, and opening the contacts across B-B as the relay armature is released due to no plate current in the relay coil.

In some instances, the input resistor, here evaluated at 220 k ohms, can be increased considerably, reducing the loading effect of the amplifier on the FM detector. Increasing the resistance from 220 k ohms to 1 megohm reduces the sensitivity of the amplifier from 40 millivolts for full output to 55 millivolts for full output.

Power-supply requirement is approximately 6.3 volts at 0.8 amperes for filaments and pilot and 300 volts at 20 ma for plates. This can safely be "robbed" from many receivers. Where this is not possible or desirable, a separate power supply must be provided. That shown at (A) in *Fig.* 2 works excellently, but is much larger than necessary. Alternative plate circuits shown at (B) and (C) work well, and not only use an electrically smaller transformer, but also generate much less heat. An electrolytic capacitor can be used in place of the 4 μf paper capacitor shown at (B), but a larger capacitance is usually necessary,

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

1 Stoner, D. L. "How to beep out FM commercials", *Pop. Electron.* March, 1957.

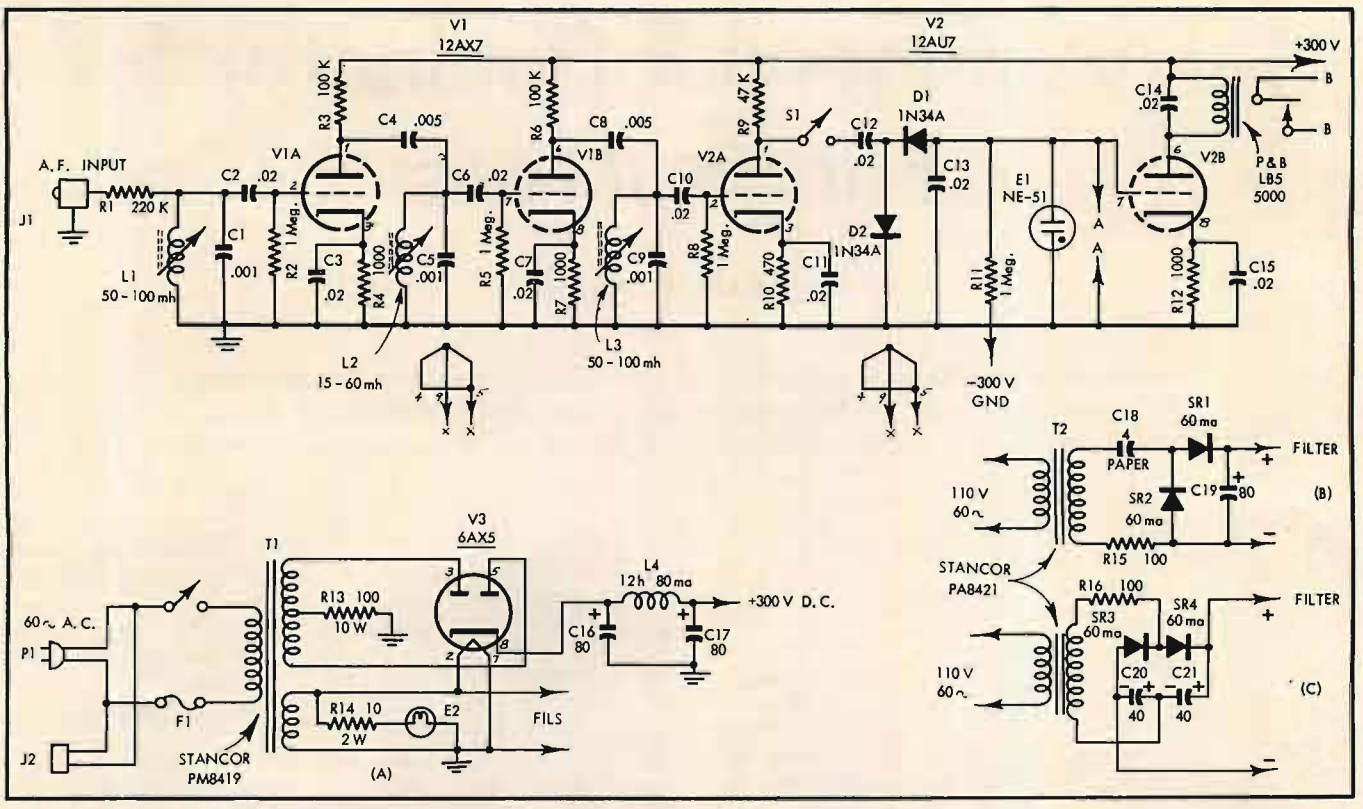


Fig 2. Circuit of sensitive 20-kc selective amplifier, with two output modes and three optional power supplies.

as electrolytic capacitors do not release their charges instantaneously. A BR-845 capacitor (8 μf. 450 volts) works well here, but a similarly rated unit of other manufacture may not work identically.

The first and third inductances here are high-grade cup-core inductances, and use of such self-shielded coils is essential here to prevent oscillation, unless rather complete shielding is installed. The second coil is unshielded, as it has nothing

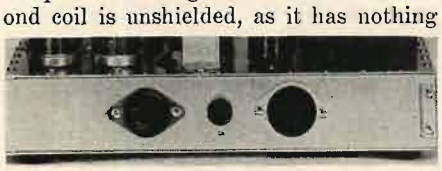


Fig. 3. A.c. connections and fuse on rear chassis apron.

to couple to, with the other coils having no external fields.

Layout and Construction

Construction is entirely straightforward, and not only requires no special techniques, but component arrangement can be modified to suit individual conditions and tastes without affecting performance. The model illustrated, which has both bias and relay outputs, and an oversize power supply, was constructed on a 7" by 12" by 2" Seezak chassis. With single output mode and either of the alternative power supplies shown in *Fig.* 2, a chassis 5" by 9" by 2" will be more than adequate.

Power supply is arranged in linear fashion along the rear of the chassis, with the choke interposed between the rectifier tube and the electrolytic capacitors to protect them from tube heat. Power input and fuse are mounted on the rear chassis apron, as in *Fig.* 3. An a.c. outlet is wired in parallel to the input plug ahead of the fuse and switch to take care of the chronic shortage of outlets in electronic installations.

Pilots and controls are mounted on the front chassis apron, as in *Fig.* 4. These can be rearranged to suit conditions and personal preferences except that the leads to the disabling switch, in the plate circuit of V_{2a} should be short and not too close to the input, or unwanted positive feedback may result.

Tuned circuits are arranged for convenience in wiring, and tuning capacitors (.001 μf tubular ceramics) are mounted directly on the inductor terminals. While power leads are cabled, signal leads are wired point to point. Output rectifier and other related components are mounted on a small terminal board, as in *Fig.* 5. As will be noted in this figure, the filter capacitors are mounted in Cinch sockets, to facilitate replacement. As with most components which are easy to change, they never seem to need it.

Adjustments

To align and adjust this amplifier, determine the "beep" frequency in use at the FM station in which you are interested. This is usually 20 kc, and can be determined by asking some stations, by use of an a. f. frequency meter, or by use of an oscilloscope. Set an audio oscillator to this same frequency to produce a steady input of the desired frequency. Set the output of the oscillator to a convenient low value, such as 100 millivolts.

(*Continued on page 99*)

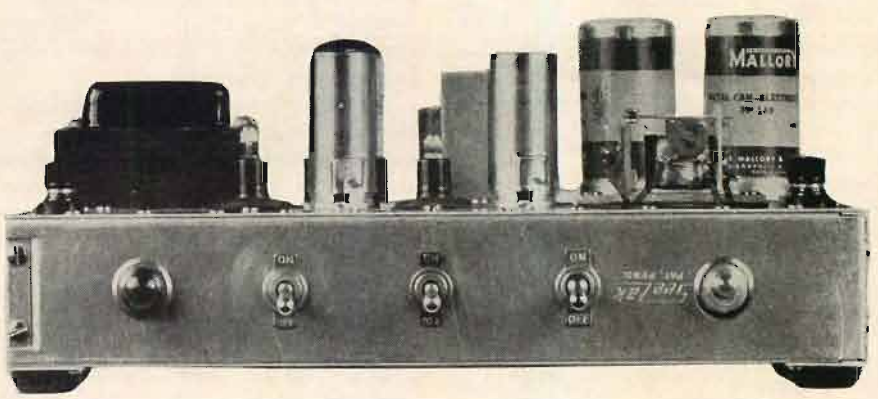


Fig. 4. Pilots and controls on front chassis apron. Components, from left to right, are: power pilot, power switch, disabling switch, mode switch, and output pilot.

The "Stereo-Plus" System

Finding a source of signal for the center-channel speaker when its use is desired because of wide speaker spacing is simplified considerably by the method proposed by these authors.

RICHARD SHOTTENFELD* and WALTER STAUDT*

TO ACHIEVE WIDEST ANGLE stereo sound, the separation between speakers should be made as great as possible. As the spacing between two stereo speakers is increased, the apparent sound source becomes broader. Ultimately, a spacing is reached beyond which the width no longer increases. Instead, the single apparent sound source divides into two—one localized at each of the speakers. The central area between the two speakers tends to become a zone of silence, sometimes referred to as the "hole in the middle."

Prolonged listening to excessively spaced speakers is tiring because attention repeatedly swings from speaker to speaker. Where decor, room size, or the desire for a relatively broad source of sound require very wide speaker spacing, a third, centrally located, speaker system can recreate the sounds that originated at the center of the stage. To do this the center channel speaker *must* be driven by a signal which is proportional to the *sum* of Channel A *plus* Channel B.

One system that has been proposed, and currently is in limited use, is shown in *Fig.* 1. This takes signals from Channel A and Channel B speaker terminals and combines them in a resistive summing network.[1] The resultant *sum* signal voltage must then be applied to a *third* power amplifier that drives the center-channel speaker. This system is effective, but the requirement for a third power amplifier channel is a serious disadvantage.

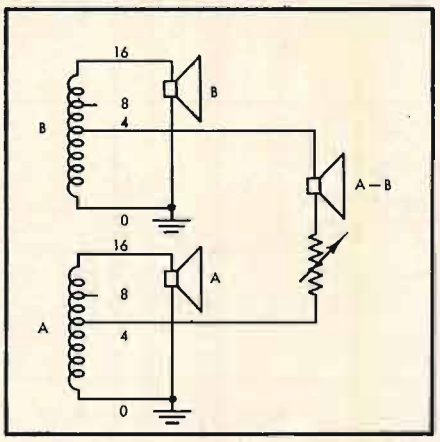


Fig. 2. Center-channel signal resulting from direct connection between corresponding impedance taps. With identical amplifiers, the signal to the center speaker is zero on in-phase or monophonic program material.

Another system, intended to avoid the need for a third amplifier channel and shown in *Fig.* 2, connects the center-channel speaker between speaker output terminals of the same impedance of Channels A and B.[1] A speaker so connected responds to the *difference* between Channel A and Channel B signals. Monophonic programs and the portions of stereo programs that originated at center stage produce identical signals at Channel A and Channel B output. The difference between identical signals is zero; therefore the center speaker will not re-create center-stage sounds, and will produce no sound from monophonic signals.

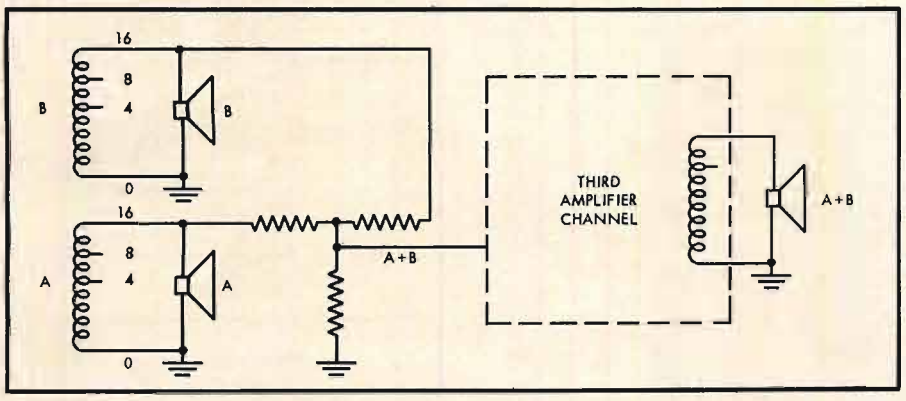


Fig. 1. Center-channel sum-signal circuit requiring a third power amplifier.

Phase-Shift System

In an attempt to avoid the shortcomings of the *difference* signal of *Fig.* 2, or the additional amplifier required with the *sum* signal of *Fig.* 1, a third system has been suggested.[2] This system, shown in *Fig.* 3, uses an all-pass network in the output of one channel to shift the frequencies at the center of the audio spectrum by 90 deg. The intent is to avoid zero output from the center speaker when identical signals appear at the output of both channels. Aside from the practical problems of constructing such a network, the effectiveness of a 90-deg. phase shift, limited to the center of the audio spectrum, is questionable.

The authors have also investigated a number of alternative systems for directly driving the center-channel speaker with a signal which is proportional to the *sum* of Channel A *plus* Channel B. The basic requirement is for two equal voltages, one from Channel A and the other from Channel B, which can be connected series-aiding to the center speaker.

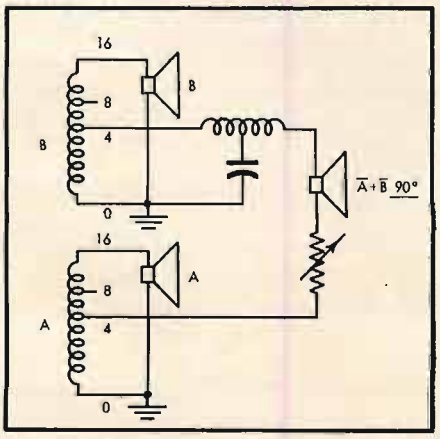


Fig. 3. Center-channel signal derived from 90-deg. phase-shift network to avoid zero output on monophonic signals.

The most obvious method, which can be used with any existing amplifier, requires a 1:1 ratio transformer for inverting the phase of the output of one

* *Pilot Radio Corporation, Long Island City 1, New York.*

[1] Paul W. Klipsch, "Stereophonic sound with two tracks, three channels by means of a phantom circuit." *JAES*, April, 1958.

[2] Paul W. Klipsch, "Three-channel stereo playback of two tracks derived from three microphones." *IRE Trans PGA*, March–April, 1959.

(*Continued on page 115*)

Transistorized Band-Pass Filter

CHARLES R. MILLER*

A simple transistor circuit which can be used as described for band-pass action, or either high-pass or low-pass filters may be used alone. With still further modification, the circuit becomes a crossover network.

With the advent of the stereophonic record, two old problems have once again presented themselves—the extraneous noises at the frequency extremes, caused respectively by turntable rumble and record wear. Rumble is obviously important in stereo, as the stereo pickup is inherently sensitive to vertical motion of the stylus. Similarly, since the signal amplitudes in stereo must be lower than in monophonic reproduction, the high-frequency noises are also more troublesome. A solution to both of these problems is a sharp-cutoff filter for both low and high frequencies, so that the full bandwidth is used only when the program material warrants it. Recent work in active filters has made it possible to accomplish these ends with a simple transistorized filter to be described.

Consider the circuit of *Fig.* 1: it can be shown that the voltage gain is given by

* *46 Schenck Ave., Great Neck, N. Y.*

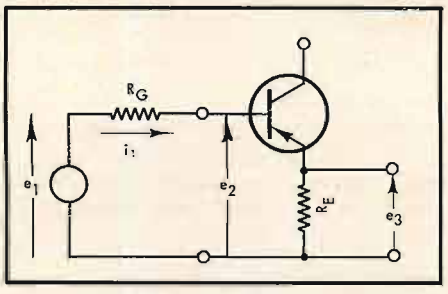


Fig. 1. Simplified circuit of emitter follower.

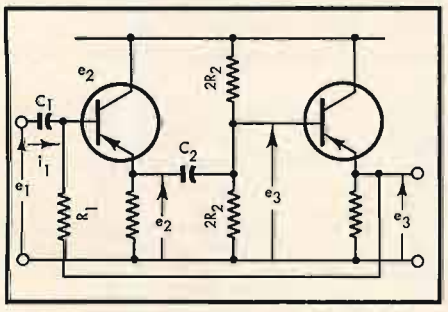


Fig. 2. High-pass filter configuration.

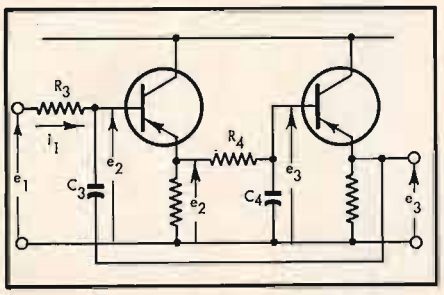


Fig. 3. Low-pass filter configuration.

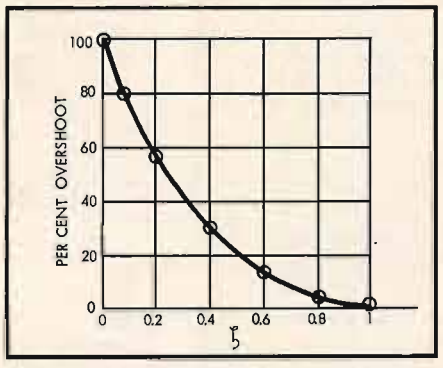


Fig. 4. Plot of overshoot vs. ζ (From "Automatic Feedback Control System Synthesis," J. Truxal, p. 39.)

$$\frac{e_2}{e_1} = \frac{\beta R_E}{\beta R_E + r_{bb} + \dfrac{1}{g_{b'e}}} \qquad (1)$$

and that the input impedance will he

$$\frac{e_2}{i_1} = r_{bb} + \frac{1}{g_{b'e}} + \beta R_E \qquad (2)$$

If we use a 2N109 transistor and make $R_g = 10{,}000$ and $R_e = 4000$, the gain is approximately 0.97 and the input impedance 362K. Thus it is seen that a simple emitter follower can do an excellent job within its frequency and signal handling limitations. In the foregoing analysis, it will be assumed that the gain is exactly unity and the input impedance infinite.

Consider next the circuit of *Fig.* 2, which uses the above approximations. The respective equations will be

$$e_2 = e_1 - i_1\left(\frac{1}{C_1 S}\right) \text{ where } S = j2\pi f \qquad (3)$$

$$e_3 = e_2\left(\frac{R_2}{R_2 + \dfrac{1}{C_2 S}}\right) = \frac{e_2 R_2 C_2 S}{1 + R_2 C_2 S} \qquad (4)$$

$$i_1 = \frac{e_1 - e_3}{R_1 + \dfrac{1}{C_1 S}} = \frac{(e_1 - e_3) C_1 S}{1 + R_1 C_1 S} \qquad (5)$$

If we combine these equations and solve for the gain, we have

$$\frac{e_3}{e_1} = \frac{R_1 R_2 C_1 C_2 S^2}{S^2 R_1 R_2 C_1 C_2 + S R_1 C_1 + 1} \qquad (6)$$

This is of the form $\dfrac{S^2}{S^2 + 2\omega_1 \zeta S + \omega_1^2}$

where

$$\omega_1 = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}} \text{ and } \zeta = \frac{1}{2}\sqrt{\frac{R_1 C_1}{R_2 C_2}},$$

which can be shown to give a high pass filter of frequency cutoff ω_1 and damping factor ζ.

In a similar way, look at the circuit of *Fig.* 3, which also uses the approximations that an emitter follower has unity gain and infinite input impedance.

$$e_2 = e_1 - i_1 R_3 \qquad (7)$$

$$e_3 = e_2\left(\frac{\dfrac{1}{C_4 S}}{R_4 + \dfrac{1}{C_4 S}}\right) = \frac{e_2}{1 + R_4 C_4 S} \qquad (8)$$

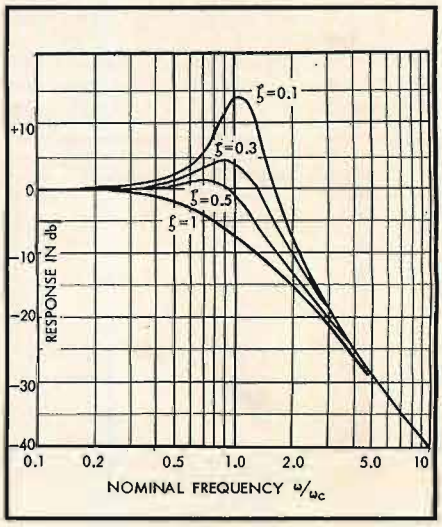


Fig. 5. Plot of frequency response vs.

Fig. 6. Schematic of band-pass filter employing transistors.

$$i_1 = \frac{e_1 - e_3}{R_3 + \frac{1}{C_3 S}} = \frac{(e_1 - e_3) C_3 S}{1 + R_3 C_3 S} \qquad (9)$$

Again if we combine these equations and solve for the gain,

$$\frac{e_3}{e_1} = \frac{1}{S^2 R_3 R_4 C_3 C_4 + R_4 C_4 S + 1} \qquad (10)$$

which has the form $\frac{\omega_2^2}{S^2 + 2\zeta\omega_2 S + \omega_2^2}$,

where

$\omega_2 = \frac{1}{\sqrt{R_3 R_4 C_3 C_4}}$ and $\zeta = \frac{1}{2}\sqrt{\frac{R_4 C_4}{R_3 C_3}}$. By the same process, this can be shown to give a low pass filter of frequency cutoff ω_2 and damping factor ζ.

If we plot per cent overshoot to a square-wave input against ζ, we get the curve shown in *Fig.* 4, and if we plot the frequency response for various values of ζ, we get the curves of *Fig.* 5. With the quadratic responses of equations (*6*) and (*10*), it is possible to make any desired compromise between overshoot and performance near the cutoff frequency. The writer has chosen a ζ of 0.55, which

Fig. 7. Frequency response of circuit of Fig. 6.

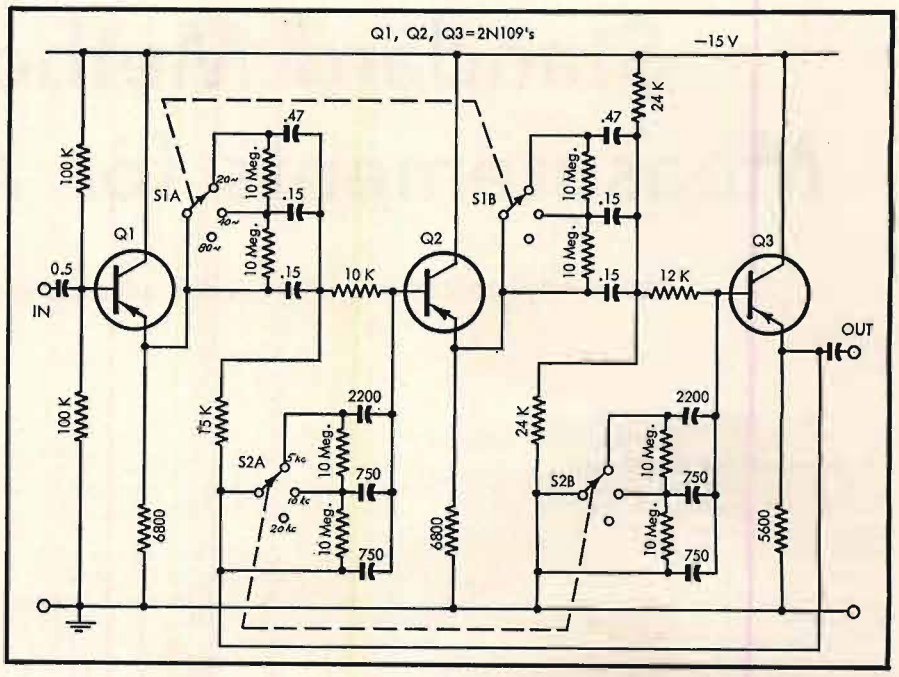
gives nearly maximal flatness and also makes the capacitors come out near EIA standard values.

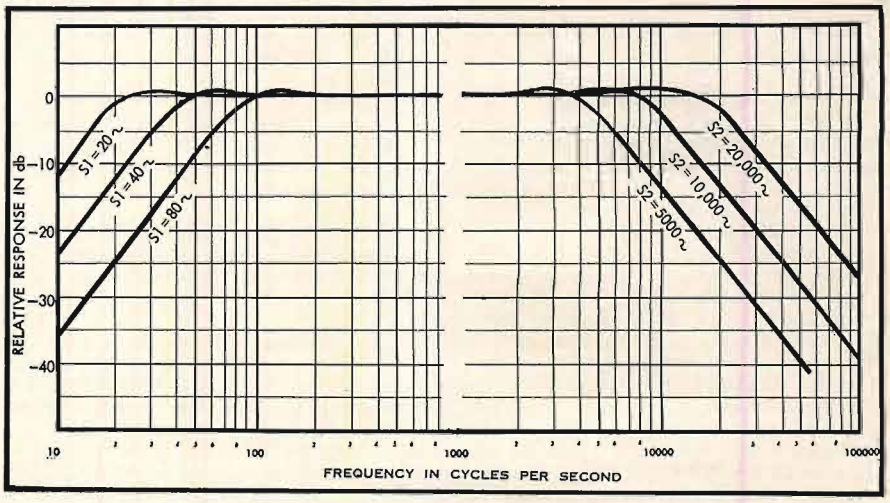
Combined Circuit

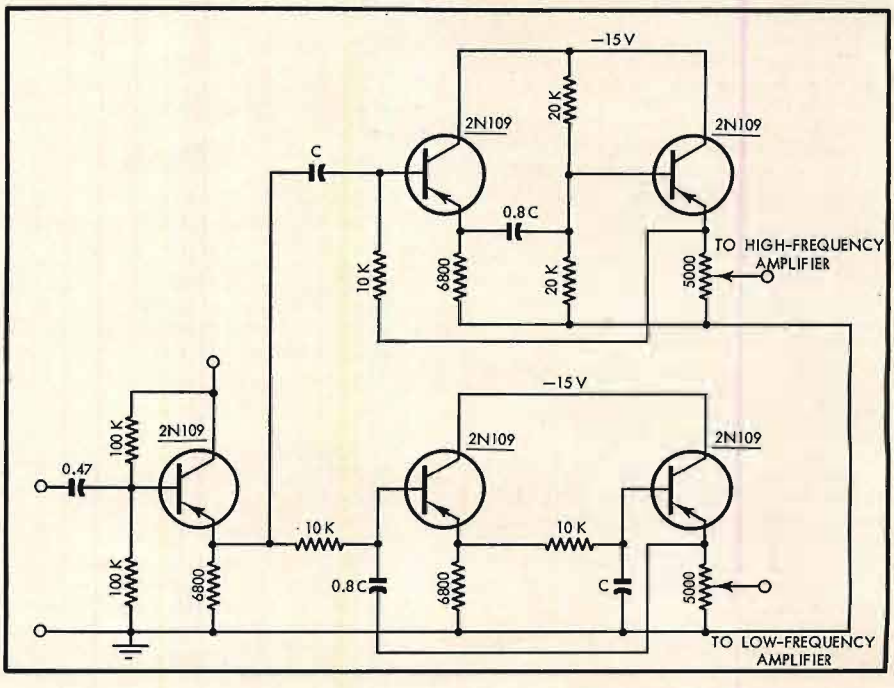
The two circuits mentioned can be combined into a single circuit as shown in *Fig.* 6, with the corresponding response of *Fig.* 7. Measurements showed that for input levels up to 1 volt rms the distortion was negligible and that just below the overload point of 3 volts rms, the distortion was of the order of 0.5 per cent for any frequency within the pass band. Hum and noise are dependent on the supply voltage; with battery operation the noise level will be of the order of 88 db below the 1 volt rms design. One further word of caution—the circuit equations show that the performance will be affected by the driving impedance. That is the reason for the additional emitter follower, Q_1, in *Fig.* 6.

The two original circuits can also be combined in parallel instead of being intermeshed. If the cutoff frequencies are made the same, the circuit of *Fig.* 8 makes an excellent electronic crossover for bi-amplifier operation. AE

Fig. 8. Circuitry for electronic crossover filter. Cutoff frequencies are the same for both sections.







Standard Methods of Measurements for Amplifiers

The complete text of IHFM-A-200 adopted in December, 1958

1.0. Standard Test Conditions

Standard test conditions shall be maintained for all tests except as otherwise specified.

1.1. Power Line Voltage

The amplifier shall be tested on 117 volts, RMS.

1.2. Power Line Frequency

Power line frequency shall be within ±2% of the lowest supply frequency for which the amplifier is rated.

1.3. Power Line Voltage Waveform

Power line voltage waveform shall be sinusoidal with less than 2% harmonic content.

1.4. Operating Temperature

The amplifier shall be preconditioned by operating at ⅓ rated power output for at least one hour in an ambient temperature not less than 20° C. in still air, and in normal operating position unless otherwise specified (Reference *1.8.*).

1.5. Vacuum Tube Characteristics

Where the performance of the amplifier is significantly affected by one or more tube characteristics, tests shall be made using selected tubes in which these critical characteristics are within ±10% of the significant published characteristics.

1.6. Signal Input

1.6.1.

Signal input waveform shall be sinusoidal with the RMS total of all components, other than the fundamental, less than 20% of rated harmonic distortion of the amplifier to be tested, at the level of measurement.

1.6.2.

Frequency shall be within ±2% of value specified for test.

1.7. Load

1.7.1.

Amplifiers rated to supply signal power to one or more loudspeakers shall be terminated in a resistance load, with not more than 10% reactive component at any frequency up to five times the highest test frequency, capable of continuously dissipating the full output of the amplifier while maintaining its resistance at the rated value of ±1%.

1.7.2.

When more than one output impedance is provided, each one in turn shall be terminated with a resistance load as in *1.7.1.* and the test repeated.

1.7.3.

Amplifiers intended to supply signal voltages to the input circuit of a subsequent amplifier shall be terminated by a load consisting of a 0.1-megohm ±5% resistor shunted by a 1000 μμf ±5% capacitor unless otherwise specified by the manufacturer.

1.7.4.

An amplifier intended for simultaneously supplying signal power for loudspeakers and a signal voltage to a subsequent amplifier shall be tested with one load per *1.7.3.* and one load per *1.7.1–1.7.2.* in place.

1.8. Shields, Covers, and Bottom Plates

If normally supplied, shields shall be in place and fastened. If accessory cases are available, the one resulting in the highest operating temperature shall be used.

1.9. Connection of Line Cord

The line cord shall be connected for minimum hum on the highest gain input and shall not be changed for any other test. One side of the power source to the amplifier shall be grounded.

1.10. Controls

1.10.1.

GAIN, LEVEL, and other controls whose primary function is the adjustment of gain shall be preset to the position of maximum gain.

1.10.2.

TONE, LOUDNESS-CONTOUR, and other controls whose primary function is adjustment of frequency response shall be preset for flattest *electrical* frequency response.

1.10.3.

For controls that vary both gain and frequency response, such as LOUDNESS controls, the position of flattest electrical frequency response shall take precedence over the position for maximum gain.

1.10.4.

Automatic controls actuated by signals within the system shall be disabled.

2.0. Tests and Ratings

2.1. Output

2.1.1. Purpose

To measure and express the capability of an amplifier to supply signal energy to its load.

2.1.2. Definition of Terms

2.1.2.1.

CONTINUOUS POWER OUTPUT shall mean the greatest single-frequency power that can be obtained for a period of not less than 30 seconds without exceeding rated total harmonic distortion when the amplifier is operated under STANDARD TEST CONDITIONS. POWER OUTPUT shall be expressed in terms of watts as defined by the formula

$$P = \frac{E^2}{R}$$

P = POWER OUTPUT
E = RMS voltage across load
R = Resistance of the load in ohms.

2.1.2.2.

MUSIC POWER OUTPUT shall mean the greatest single-frequency power that can be obtained without exceeding rated total harmonic distortion when the amplifier is operated under STANDARD TEST CONDITIONS except that the measurement shall be taken immediately after the sudden application of a signal and during a time interval so short that supply voltages within the amplifier have not changed from their no-signal values.

2.1.2.3.

VOLTAGE OUTPUT shall mean the RMS voltage developed across the load of paragraph *1.7.3.*

2.1.3. Test Procedure

2.1.3.1. Measurement of CONTINUOUS POWER OUTPUT

2.1.3.1.1.

Operate amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*)

2.1.3.1.2.

Adjust INPUT FREQUENCY to value specified for the test.

2.1.3.1.3.

Adjust SIGNAL INPUT LEVEL to the maximum value for which the total harmonic distortion percentage is the same as the rated distortion for the amplifier.

2.1.3.1.4.

Measure the RMS voltage across the load.

2.1.3.1.5.

Compute the POWER OUTPUT by the formula of *2.1.2.1.*

2.1.3.1.6.

Accuracy of measurement shall be sufficient to assure statement of the POWER OUTPUT within ± ½ db.

2.1.3.2. Measurement of MUSIC POWER OUTPUT

2.1.3.2.1.

Operate amplifier under STANDARD TEST CONDITIONS with no signal applied and note significant supply voltages.

2.1.3.2.2.

Perform procedure of *2.1.3.1.1.* through *2.1.3.1.6.* except that the significant supply voltages shall be maintained at the same value as they were under no-signal conditions.

2.1.3.3. Measurement of VOLTAGE OUTPUT

Perform the tests of *2.1.3.1.1.* through *2.1.3.1.4.* inclusive.

2.1.4. Rating of Power Output

2.1.4.1.

It shall be standard to rate power amplifiers in terms of MUSIC POWER OUTPUT and/or CONTINUOUS POWER OUTPUT at the standard frequency of 1000 cycles per second except that split-frequency range amplifiers shall be tested as in *2.1.4.3.*

2.1.4.2.

It shall be standard to rate voltage amplifiers in accordance with the definitions of *2.1.2.4.* obtained by using the procedure of *2.1.3.3.* for the standard test frequency of 1000 cps except that split-frequency-range amplifiers shall be tested as in *2.1.4.3.*

THE NEW TURNTABLE THAT CHANGES RECORDS!

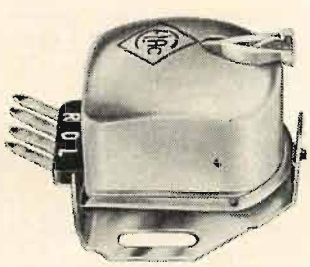
The Push-Button Miracle for stereophonic and monophonic high fidelity sound!

MIRACORD XS-200

The pushbutton miracle of high fidelity sound—with *every* practical and proven feature for the perfect reproduction of stereophonic or monophonic records.

- it's a heavyweight, professional-type turntable—*and* a fully-automatic changer!
- a special switch adapts Miracord to stereophonic or monophonic reproduction, with finest quality output on either system!
- vibration eliminated by special mounts!
- 5 push-buttons permit you to start, stop, pause, repeat or filter, without touching tone arm!
- Magic Wand spindles eliminate pusher platforms and stabilizing arms!
- intermixes 10" and 12" in any sequence; plays all 4 speeds, has a 4-pole motor. Plug-in head!
- shuts off automatically, returns tone arm to rest position!
- and many other outstanding features, not found in any other record changer or record player!

—yet it costs only $67.50



STEREOTWIN 210/D

a thrilling new standard in a stereo cartridge!

Acclaimed by engineers and audiophiles, STEREOTWIN 210/D is the finest cartridge for the stereo age. "Moving-magnet" principle gives new high in quality performance. Hum is eliminated by Mu-Metal casing.
Stylus replacement is instant. Phenomenal separation: 22 db at 1000 cps.
EXCLUSIVE ADJUSTMENT puts stylus in proper position both vertically and horizontally for record changers or manual tone arms.
Truly an audio engineer's cartridge at an audiophile's price!

NOW $34.50

FAR AHEAD > THE FINEST BY FAR **Available at selected dealers.**

For Free catalogue, please write Dept. A

AUDIOGERSH CORP.
514 Broadway, New York 12, N.Y. WORTH 6-0800

2.1.4.3. Split-Frequency-Range Amplifiers

The low-frequency channel shall be tested at a frequency at least two octaves below the crossover frequency. The high-frequency channel shall be tested at a frequency at least two octaves above the crossover frequency.

2.1.5.

POWER BANDWIDTH is intended to express the CONTINUOUS POWER (*2.1.2.1.*) handling *vs.* frequency capabilities for the rated total harmonic distortion. It shall be standard to rate amplifier POWER BANDWIDTH by stating the lowest frequency and the highest frequency for which the total single-tone distortion measured 3 db below rated CONTINUOUS POWER OUTPUT, will be equal to the rated single-tone distortion.

2.2. Sensitivity

2.2.1. Purpose

To measure and express the minimum SIGNAL INPUT required to produce rated POWER OUTPUT.

2.2.2. Definition of Terms

2.2.2.1.

SENSITIVITY for a power amplifier shall mean the INPUT VOLTAGE LEVEL, expressed in millivolts or volts, which, when applied to the input terminals of an amplifier operating under STANDARD TEST CONDITIONS (paragraph *1.0.*), will develop rated power in the load.

2.2.2.2.

SENSITIVITY for a voltage amplifier shall mean the INPUT VOLTAGE LEVEL, expressed in millivolts or volts, which, when applied to the input terminals of an amplifier operating under STANDARD TEST CONDITIONS (paragraph *1.0.*), will develop rated voltage across the load.

2.2.3. Test Procedure

2.2.3.1.

Operate amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*)

2.2.3.2.

For each input in turn, apply sufficient INPUT SIGNAL LEVEL at 1000 cps to develop rated power or voltage.

2.2.4. Ratings

It shall be standard to express the SENSITIVITIES at the various inputs of an amplifier by a tabulation of the values obtained in the test procedure of *2.2.3.*

2.3. Frequency Response

2.3.1. Purpose

To measure and rate the accuracy with which the FREQUENCY RESPONSE of an amplifier conforms to EQUALIZER FREQUENCY RESPONSE as defined in *2.3.2.2.* and to FLAT FREQUENCY RESPONSE as defined in *2.3.2.3.*

2.3.2. Definition of Terms

2.3.2.1.

FREQUENCY RESPONSE shall mean the variation in voltage gain as a function of frequency when the amplifier is operated under STANDARD TEST CONDITIONS (paragraph *1.0.*).

2.3.2.2.

EQUALIZER FREQUENCY RESPONSE shall mean one or more of the named and recognized frequency characteristics.

2.3.2.3.

FLAT FREQUENCY RESPONSE shall mean constant output voltage for constant INPUT VOLTAGE LEVEL independent of frequency.

2.3.2.4.

ZERO-REFERENCE FREQUENCY shall be 1000 cps for flat inputs and the standard reference frequency for each equalizer characteristic.

2.3.3. Test Procedure

2.3.3.1.

Operate amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*) with measured INPUT SIGNAL LEVEL for every test frequency.

2.3.3.2.

Adjust INPUT SIGNAL LEVEL to develop a measured output across the load. This output shall be no higher than 10 db below rated output and no lower than 20 db above residual noises.

2.3.3.3.

Measure the voltage gain at ZERO-REFERENCE FREQUENCY (*2.3.2.4*). Use this voltage gain as a reference gain.

2.3.3.4.

Measure the voltage gain at various test frequencies between specified frequency limits for flat channels and between frequency limits as defined by the equalizer characteristic for equalized inputs.

2.3.3.5.

Compute the ratio in db of the gain obtained from *2.3.3.4.* to the ZERO-REFERENCE GAIN of *2.3.3.3.*

2.3.3.6.

Repeat *2.3.3.1.* through *2.3.3.5.* for each frequency characteristic to be rated (equalizers, tone controls, etc.).

2.3.4. Ratings

2.3.4.1.

It shall be standard to express the FREQUENCY RESPONSE of flat-frequency-response channels by a curve with the result of *2.3.3.5.* plotted as the ordinate on semi-logarithmic paper. The relation between db and frequency scales on the curve shall be such that a 20-db change on the ordinate shall correspond in length to one decade of frequency variation on the abscissa.

2.3.4.2.

It shall be standard to express the FREQUENCY RESPONSE of equalized input channels as the difference between the db response obtained in *2.3.3.5.* and that of the standard equalization.

2.3.4.3.

It shall be standard to rate the frequency response of each equalized channel and of each flat-frequency-response channel by two numbers which shall be equal to the maximum positive and maximum negative deviation from the response at ZERO-REFERENCE FREQUENCY shown in the curve of *2.3.4.1.*

2.4. Distortion

2.4.1. Purpose

To measure and rate the distortion of an amplifier.

2.4.2. Definition of Terms

2.4.2.1.

For the purposes of this standard, distortion shall mean the presence of frequency components in the output which were not present in the input signal.

2.4.2.2.

Single-tone distortion shall mean the distortion resulting when a single-frequency input is applied.

2.4.3. Test Procedure

2.4.3.1. Single-Tone Distortion

For this test, the indicating instrument shall have full wave rectifying characteristics, shall respond to the average value, and shall be calibrated to indicate the RMS value of a sinusoidal waveform.

2.4.3.1.1.

Operate the amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*).

2.4.3.1.2.

Apply a signal input at frequency specified for the test.

2.4.3.1.3.

Measure voltage at output and designate by the symbol E_o.

2.4.3.1.4.

Remove the component of the output voltage corresponding to the input voltage waveform and measure the value of the residual components and designate by the symbol E_R.

2.4.3.1.5.

Compute the per cent distortion from the formula:

$\frac{E_R}{E_o} \times 100$ for the power output level given by

$$P = \frac{E_o^2}{R_{load}}$$

2.4.3.2.

The distortion reading obtained with the signal source connected to the distortion-measuring instrument shall be less than 1/5 of the measured distortion of the amplifier under test.

2.4.4. Ratings

2.4.4.1.

It shall be standard to rate distortion at 1000 cps except that split-frequency-range amplifiers shall be tested as in *2.1.4.3.*

2.4.4.2.

It shall be standard to rate distortion for amplifiers at rated output and at 3 and 20 db below rated output.

2.5 Hum and Noise

2.5.1. Purpose

To measure the internally generated HUM and NOISE in an amplifier and establish a method for meaningful comparison between amplifiers of varying sensitivities.

2.5.2. Definition of Terms

2.5.2.1.

HUM shall mean the voltage, at line frequency and its multiples, delivered to its load by an amplifier operating with no input signal applied.

2.5.2.2.

NOISE shall mean all voltage components, other than HUM as defined in *2.5.2.1.* delivered to its load by an amplifier operating with no input signal applied.

2.5.2.3.

The term OPEN CIRCUIT shall refer to NOISE or HUM measurements made when all input terminals of the amplifier are open circuited.

2.5.2.4.

The term CLOSED CIRCUIT shall refer to NOISE or HUM measurements made when active input terminals of the amplifier are short circuited.

2.5.2.5.

HUM AND NOISE FACTOR shall be defined as the ratio in db of the HUM and NOISE voltage in the output to the signal-output voltage at ZERO-REFERENCE FREQUENCY.

2.5.3. Test Procedure

For this test, HUM and NOISE voltages shall be measured with an instrument which has full-wave rectifying characteristics, responds to the average value, and is calibrated to indicate the RMS value of a sinusoidal waveform.

In addition, the frequency response of the instrument shall be weighted so that it follows the 40 db (A) curve of ASA Standard Z 24.3—1944.

2.5.3.1.

Operate amplifier under STANDARD TEST CONDITIONS (paragraph *1.0.*) with all gain controls set at maximum.

2.5.3.2.

Apply a ZERO-REFERENCE-FREQUENCY test signal of sufficient amplitude to develop rated output.

2.5.3.3.

Measure and record the RMS output voltage.

2.5.3.4.

Disconnect the test signal source. Measure and record the HUM and NOISE voltage output.

(*Continued on page 97*)

First Audioman Selected

"In recognition of his interest and activities in the field of component high fidelity and for his contribution of counsel and assistance to other people interested in the reproduction of music," the first Audioman of the Month is

ROY R. MUMMA

Audioman No. 1—Roy R. Mumma

MANY MONTHS HAVE PASSED since the closing of the lists for the selection of the twelve Audiomen of the Month—but the qualifications were studied carefully and all have been chosen—and notified. To the many who entered and sent photos and their qualifications, we are extremely grateful; to those who were not selected, we can only say we are sorry there are only twelve months in the year; to those who were, our heartiest congratulations.

The qualifications and the choices of equipment were both interesting and enlightening. The judges felt that anyone deserving the title of Audioman of the Month should by the end of the contest should have converted to stereo, although many had otherwise excellent installations. Some others apparently ply their hobby in secret, and do little or nothing to help beginners in the selection and planning of their systems. On the whole, therefore, we believe that those selected are excellent representatives of an important and continually growing hobby—music in the home. The next contest will be announced early in 1960, and while the emolument is not large, the honor is. So polish up the handles of your cabinets, and you may be one of next year's Audiomen.

Roy R. Mumma, of 3223 Arapahoe Road, Pittsburgh, Pennsylvania, is the first Audioman of the Month. He is married, a Supervisor with United States Steel Corporation, and active in church, civic club, and business organizations. He has been Technical Chairman of the Advisory Council of the Industrial Audio-Visual Association (Chicago) for two years. Not all his spare time is spent with audio—his other hobbies are photography, gardening, woodworking, drawing, stamp collecting, and providing picture travelogue lectures for all types of groups. Roy likes baseball and football, and attends operas, concerts, or plays at least once a month. He returned from a seven-week tour of Europe last year with 2000 Kodachrome slides, and two full pages of colored photos of the Brussels World's Fair appeared in the magazine section of *The Pittsburgh Press* last Nov.

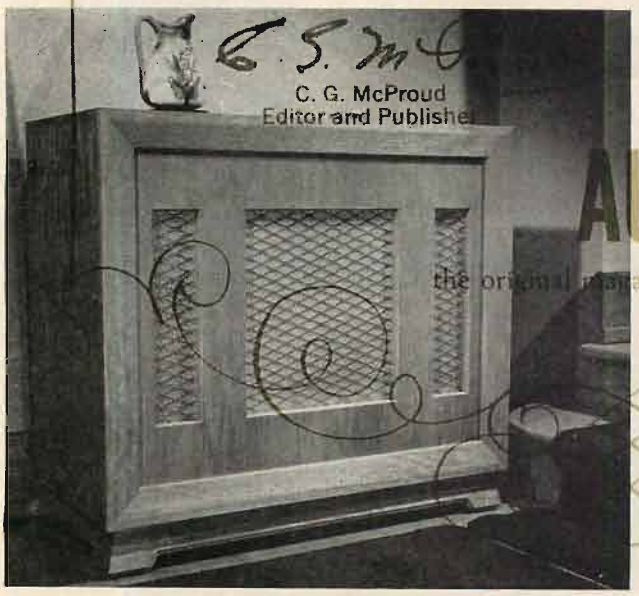
Mr. Mumma's present installation consists of an Altec 306A AM-FM tuner, an Altec 445A stereo preamp, and two Altec power amplifiers—340A and 350A—together with a Rek-O-Kut N-33H turntable with Fairchild 282 arm and SM-1 cartridge for stereo and a Rek-O-Kut B-12H turntable and 120A arm with an ESL C-1 cartridge for mono. Two Altec 604D Duplex speakers are mounted in custom-built bass-reflex cabinets which are similar in design to the equipment and record cabinet, and all are of Korina. One of the power amplifiers is used separately with a Fleetwood 900 TV with the remote control some 25 feet from the picture tube. Two Shure 55S Unidyne microphones are used with a Concertone 1401D tape recorder for live recordings, and off-the-air tapes are made regularly.

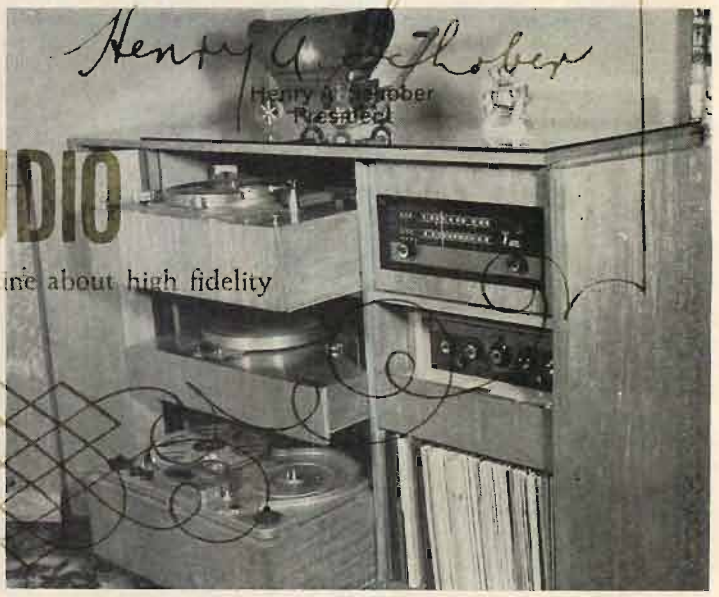
Roy's interest in electronics goes back to 1911 with the acquisition of "Harper's Electricity Book for Boys." His first "wireless" set soon followed, and by 1918 he was teaching radio communication in an officer training camp in Texas. In 1927 he purchased his first magnetic pickup, a Bosch "Recreator," and it was used with a Western Electric "birdcage" amplifier to give concerts to neighbors, as well as for home entertainment. A 33⅓-rpm turntable and an "Auditorium" Jensen followed in 1931, while 1939 found Roy with a Thordarson 45-watt amplifier and a Brush PL-20 arm and cartridge—one of the first lightweight high-quality pickups.

Among many experiences helping friends with their hi-fi installations, he describes one in 1950 as follows: "After a whole Saturday spent installing equipment in a cabinet, it came time to test the rig. Nobody had given a thought to LP records, so everything ground to a stop until I made a 16-mile round trip home for a few of my own records.

"Yes," he adds, "it worked." Æ

Left, bass reflex cabinet of Korina; right matching equipment cabinet. These are only two of the six in the complete installation, all of the same design.





The Tape Guide

Microphones for Recording

HERMAN BURSTEIN*

Understanding the different types of microphones and their characteristics will help the tape recordist get the high-quality results he always strives for.

WHILE THE MICROPHONE is a vital adjunct to the tape recorder, it is not an integral part of the latter. In fact, some of the high-quality home tape machines are sold without a microphone because it is felt that the individual critical enough to desire such a machine will also be critical enough to wish to make his own decision concerning the microphone for his purposes. On the other hand, it is virtually universal practice for medium- and low-price tape recorders to include a microphone as part of the package.

If moderately accurate reproduction of speech is all that the recordist desires, an inexpensive microphone of the kind that usually comes with a tape recorder will probably suffice. But if one plans to record live music or wishes a true facsimile of the spoken word, it is likely that a low-cost microphone will be unsatisfactory for one or more of the following reasons: inadequate frequency range, irregular frequency response, unsuitable pickup pattern, inability to suppress extraneous noises, susceptibility to overloading.

Accordingly, it is the purpose of this article to discuss the principal types of microphones in terms of their characteristics and advantages. To illuminate the path toward satisfactory recording of live sources, the discussion shall also deal with such things as microphone placement, low- *vs.* high-impedance microphones, mixers, and so on.

A microphone consists of an element which vibrates in accordance with the sound waves that strike it, together with a transducing device that converts the mechanical motion into an electrical signal. The nature of the transducer is the principal characteristic that distinguishes one type of microphone from another. For our purposes, which concern tape recording by the amateur in the home, school, church, and the like, we may distinguish among three fundamental types: (1) piezoelectric; (2) magnetic; (3) capacitive.

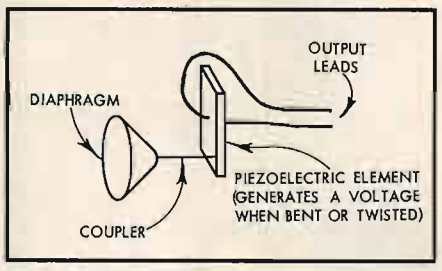


Fig. 1. Elements of a piezoelectric microphone.

Piezoelectric Microphones

The microphones included with popular-priced tape recorders are generally of the piezoelectric variety. *Figure* 1 shows the principle of operation in elementary form. A piezoelectric substance, such as a Rochelle salt crystal, has the property of producing a voltage when bent or twisted. The motion of the microphone diaphragm bends the crystal slightly, causing a voltage to be developed between the opposite faces of the crystal. This voltage varies in accordance with the sound.

For the most part, crystal microphones have limited response in the low bass region and exhibit a sharp drop above 7000 to 9000 cps. Also, they tend to exhibit a peak in response at about 4000 to 6000 cps, which adds clarity to voice reproduction but is ordinarily not desirable in the case of music. *Figure* 2

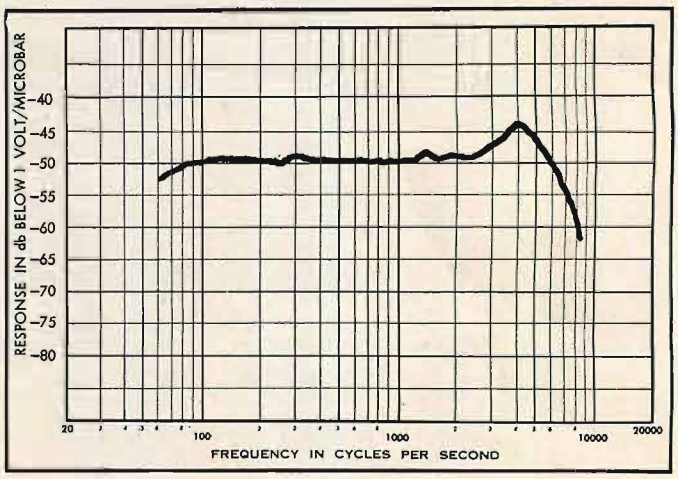


Fig. 2. Frequency response of a low-priced crystal microphone.

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

AMPEX 960

STEREOPHONIC RECORDER/ REPRODUCER

RECORDS STEREO
OR MONOPHONIC

ABOVE--960 PORTABLE STEREO RECORDER/REPRODUCER

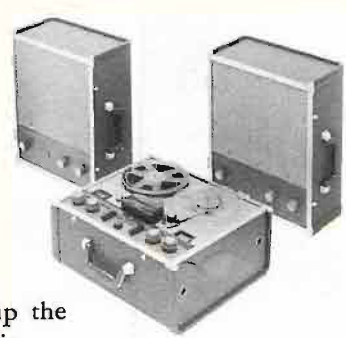
BELOW--MODEL 2560 PORTABLE STEREO SYSTEM CONSISTING OF 960 AND PAIR OF 2010 AMPLIFIER-SPEAKERS

Stereo Portable

ABOVE--960 PORTABLE STEREO RECORDER/REPRODUCER

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

Stereo Portable PLUS!



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

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

RECORDER/REPRODUCER

SPECIFICATIONS

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

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

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

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

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

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

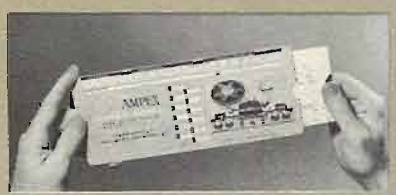
FLUTTER AND WOW: Under 0.2% rms at 7½ ips; under 0.25% rms at 3¾ ips

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

KEY TO THE EXCITING FUN FEATURES OF THE 960--

THE AMPEX STEREO-GRAPH

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



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

than a dozen of the most popular uses for the 960 . . . including sound-on-sound, language and music instruction, and other special effects. A convenient tape footage/playing time indicator is included on the reverse side.

MODEL 2010
MATCHING AMPLIFIER-SPEAKER

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

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

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

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

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

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

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

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

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

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

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

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

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

When you strike up the ba

Music sounds best on tape—it always has—but now you can afford it! 4-track, 7½ ips stereo tapes bring you twice as much music at half the cost, with "master recording" fidelity and infinite wearability. Hundreds of new 4-track stereo tapes now in stores . . . produced by 17 leading recording companies: Audio Fidelity / Bel Canto / Concertapes / Dot / Everest / Hi-Fi Tapes / Kapp / M-G-M / Mercury / Omega-tape / S-M-S / Vanguard / Verve / Vox / Warner Bros / Westminster / World Pacific. For list of 4-track tapes and dealers write 1024 Kifer Road, Sunnyvale, California. **UNITED STEREO TAPES** UST

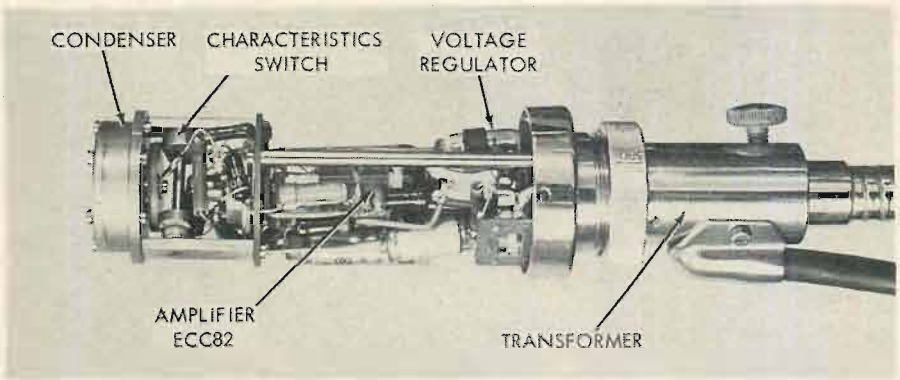


Fig. 10. Internal view of Teladi condenser microphone. (Courtesy Durant Sound Company)

and plate form a capacitor[1] having a value of a few micromicrofarads. A d.c. voltage, between 100 and 200 volts, is applied through several megohms resistance to the diaphragm, causing the capacitor to charge. Sound waves striking the diaphragm cause it to move very slightly toward and away from the plate, thus changing the capacitance. The ability of a capacitance to store current (accept a charge) varies with the value of the capacitance. When the diaphragm moves toward the plate, the capacitance is increased, resulting in current flow toward the capacitance. The current flows through the large resistor R_l, producing an a.c. voltage across R_l. Conversely, when the diaphragm moves away from the plate, the capacitance is decreased, resulting in current flow away from the capacitance. Current again flows through R_l but in the opposite direction, producing an a.c. voltage of opposite polarity across R_l. The a.c. voltages resulting from the movements of the diaphragm are fed to the grid of a tube enclosed in the microphone. The tube serves as an amplifier and to isolate the capacitor from the following circuitry. (The capacitor has extremely high impedance, and if it is to work properly it must work into a very high load resistance. The tube supplies such a load. On the other hand, the output of the tube has suitably low impedance so that the signal may be fed without losses to the next stage.)

A power supply is required to provide a high d.c. voltage to the microphone element as well as to supply the current required by the tube in the microphone housing. The power supply is connected by cable to the microphone. The principal disadvantage of the condenser microphone, is its need for a relatively bulky and cumbersome power unit that must go wherever the microphone goes. However, it is possible to operate the microphone at a considerable distance from the power supply, so that the former does have some independence of movement.

Figure 10 is an internal photo of a condenser microphone, and *Fig.* 11 shows internal and external views of another condenser microphone and its associated power supply; note that there are two condenser elements for stereo use.

Impedance

Dynamic and ribbon microphones are low-impedance devices. This signifies that they produce, *in relative terms,* high signal current and low signal voltage. But the tape recorders in common use employ voltage amplifiers rather than current amplifiers. Therefore it is of little value that the microphone turns out a relatively large current.

Accordingly, it is necessary to step up the voltage produced by the microphone, which is done by a miniature transformer within the microphone housing. This results not only in a higher output voltage but also in a higher output impedance. Unfortunately, as the output impedance goes up, the microphone becomes more susceptible to treble losses caused by capacitance across the output. The principal source of such capacitance is the cable leading from the microphone to the tape recorder.

The so-called high-impedance microphones of the dynamic and ribbon type usually have an impedance in the range of 10,000 to 50,000 ohms; 25,000 ohms is typical. Hence one cannot use much more than 10 to 15 feet of microphone cable without endangering treble response. The microphone manufacturer can provide exact information as to permissible cable length for his units. Obviously, the use of low-capacitance cable will permit one to maximize the length.

To permit long runs of microphone cable, many dynamic and ribbon microphones employ only a limited step-up of voltage and concomitantly have a low output impedance. The values most commonly encountered are 30, 50, 100, 150, 200, 250, and 600 ohms. These output

Fig. 11. (A) Internal and (B) external views of Telefunken SM-2 stereo condenser microphone and (C) power supply. (Courtesy Gotham Audio Sales Co. Inc.)

[1] Use of the word "condenser" has practically disappeared from serious electronic literature, partially as a result of instruction manuals for the armed services. Navy brass maintains that a condenser is a device in which steam is reduced to water, and does not permit use of the word in electronic manuals to describe the device which has the property of capacitance—a capacitor. Only place where condenser is used acceptably is to describe this particular type of microphone. This may explain AUDIO's consistent use of "capacitor," although a sentence like "This capacitor has a capacitance of 82 μμf" may sound strange. "Capacity" is often used incorrectly where "capacitance" is meant, but should only refer to ability of a container to hold a specified amount, or in a phrase like ". . . power handling capacity. . . ." The device which has the property of inductance is correctly called an inductor. **Ed.**

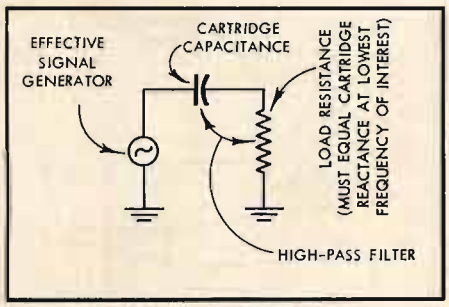


Fig. 3. Equivalent circuit formed by piezoelectric microphone and load resistance.

shows a typical frequency-response characteristic of a low-priced crystal microphone.

The piezoelectric microphone lends itself better than the other types to construction of an inexpensive unit, being fundamentally a simpler thing to build. Hence it tends to be associated with performance of moderate quality. But fairness requires us to recognize that crystal microphones can be and are made to have frequency response and other characteristics suitable for critical applications. Such microphones, which of course are substantially more expensive than the garden variety, have been employed by broadcasting and recording studios.

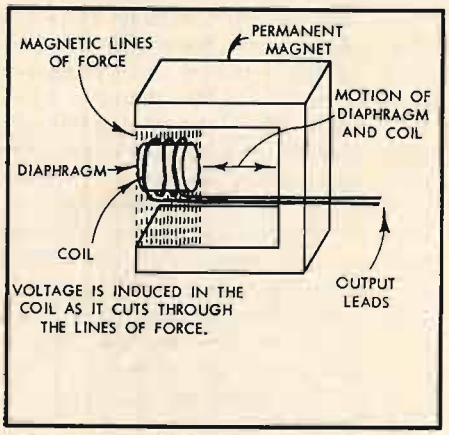


Fig. 4. Elements of a dynamic microphone.

The common variety of crystal microphone is subject to damage by high temperatures and by excessively dry or humid conditions. Thus a crystal microphone may come to grief if left in the trunk of a car on a hot day. On the other hand, there are some superior kinds of crystals which are able to withstand the extremes of temperature and humidity normally encountered.

Another way of meeting the temperature and humidity problem is to use a ceramic element having piezoelectric properties. Microphones with a ceramic element are considered relatively immune to climatic conditions.

The transducing element in a piezoelectric microphone is in the nature of a capacitance. *Figure* 3 shows the equivalent electrical circuit formed by this capacitance and the load resistance of the microphone amplifier (in the tape recorder). In effect, they constitute a high-pass filter. To preserve low-frequency response, it is necessary to have a sufficiently large load resistance. The minimum value for full bass response varies with the particular microphone. Typically, load resistances as high as 3 to 5 megohms are required to maintain bass response. Often, however, the load resistance in a tape recorder is a good deal less, perhaps as low as 250k ohms. In such a case, the input circuit of the tape recorder would have to be modified to provide a suitable resistance for the piezoelectric microphone to be used.

Dynamic Microphones

Most home recordists desiring results consistent with high fidelity standards and willing to spend between approximately $25 and $50 for a microphone will employ a magnetic type, frequently of the dynamic kind. *Figure* 4 shows in essence how a dynamic microphone works. Sound waves strike a diaphragm, to which is attached a coil situated in a magnetic field. Motion of the coil, as it cuts through the magnetic lines of force, causes a voltage to be induced in the coil. This voltage corresponds to the sound entering the microphone. *Figure* 5, which represents a good quality dy-

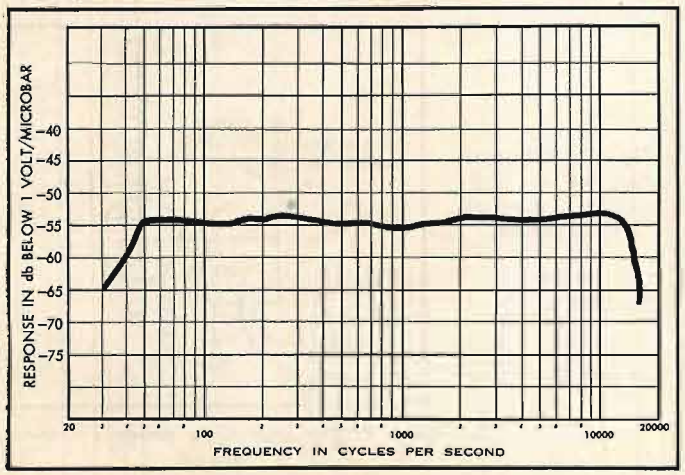


Fig. 5. Frequency response of a good-quality dynamic microphone.

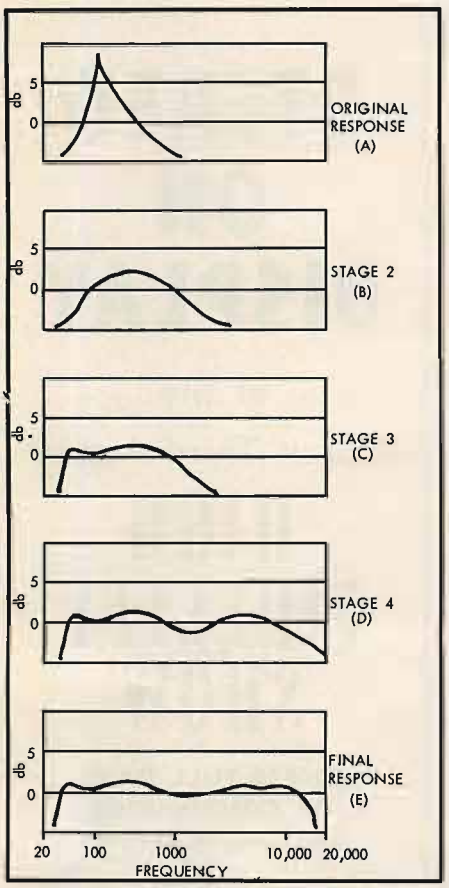


Fig. 6. Stages in smoothening and broadening the response of a commercial dynamic microphone.

namic microphone priced under $50, illustrates the smooth, wide-frequency-response characteristic of dynamic microphones.

While it is not the purpose of this article to explore the refinements of design of microphones, a few words should be said to explain why high-quality microphones cost as much as they do, considering how simple is their basic principle of operation. We may use dynamic microphones to illustrate the point. Actually, these can become quite complex affairs, involving the application of mechanical-acoustic principles to smooth and extend the frequency response of the basic mechanism. Damping and resonating devices in the form of felt, tubes, air chambers and cavities, shape of the housing, and so on are combined to produce the desired frequency response. *Figure* 6 presents a series of curves showing how the initial response of an elementary dynamic microphone (A) was gradually smoothened and broadened by the successive addition of several mechanical-acoustic devices, culminating in a microphone of very high quality. *Figure* 7 is a drawing of another high-quality microphone, suggestive of its design complexity; note, for example, the three different entrances for low, middle, and high frequencies.

Ribbon Microphones

The principle of operation of the ribbon (also known as velocity) microphone is shown in *Fig.* 8. It employs a very thin ribbon of metal suspended between the parallel pole pieces of a permanent magnet. As the ribbon moves in response to sound waves, it cuts the magnetic lines of force between the pole pieces, inducing a voltage in the ribbon. This is very similar to the operation of a dynamic microphone, except that in the present instance a ribbon instead of a coil cuts through the magnetic field. The ribbon, however, can be considered a coil with a single turn.

The ribbon microphone is capable of very smooth performance over a wide range, 30 to 15,000 cps or better. In the past, the ribbon microphone has been at a disadvantage in other respects, namely fragility, high sensitivity to shock, tendency toward boominess on close-up recording, and size (some units weighed as much as 8 pounds). But these flaws have been overcome altogether or in large measure, so that the modern ribbon microphone offers excellent performance in a small, reasonably sturdy unit that,

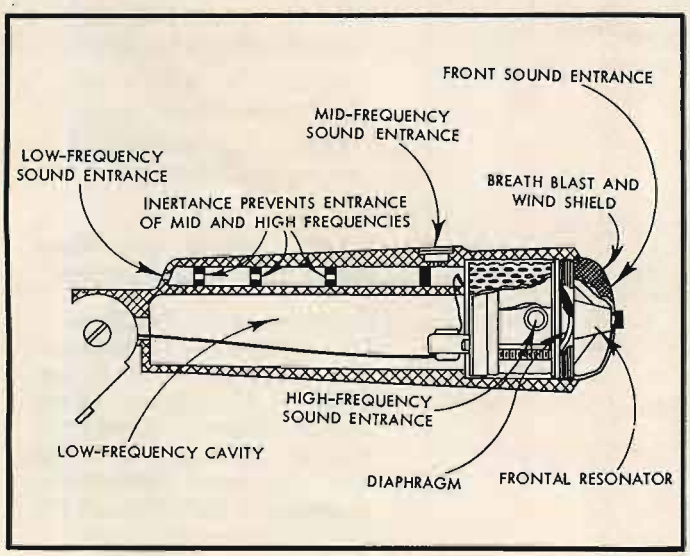


Fig. 7. Construction of a high-quality dynamic microphone.

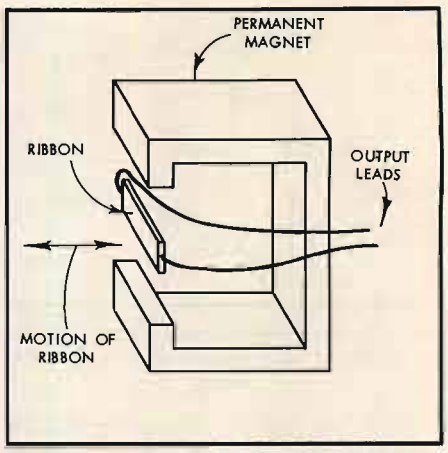


Fig. 8. Elements of the ribbon microphone.

considering its quality, is moderately priced. While the ribbon microphone may still be somewhat more fragile than the dynamic, some manufacturers of the former make it possible for the user to replace the ribbon in case of failure, thus avoiding a time-consuming return of the unit to the factory for repair, while practically no dynamic microphone can be repaired by the user.

Condenser Microphones

With respect to frequency range, smoothness, distortion, overloading characteristics, and—the ultimate test—how it sounds to the ear, the condenser microphone is considered by many to provide the highest quality. On the other hand, its cost is also the highest, being typically between $200 and $300, whereas very fine piezo-electric, dynamic, or ribbon microphones can be obtained for $50 and less. This is quite a difference. Yet some audio-fans pay close to or above $1000 for top quality tape recorders, and in their case the expenditure of an additional $150 or $200 for the best in microphones may not seem out of line.

Figure 9 indicates the basic construction of a condenser microphone. It consists of a very thin circular diaphragm of metal or a metallized substance, which is separated by a minute distance—of the order of one-thousandth of an inch —from a metal plate. The diaphragm

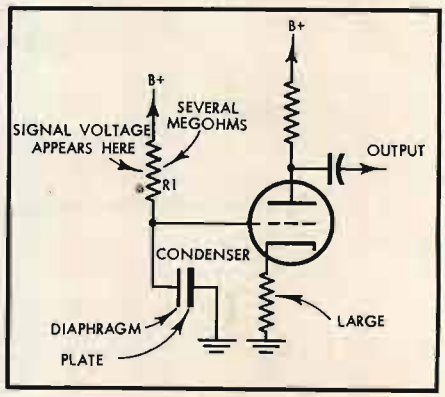
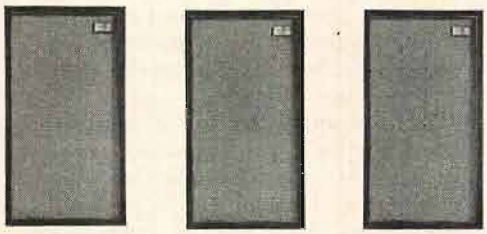


Fig. 9. Elements of a condenser microphone.

A MOST SIGNIFICANT ADVANCE
STEREO • PLUS*
3-CHANNEL SOUND BY PILOT

Pilot solves the "Hole-in-the-Middle" problem with a revolutionary A plus B 3rd channel.

A major advancement in the stereophonic art, STEREO • PLUS is an ingenious circuit now incorporated in all Pilot basic and control amplifiers. STEREO • PLUS provides *the* third channel signal — the *sum* of Channel A *plus* Channel B — to re-create center-of-stage sounds and solve the hole-in-the-middle" problem, without requiring additional equipment or a third channel power amplifier. ✚ In an effort to achieve widest angle stereo sound, the separation between speakers is frequently made greater and greater. As the spacing between two stereo speakers is increased, the apparent sound source becomes broader. However, a point is reached beyond which the width no longer increases. Instead, the single apparent sound divides into two separate sources, one localized at each of the speakers. The central area between the speakers tends to become a zone of silence, sometimes referred to as the "hole-in-the-middle". ✚ Prolonged listening to excessively spaced speakers is tiring because attention repeatedly swings from speaker to speaker. Where room size or decor, and the desire for a relatively broad source of sound require very wide speaker spacing, a third centrally located speaker system will re-create the sounds that originated at the center of the stage. In order to accomplish this, the stereophonic amplifier *must* drive the center channel speaker with a signal which is the *sum* of Channel A *plus* Channel B. ✚ Monophonic programs, and the portions of stereo programs that originated at the center of the stage, produce identical signals at Channel A and Channel B amplifier outputs. The *difference* between identical signals is *zero*— no center-channel signal at all! ✚ Conventional stereo amplifiers can supply nothing but a *difference* signal to a center channel speaker that is connected between taps of the same impedance, such as the 4 ohm taps of Channels A and B. A center channel speaker so connected will *not* re-create center stage sounds, and will produce *no sound* from monophonic signals. ✚ As an important added feature, Pilot STEREO • PLUS basic and control amplifiers are the only amplifiers that *simultaneously* can drive these speaker systems: three channel stereo (with sum center channel); two channel stereo; *and* monophonic. With *one* Pilot STEREO • PLUS amplifier—such as the Pilot 232 or 260 basic amplifier, or Pilot 240 or 245-A control amplifier—you can operate these speakers in any combination or all at the same time! STEREO • PLUS by Pilot is another valuable product resulting from 40 years of experience and progress in electronics.



A A+B B

*PATENT APPLIED FOR

PILOT

FOUNDED IN 1919

PILOT RADIO CORPORATION, 37-04 36th STREET, LONG ISLAND CITY 1, N. Y.

Fig. 12. An in-line microphone step-up transformer, UTC Model MC-1. (Courtesy United Transformer Co.)

impedances make feasible cable lengths of 100 feet or more.

A number of microphones give the user the option of high or low impedance, exercised by pushing a switch or hy rewiring the cable connections to the microphone. Sometimes there may be a choice between two values of output impedance.

Low-impedance microphones deliver a much smaller signal than do high-impedance ones. Therefore it is necessary to step up this voltage before it is fed to the tape recorder. This is done by means of a microphone transformer located at the far end of the cable, either incorporated in the tape recorder or external to it. Tape machines of professional grade sometimes have a built-in transformer to accommodate low-impedance microphones. If not, then an in-line transformer such as that of *Fig.* 12 becomes necessary. The microphone cable is connected to the transformer, and the latter in turn plugs into the tape machine. While a high-quality in-line transformer is well-shielded, nevertheless care should be taken to keep it away from motors, transformers, and other sources of hum.

Use of a low-impedance microphone together with a step-up transformer leaves one with about the same signal level as can be obtained from a high-impedance microphone of similar construction.[2] The amount of step-up by the transformer is determined by its ratio of secondary turns to primary turns. The number of secondary turns is limited by winding capacitance, which causes treble attenuation. The number of primary turns can be reduced only so far (in order to obtain a high secondary/primary ratio) because it is necessary to have sufficient turns to match the impedance of the microphone; otherwise the signal level drops.

[2] The voice coil of a typical dynamic microphone usually has an impedance in the range from 30 to 50 ohms, and in the low-impedance form the output leads simply connect to the coil directly. High-impedance dynamic microphones usually have a transformer built into the housing. Ribbons used in microphones have impedances around ¼ ohm and it is almost imperative that a matching transformer be close to the ribbon. Ed.

The piezoelectric microphone has a relatively high impedance. In this case the impedance is capacitive. As previously pointed out, it is generally necessary to have a load resistance of several megohms to prevent low-frequency losses. The capacitance introduced by a long cable does not affect treble response, but instead reduces the signal level at all frequencies.

The transducing element in a condenser microphone has an extremely high impedance, but as already explained the tube in the microphone serves to reduce the output impedance to suitable proportions so that cable or other capacitance will not significantly affect the treble frequencies. Moreover, the microphone contains a transformer—either in the housing or in the power supply—to further reduce the impedance and thereby permit a long cable run. Then, as with the dynamic and ribbon types, it *may* be necessary to employ a step-up transformer at the far end of the cable to provide sufficient signal voltage to drive the tape recorder. Whether the transformer is needed depends upon how much signal amplification has already taken place in the microphone.

Sensitivity

The greater the signal voltage produced by the microphone, the higher will be the ratio of audio signal to the hum and noise generated by the tape recorder amplifier. Hence microphone sensitivity —output voltage for a given sound pressure—is an important characteristic to be taken into account.

The customary method of rating the sensitivity of high-impedance microphones is on the basis of a sound pressure of 1 microbar or 1 dyne per square centimeter, which are the same thing. For convenience, we shall use the term microbar. The output voltage is expressed as a given number of db below 1 volt. Thus a typical rating is – 55 dh/microbar, signifying that for a sound pressure of 1 microbar the microphone delivers an output 55 db below 1 volt. The frequency at which this measurement is taken is customarily 1000 cps. Since the voltage is stated as a negative figure, the lower the digital value the higher is the sensitivity. Thus a microphone with a rating of – 49 db (per microbar) is more sensitive than one with a rating of – 52 db.

Generally, a sensitivity of – 55 db or better is sufficient to permit a satisfactory signal-to-noise ratio when using a tape recorder having reasonably low noise and hum. With top-quality tape machines, a sensitivity as low as – 60 db is practical. It is quite difficult to obtain a truly good signal-to-noise ratio with microphones that are appreciahly less sensitive than – 60 db.

Crystal microphones as a rule have considerably more output than do dynamic and ribbon ones. Sensitivities such as – 50 db and better are common among crystals. On the other hand, when one gets into crystal microphones of superior quality, the sensitivity tends to go down in exchange for wider and smoother response. Then the sensitivity may be no better than that of the magnetic microphones. It may be added that ceramic microphones, while possessing greater durability than the crystal ones, in exchange tend to be less sensitive, assuming that the two types are otherwise constructed in similar fashion.

A different method of rating sensitivity is used for low-impedance microphones. Now the output reference level is 1 milliwatt (instead of 1 volt), while the standard sound pressure is 10 microbars (instead of 1 microbar). Thus if a low-impedance microphone delivers 55 db below 1 milliwatt of power for a sound pressure of 10 microbars, it is rated at – 55 dbm/10 microbars. For low-impedance dynamic and ribbon microphones, – 55 dbm is a typical rating and indicates sufficient sensitivity *when used in conjunction with a step-up transformer* to insure a satisfactory signal-to-noise ratio. After step-up by an in-line transformer, the voltage output will be close to that of a high-impedance microphone rated at – 55 db/microhar.

A condenser microphone, because of amplification by a tube within the housing, may deliver considerably more signal than magnetic microphones. To illustrate, one make of condenser microphone has a rating of – 48 dbm/microbar; another has a rating of – 30 dbm, which is sufficient to drive a tape recorder with-

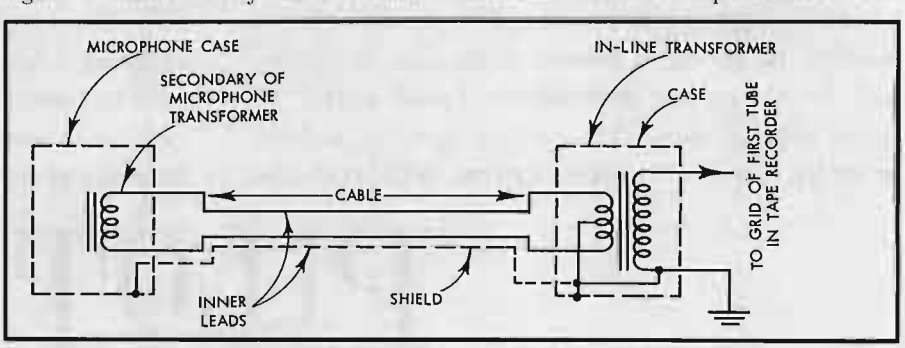
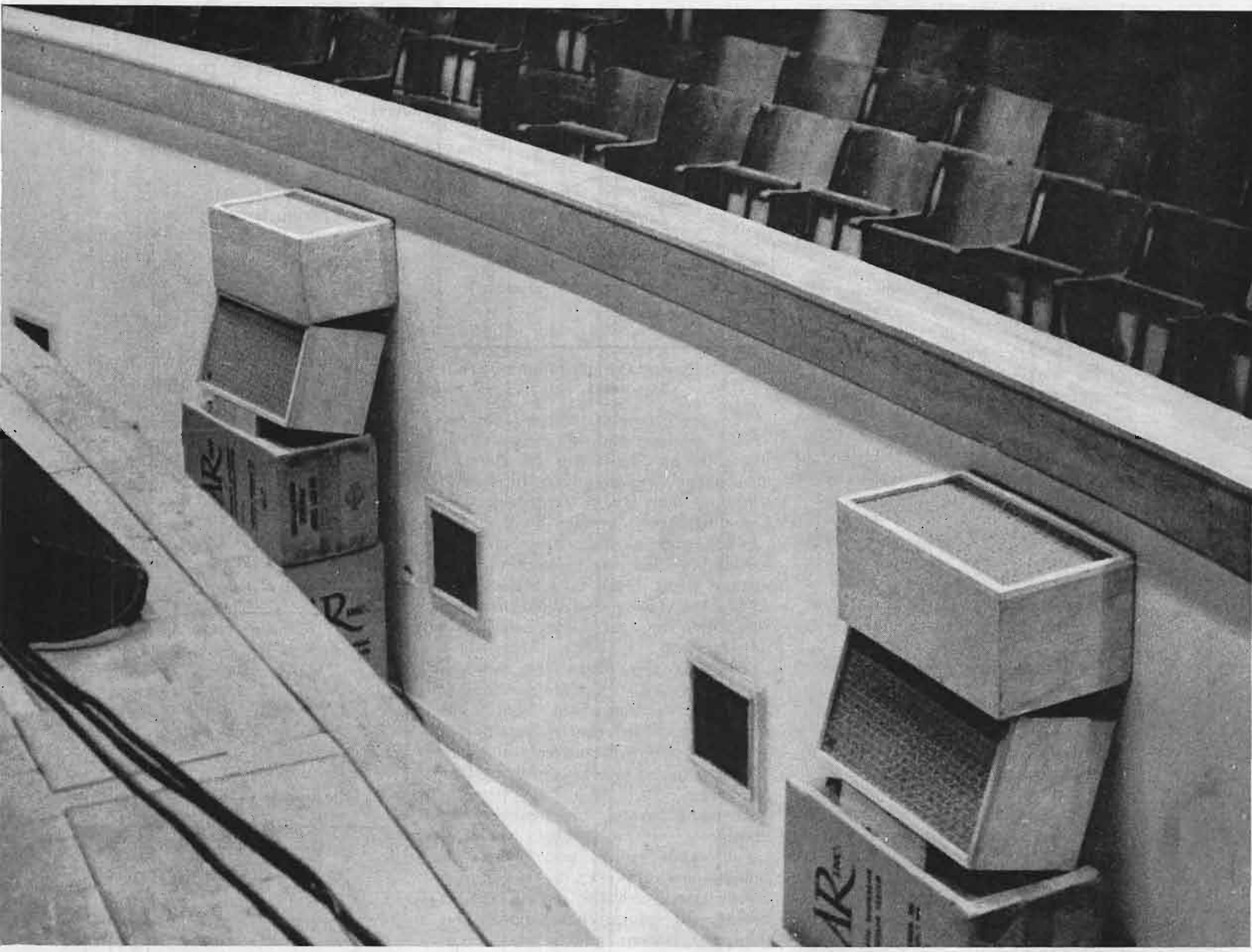


Fig. 13. Balanced microphone connection.

orchestra pit in beersheba



When the Martha Graham dance group toured Israel, six AR-2 loudspeakers, with tape reproducing equipment, were taken along to provide musical accompaniment under circumstances where it was impractical to use live musicians.

Above are four AR-2's mounted in the orchestra pit of Cinema Karen in Beersheba (two more were placed backstage). These speakers were selected for the job because of their musical quality; the natural sound of the live instruments, rather than pseudo-hi-fi exaggerations, was desired.

AR *acoustic suspension* speaker systems—the AR-1, AR-2, and AR-3—are designed primarily for use in the home, but are also employed extensively by professional laboratories and studios. They are priced from $89 to $231.

Literature is available on request.

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

out a step-up transformer. However, these greater sensitivity figures do not mean that one is thereby going to obtain a proportionately higher signal-to-noise ratio than with magnetic microphones. Now the signal-to-noise ratio tends to be determined not by noise and hum in the tape recorder but by noise and hum in the microphone tube. Situations may arise where a noisy tube in the condenser microphone leads to a poor signal-to-noise ratio. Obviously this calls for replacement by a carefully selected tube.

Balanced Versus Unbalanced Connection

When a long cable is employed (with a low-impedance microphone), the chances of hum pickup are increased. Therefore it is frequent, though not universal, practice in low-impedance microphones to provide a balanced connection, illustrated in *Fig.* 13, as contrasted with the unbalanced connection ordinarily employed with high-impedance microphones, illustrated in *Fig.* 14.

In the unbalanced connection, one output lead of the microphone is connected to the cable shield, while the other lead goes to the inner (hot) lead of the cable. In the balanced connection, however, a microphone cable with two inner leads is used. These are connected to the output leads of the low-impedance microphone. The cable shield is connected to the microphone case and is grounded at the other end to the in-line transformer case. The primary of the in-line transformer has a center tap connected to ground, which serves to cancel the hum, static noise, and so on picked up by the inner leads in the cable.

Polar Characteristics

Microphones have three basic types of pick-up patterns, known as polar characteristics, which are illustrated in *Fig.* 15.

Probably the most widely used microphones although not necessarily the best in all situations, are those with an omnidirectional pattern, shown at (A), which pick up sound about equally well in all directions. Actually, as shown in *Fig.* 16, these microphones tend to be somewhat directional as frequency increases. Here the pick-up pattern is plotted for three different frequencies, and it may be seen that the pattern is more directional at 10,000 cps than at 1000 cps.

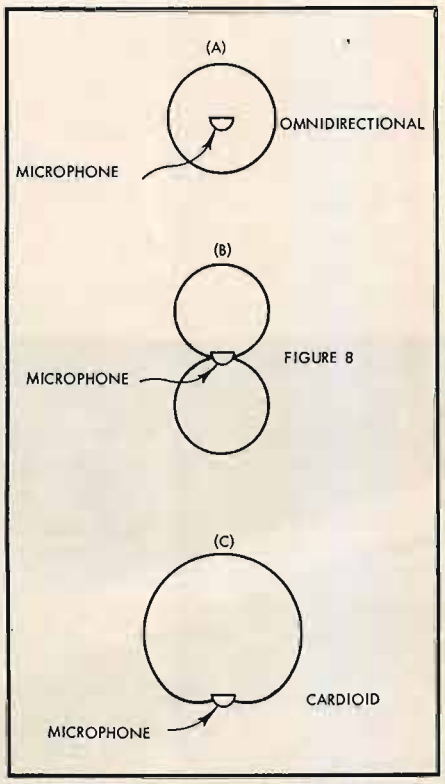


Fig. 15. Basic microphone pick-up patterns.

The second type of pattern is the cardioid, or heart-shaped characteristic, illustrated at (B) in *Fig.* 15. Here the microphone is essentially unidirectional, becoming more so as frequency rises. The difference in sensitivity of such a microphone to sounds in front of it and sounds behind it may be as much as 15 db and more. Some microphones have what is called a super-cardioid characteristic, signifying that the pick-up area is narrower still.

The third type of pattern, shown at (C) in *Fig.* 15, is the bidirectional, or "Figure-8," characteristic. Such microphones are about equally sensitive to sounds at the front and rear and have limited response to sounds arriving from the sides.

Dynamic, crystal, and condenser microphones are inherently omnidirectional, while ribbon microphones are bidirectional. However, by various mechanical and acoustic devices the inherent patterns can be changed. Thus dynamic, ribbon, and crystal microphones are available with cardioid patterns, achieved through multiple sound entrances, varying the size of these entrances, phasing devices, and other means. Condenser microphones, by means of double diaphragms—one on each side of the plate—and by applying voltages of varying level and polarity to each diaphragm, can be made to provide an omnidirectional, cardioid, or Figure-8 pattern as desired. Accordingly, one's decision to purchase a given type of microphone is not necessarily dependent upon the inherent polar characteristic of that type.

The omnidirectional microphone is advantageous when sounds are to be picked up all around it. If one is recording speech or music in the home, it is not necessary to place everyone in a restricted area in front of the microphone. Instead, it can be located in the middle of the group. When recording in a hall or auditorium, the omnidirectional microphone permits one to place it near the sound source, thereby providing a high signal output, and at the same time enables one to pick up an appreciable amount of reverberated sound arriving from the rear and sides, imparting the sensation of spaciousness.

The cardioid microphone, since its pick-up pattern is concentrated at the front, may be placed farther from the sound source than the omnidirectional microphone, yet produce equal signal output. One can place the cardioid roughly twice as far away.

Because it discriminates against sounds from the rear, the cardioid microphone can be oriented to exclude extraneous sounds. To the extent that it discriminates against reverberated sound, it prevents overemphasis of bass frequencies, which tend to reverberate more than high frequencies. The cardioid is highly useful where problems of acoustic feedback exist, as in public address systems, where it is necessary to prevent the microphone from picking up the sound emanating from the loudspeakers.

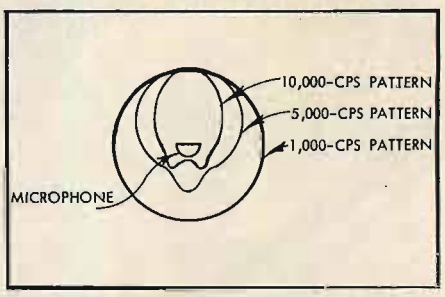


Fig. 16. Variation of pick-up pattern of an omnidirectional microphone with frequency.

The Figure-8 microphone, like the cardioid, enables one to "aim" at the sound source. The fact that the former is sensitive to sound at the rear as well as at the front means that it will pick up more reverberated sound than the car-

(*Continued on page 99*)

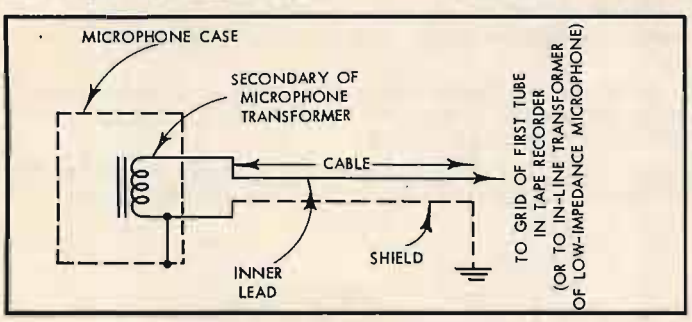


Fig. 14. Unbalanced microphone cable connection.

Viking builds the PERFECT MEMORY for your music system

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

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

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

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

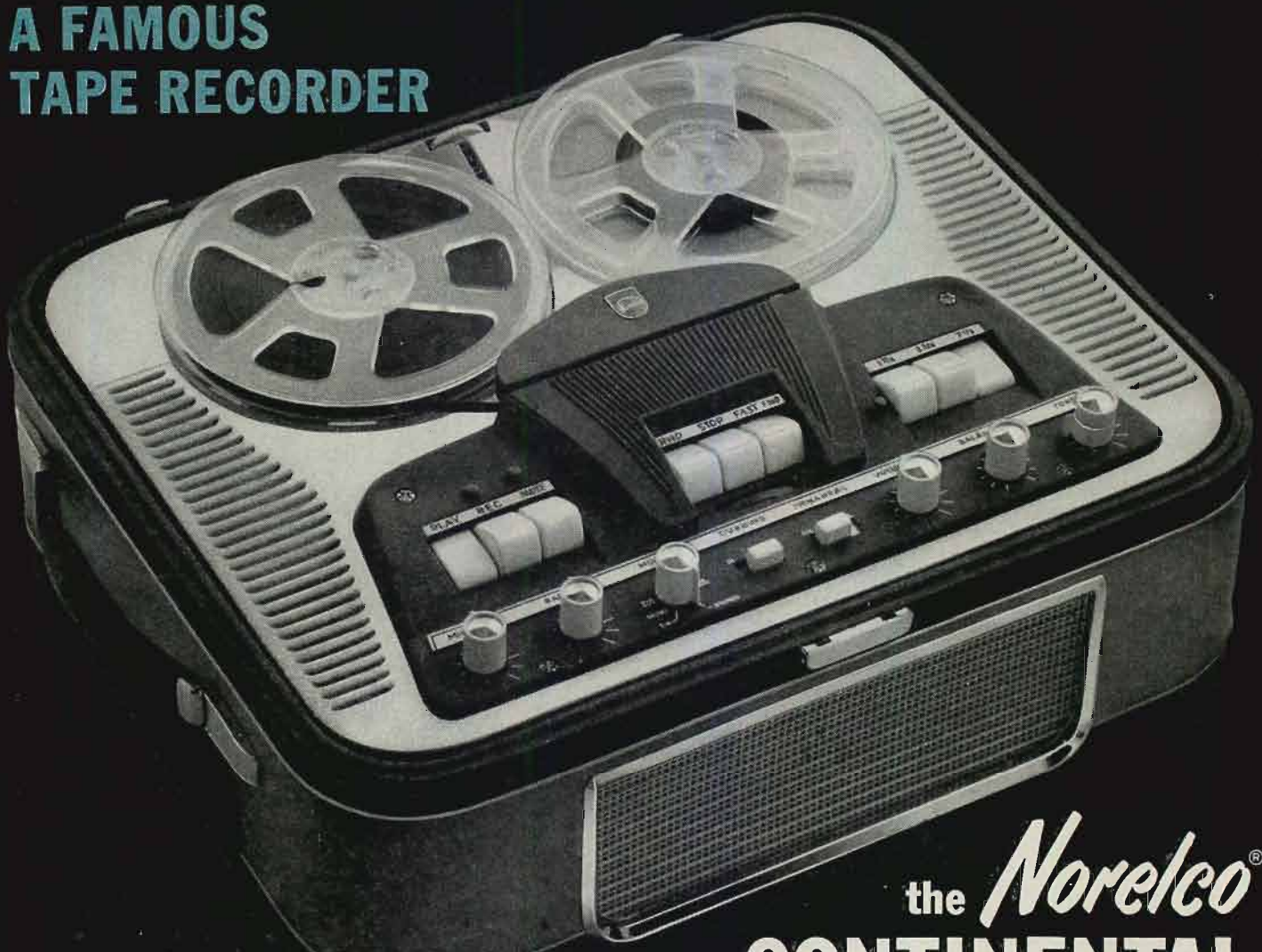
Viking tape components are sold through high fidelity dealers, exclusively. Further technical information may be obtained by writing directly to Viking's Customer Service Department.

Viking OF MINNEAPOLIS, INC.

9600 Aldrich Avenue South, Minneapolis 20, Minnesota

EXPORT DIVISION: 23 Warren Street, New York City 7, New York
Cable: SIMONTRICE, NEW YORK (All Codes)

THE EVOLUTION OF A FAMOUS TAPE RECORDER



the Norelco® CONTINENTAL "400"

(MODEL EL 3536) SPECIFICATIONS

• *Self-contained including dual hi-fi preamps, recording and playback amplifiers and Norelco wide-range loudspeaker* • *Fully compatible with conventional monaural and stereo pre-recorded magnetic tapes* • *Three speeds—7½, 3¾, 1⅞ ips* • *Can be played back through your hi-fi system*

SIGNAL-TO-NOISE RATIO: *55 db or better* • **CROSSTALK:** *55 db* • **WOW AND FLUTTER:** *At 7½ ips, 0.15%; at 3¾ ips, 0.2%; at 1⅞ ips, 0.35%* • **MODULATION INDICATOR:** *Magic Eye (Type EM84)* • **PROGRAM INDICATOR:** *Built-in, 4 digit adjustable* • **PAUSE BUTTON:** *Instantaneous with locking device* • **FAST FORWARD AND REVERSE:** *Less than 2 minutes for 1200 ft. of tape* • **DUBBING FACILITIES:** *Sound on sound* • **AUTOMATIC STOP:** *At ends of tape (with metalized strips)* • **INPUTS (3):** *for stereo microphone (1); for stereo phono or tuners (2)* • **OUTPUTS (4):** *For extension speakers (2); for external amplifiers (2);* • **MONITORING:** *Special output for stereo headphones* • **STEREO DYNAMIC MICROPHONE:** *dual elements* • **SPECIAL CONTROLS:** *For recording only—ganged mike volume and ganged phono/radio volume; For playback only—2 channel tone (individual concentric controls but friction ganged); ganged volume; and ganged channel balance* • **SWITCHES:** *Dubbing (1): monaural output switch for connecting output stages in parallel for monaural playback (1); 4-position selector (1)—1st Pos. Public Address; 2nd Pos. Monaural Track 1 (& track 4 when tape reel is inverted); 3rd Pos. Monaural Track 3 (& track 2 when tape reel is inverted); 4th Pos. Stereo* • **TUBE COMPLEMENT:** *EF86 (2), ECC83 (3), EL84 (2), EM84 (1)* • **LINE VOLTAGE:** *117 volts AC at 60 cycles* • **POWER CONSUMPTION:** *110 w* • **DIMENSIONS:** *18½"x 15½"x8½"* • **WEIGHT:** *55 lbs.*

a superlative new 4-track stereo-record/ stereo-playback tape recorder developed and guild-crafted for you by Philips of the Netherlands

Norelco®

For additional descriptive literature write to:

North American Philips Co., Inc.
High Fidelity Products Division
230 Duffy Avenue, Hicksville, L. I., N. Y.

What is High Fidelity?

J. GORDON HOLT*

All hitherto published explanations of high fidelity have been written for the specific purpose of confusing the novice hi-fi enthusiast and frightening away the would-be hi-fi enthusiast. Here at last is the hi-fi primer to end all hi-fi primers, written in the simplest of terms and sugar-coated for the person who likes to daydream while reading.

THERE IS REALLY NOTHING at all confusing about high fidelity, once it is thoroughly understood. It is sometimes difficult to understand, but not very.

High fidelity is fidelity that is higher than low fidelity. It is concerned with the pluperfect electro-mechanical reproduction of the molecular disturbances set up in the air by vibrating bodies. These are generally musical bodies rather than other types, although they can be nonmusical too, which is why all knowledgeable high fidelity enthusiasts play noise records instead of music.

The novice need not be concerned with the lack of a sharp line of demarcation between hi-fi and low-fi, except inasmuch as this proves that there is really no such thing as high fidelity. There are three degrees of fidelity, one of which is not fidelity at all, and none of which can be distinguished from the others. The latter two are called high fidelity and medium fidelity, but medium fidelity is in reality nothing more than high fidelity for low incomes. This must not be confused with low fidelity for high incomes, which is grounds for certain types of legal action in some states.

Components

A high-fidelity system may be visualized as a chain with a phonograph pickup at one end and a listener at the other end, with sausage-like links, called components, in the middle.

Pickups

The first component or link is known as the pickup, because it picks up the bends in a record groove and converts them into various forms of distortion and frequency response. The turntable is sometimes considered an integral part of the pickup, but it isn't really because they may be purchased separately as well as together. Pickup arms may be purchased separately too, except when the turntable is a record changer.

* *Golf View & Rose Valley Rds. Wallingford, Pa.*

Turntables

The turntable is a circular table which turns, or rotates, the record in the same direction at all times. It is essential that the turntable not change direction while playing a record, or disc, for this will cause wow, which is unpleasant to musical ears as well as to the people who have the musical ears. Wow that is too fast to be called slow-speed wow is called high-speed wow, or flutter, while mechanical vibrations cause grumbling noises and sometimes profanity.

Every turntable has a motor, futuristic styling, and lower rumble than all competing brands tested by an Independent Consumer Investigations Laboratory.

Styli

All pickups have styli, which are either changeable by the user or are not, depending upon several factors which are most exceedingly important and should be borne in mind whenever shopping for a pickup.

Most styli wear out with use, although non-wearing osmium styli are supplied with all department-store console phonographs.

Amplifiers

The next sausage (or link) in the high-fidelity chain is the amplifier. This converts the tiny electrical impulses from Debussy's *Clair de Lune* into watts of horsepower such as Bach's *Toccata and Fugue in D Minor*. Either 1 or 100 watts of power is entirely adequate for home listening, so the wise buyer will choose an amplifier of that power and will not allow himself to be misled by conflicting expert opinions.

Some amplifiers have a built-in preamplifier and some do not, just as some of them have Fletcher-Munson curves[1] and others have transistors.[2] It isn't necessary for the novice hi-fi enthusiast to worry about the difference unless he is the kind of person who *likes* to worry about differences.

One difference between amplifiers is known as distortion, and it is by far the most important characteristic of an amplifier because it affects the way it sounds. Frequency response is even more important than distortion, except to those bigots who consider distortion more important than frequency response. These people have golden ears and attend orchestra concerts and make a point of always selecting records with blemishes, that are sometimes known as clicks and pops. Clicks and pops are the most important characteristics of phonograph records, just as hiss is the most important characteristic of magnetic tape. Tape hiss, however, is of less significance to people who own phonographs and not tape decks. Some of these contain playback equalizers and some of them have RIAA.

RIAA'S

The RIAA is a curve, like a frequency response. The ideal frequency response curve is not a curve at all; it is a straight line. This is called uniform frequency response, and it is desirable except when it is complementary to another curve which is not a straight line and is therefore called an equalization curve.

Equalization is less important today than it used to be, because all record manufacturers add a certain amount of bass attenuation and decibels to their discs, whereas several years ago they did the same thing only differently, depending upon whim and supported by Good Engineering Practice. It used to be very confusing, but it isn't any more, thanks to the discovery of RIAA.

Loudspeakers

After the RIAA comes the loudspeaker, which is the most important link in the high-fidelity chain because it is the worst. Some loudspeakers have horns, but high fidelity enthusiasts living in the Manhattan area are not allowed to use horns so they use direct radiators.

(*Continued on page 98*)

[1] The Fletcher-Munson curve was named after Messrs. Fletcher and Munson, who wrote a technical paper proving once and for all that equally loud sounds aren't necessarily equally loud.

[2] Transistors are not named after anybody, because some of these are much louder than others, regardless of frequency.

Defense and the Hi-Fi Bachelors

C. H. MALMSTEDT*

Deep in a world of calculus, navigation, thermal units, boilers and ballistics, a superb "home" hi-fi system helps maintain a balance between the science of the age and the culture of the ages.

In Two Parts—Part One

IT BEGAN in the early 1950's on board a destroyer—the USS *Evans* of the U.S. Seventh Fleet. Operating in waters of the Western Pacific during and after the Korean War, the *Evans* was a busy beaver: direct action in the war, patrolling of the Formosa Straits, a full schedule of training made necessary by manpower requirements and the rapidly increasingly complexity of scientific equipment necessary to naval operations in modern national defense; then the long, lonely haul back to home base in Long Beach, California—and out again for more of the same.

Among those to whom this posed a cultural problem was Lt. E. L. St. Ville, then chief engineering officer of the *Evans*. The problem: The West and its way of life had to stand well defended against all who would challenge it, and to this end it was every man's duty to give it the best that was in him; but even the best of hopes and assurances gave no promise of an early return to an unthreatened life at home or abroad. The crux of the problem, then was how to carry along in the world of science and defense, afloat or ashore, a means of keeping in unbroken contact with what was one of the finest things in the Western way of life—music.

On board the *Evans*, the first answer was a hi-fi record player and a slowly growing stack of LP records, specimens from pop tunes of the day to symphonies and operas.

While the *Evans* ploughed the Pacific, its chief engineer discovered via hi-fi music what many technical men have discovered: that science, far from being the enemy of the arts, as many have insisted, is in fact the pollen-carrier that exposes to the finest music many who might otherwise never be subjected to its beauties; and he discovered that it works the other way round, too—music has become the pollenizer of limitless scientific advance. On the *Evans*, books and magazines on sound reproduction soon took their place beside volumes on marine engineering and naval proceedings. The hi-fi system then was, however, far from the superb installation that now graces a room of the Bachelor Officers' Quarters at the U.S. Navy Postgraduate School on California's Monterey Peninsula.

* *Carmel Valley, California.*

Old Glory amid oaks at the entrance to the BOQ—a setting that enhances the best of hi-fi music within. (Official Photograph, U.S. Navy.)

Back on Dry Land

Fission for the next stage of development was provided by the San Francisco Hi-Fi Show of 1956. The fissioning agent was a JBL "Hartsfield" speaker incorporating a 15-inch woofer and a high-frequency driver with acoustical lens. The then-current price—$750—was enough to cause any sailor to blink more than once, and to render him forever unhappy with anything less. Want ads soon located the same speaker for some 30 per cent less, a rare event. Within hours, the speaker stood in a corner of a BOQ room, with a ready audience of navy officers waiting to hear it, even with only the old record player to drive it.

Connected to the 8-watt output of this unit, the new speaker quickly proved itself. It actually took less energy to drive it than did the three speakers incorporated in the record player.

The audience stood back enthralled—and the big chain reaction had begun.

Among other officers assigned to the General Line School for postgraduate work, as was Lt. St. Ville, myriad hi-fi installations began to crop up. There was, however, no indication as yet that this positive chain reaction would eventually influence installations in the homes and naval facilities of foreign countries—nor of the fact that the very decor, furniture, and general appointments of Lt. St. Ville's room would soon undergo a modification dictated largely by sound-reproduction considerations. Why limit the beauties of opera, symphonies, choral renditions, with inade-

"Spinet" Equipment Cabinet with B-500 "Spinet" Speakers for stereo.

Urban Stereo Ensemble of B-302A Speakers with Equipment Cabinet.

Provincial Equipment Cabinet with B-302A Provincial Speakers.

Decorator Settings for the Very Best in Sound

As a charming center for The Very Best in Sound, team your Bozak Speakers with a Bozak Equipment Cabinet of identical styling and craftsmanship. Roomy, well-ventilated accommodations for your choice of top-quality components include adjustable shelves for the tuner, control and power units . . . space for turntable or changer with record-storage below . . . front doors and removable backs for maximum convenience in installation and use. These features, plus the restrained good taste of design, make a Bozak ensemble the logical way to integrate the finest in sound re-creation with your own preference in décor. See a Bozak franchised dealer, or write today for literature.

BOZAK • DARIEN • CONNECTICUT

After the day's chores—relaxation. Navy nurses Gretchen Hill and Dorothy Tomac dropped in for a share of it, too; Lt. St. Ville hosting. (Official Photograph, U.S. Navy.)

quate acoustic receptivity? Down went a wall-to-wall rug. And that desk over there, against the other wall. Now, over here, a sofa, just the right distance from the speaker; drapes for those windows; a man spends his money for one kind of recreation or another; let's make this one as close to perfect as possible.

The quest for perfection led through amplifiers. Next over the counter came a Scott 121-B pre-amplifier and a McIntosh 60-watt power amplifier. Result: "Wonderful sound . . . Also, not-so-wonderful rumble," for the Scott and the McIntosh amplified not only the perfection of music but as well the imperfections of the old-style turntable. Despite its valiant past service, the weak link in the chain had to go. Its successor: a Scott 710-A stroboscopic three-speed professional turntable with an ESL professional arm and cartridge.

Eureka

Now the Hartsfield and the amplifiers came truly into their own. So much so, in fact, that the new turntable soon acquired a mate—a Fairchild 411-H three-speed professional. The supply of discs, meanwhile was climbing rapidly. So was the popularity of the BOQ room that housed them, and things soon took on a communal aspect: Who had what composition recorded by which orchestra? Soon the corridors that had for years heard little more than talk of engineering, navigation, aviation and reactors, rang with cries such as: "Going into town? Good. Bring me back a Beethoven Number Nine. The RCA one by Furtwaengler and the Bayreuth Festival Orchestra and Chorus . . . And, say, there's a nurse below who wants the Von Karajan one of the Tschaikowsky Sixth. Columbia. Okay?"

It was more than O.K. Students from foreign lands—Chile, Belgium, Formosa, Japan—became interested. There was more to be learned here than the science of modern defense and warfare. In Lt. St. Ville's room alone, the collection of popular and classical records was already in the hundreds and the quality of sound reproduction "out of this world," obviously unsurpassable.

And then the inevitable happened.

It was the San Francisco Hi-Fi Show of 1958 that upset this monophonic apple cart. The new audio fans of the Postgraduate School had, of course, known about tape and the captivating advance of stereophonic sound; but this was the first time they had heard it on a grand scale—music so faithfully reproduced in "latitude and longitude" that it was as though a new dimension had been introduced to perception itself, even if that dimension was called an "illusion." One thing they knew for a certainty—the "unsurpassable" installation at the BOQ would never be the same again.

It wasn't. Stereo came in fast.

First: an AM-FM tuner (Scott 330-B) to bring in the AM-FM stereo broadcasts transmitted from time to time by the San Francisco stations; another pre-amplifier (Scott 121-C), and another McIntosh 60, to feed a second bass-reflex speaker—a home-made job resulting from a do-it-yourself program and consisting of a 15-inch woofer and two three-inch cone tweeters. The Fairchild turntable now acquired a Rek-O-Kut professional pickup arm and a Pickering 371-D magnetic stereo cartridge—which later gave way to a Fairchild 232 which, in turn, is now resting while a Shure Dynetic is being tried out.

The system was better than ever. But it was barely completed before it became inadequate. Too many shortcomings. For one thing, not many stereo discs were yet available. For another, much good stuff came over the AM-FM stereo broadcasts but was then lost. And already there was talk about the coming of multiplexed FM stereo broadcasting; more good stuff that would be lost—

(*Continued on page 78*)

Left: Center and right channel speakers and friends: Lt. E. L. St. Ville, Lt. Richard Avrit, Miss Danye Tamminga, and Miss Jean Meyers. Right: Left channel and center speaker systems. The piano, too, has been recorded on many an occasion.

Altec presents the 353A—
the ultimate in stereo power...
control...modern styling.

NEW ALTEC 50 WATT STEREO

AMPLIFIER • PREAMPLIFIER

Only Altec offers you so many features
in a single stereo unit—at such a low price.

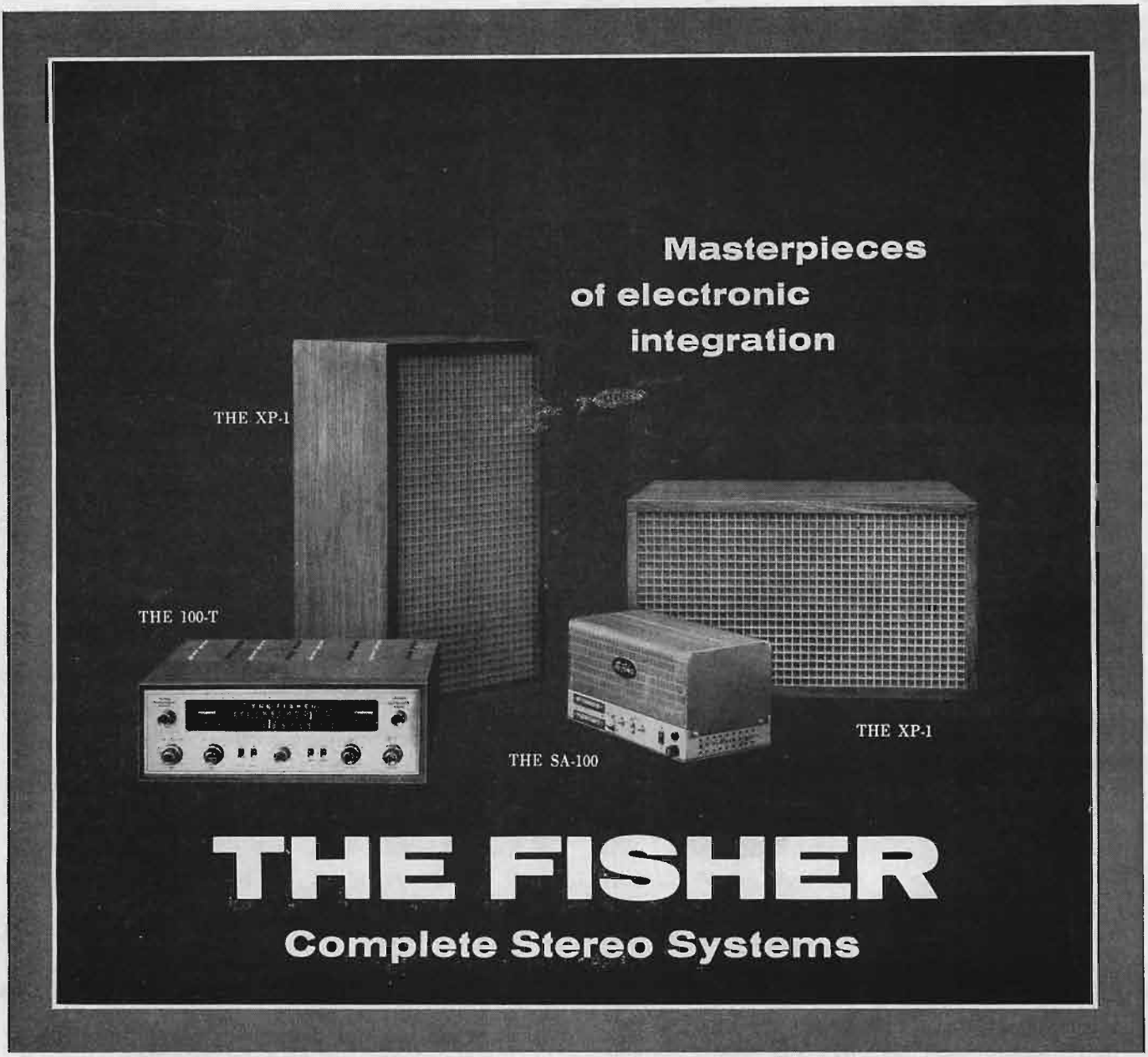
• 100 watts stereo program peak power, 50 watts rms continuous, 25 watts per channel (nominal), stereo or mono. • Matricing network for three channel stereo. • Entirely new fashion-coordinated design and colors (platinum pink and platinum gold) blend beautifully in any decor. • Highest quality components including full-size tubes, maintain reserve power to give top performance for years even under maximum operating conditions. • Simplified controls for greater ease of operation. • Exclusive Altec ventilation formula prevents overheating. • Feedback type equalization plus feedback all around tubes for minimum distortion. • Recorder outputs independent of gain and tone controls. • Dual microphone inputs for stereo recording. • 14 stereo or mono inputs: magnetic phono, ceramic phono, tape head, tape machine, radio, microphone, and multiplex. • 6 stereo or mono outputs: channel A and channel B recorder, left and right speaker, center channel speaker, auxiliary speaker. • Dimensions 5⅞" H x 15" W x 11¼" D (over knobs) • Weight: approximately 35 pounds. • PRICE: **$199.50**

CONTROLS: Input selector switch, Channel balance control, Dual Gain control, Dual Bass control, Dual Treble control, Stereo two channel—three channel switch, Stereo standard—reverse switch, Stereo—monophonic switch, Rumble filter switch, Loudness contour switch • DISTORTION: Less than 1% THD at 25 watts 1,000 cps, each channel; Less than 1% THD at 20 watts 30 to 15,000 cps each channel • FREQUENCY RESPONSE: ±1.0 db 20 to 20,000 cps at 25 watts; ±0.5 db 10 to 30,000 cps at 1 watt • TONE CONTROL RANGE: ±14 db at 50 cps; ±14 db at 10,000 cps • OTHER FEATURES: Auxiliary speaker connections for stereo or mono programs. AC circuit breaker for thermal overload protection, DC heater supply to low level signal tubes. Silicon rectifiers in high voltage supply.

ALTEC® LANSING CORPORATION

ALTEC LANSING CORPORATION, Dept. 10A
1515 South Manchester Avenue
Anaheim, California
A Subsidiary of Ling-Altec Electronics, Inc.

12-85



FISHER COMPLETE STEREO SYSTEMS are the result of a well-established fact that performance standards for stereo—*true*, full-dimensional stereo—are much higher than those for comparable monophonic reproduction. To meet those requirements in this, the fabulous age of stereo, we are proud to offer not one, but *five* complete stereo SYSTEMS. In each of them you will find components of the highest quality, and *perfectly* matched—not merely in appearance, but in function and performance as well. What is more, each system has been designed for simple and instant installation.

Plan to hear the FISHER Stereo Systems at your high fidelity dealer.

These FISHER components may also be purchased INDIVIDUALLY, *to augment the performance of any quality component you already own.*

WRITE TODAY FOR NEW STEREO LITERATURE!

FISHER RADIO CORPORATION • 21-29 44th DRIVE • LONG ISLAND CITY 1, N. Y.

Export: Morhan Exporting Corp., 458 Broadway, New York 13, N. Y.

Simultaneous Design

WILLIAM G. DILLEY*

A look into the newly created field of the "Audio-Architect"

THE PROBLEMS of audio-electronic engineers are quite straightforward and well understood. Not so fortunate is the audio-architectural engineer. The blending of these two fields, while logical, causes rise to problems not experienced in either separately. Whereas the audio engineer is usually dealing with technical subjects and technically trained people, the rapid expansion of audio into the home has thrown the audio-architect into direct dealing with the non-technical public. To him lies the task of resolving their musical whims in an architectural manner while still retaining his self respect as an audio engineer.

Internal, or built-in, installations can be designed with the conception of the home and offer no real problems, but the external, or free-standing designs can cause considerable audio compromise. The true audio fan is a joy to work with, since no architectural butchery is too great a price if the audio installation is perfect. This individual, however, represents a minority, since his interest usually results in a "do-it-yourself" project.

The "average custom installation public" (if such a generalization can be used) desires excellent audio reproduction but *without* grotesque objects and gadgets offending the eye. The primary consideration, obviously, becomes the speaker system, if of any significant size.

Excluding all audio labor, this design then is satirically defined as: The art of successfully obscuring mammoth objects and blending huge fixtures into the decor of their surroundings.

Such a task the author experienced in his own home. I am an advocate of huge horns and most certainly would, for, my own pleasure, prefer rack-mounted Ampex tape machines. Inasmuch as my living room must double as a "business" listening area for extracurricular advertising purposes, this approach was not permissible. The design must closely parallel a typical home installation. I allowed myself the one luxury of retaining horn design in the speaker systems, and set about the task of losing them in the room.

The console consists of an integral unit to house all electronic equipment and act as a limited storehouse for records and tapes. (Partitioned sliding drawer in bottom.) Since it was originally designed as a monophonic unit, the placement of some items is not now optimum.

A Grundig TM819 tape recorder was selected, because of its luxuries and attendant small size. The main consideration was the hysteresis synchronous motor with direct drive, and both direction and speed being controlled by motor windings alone.

A stereo head was added in place of one of the erase heads to convert to stereo, with no internal wiring or switching changes required. A dual channel pre-amp was designed to fit into a 3-in. space to the rear of the tape recorder and provides control for all stereo operation. The Fisher control on the front is used for all monophonic operation. Records are played on a Rek-O-Kut turntable with a Fairchild arm utilizing either Fairchild 232 (stereo) or Fairchild 225A (mono). The unit is powered by two Fisher 80AZ 30-watt amplifiers located below the turntable and tape deck.

The speaker systems were located opposite the main seating area in spite of the fact that no true corners existed for two corner designed speakers. One partial corner existed and was utilized, as shown in the accompanying photo. An extension was needed on one side to complete the horn and was further expanded to serve as room divider, planter, and TV cabinet. The enclosed cabinet allowed no ventilation, so the unit is supported ½" off the floor to allow normal chimney type ventilating action-exhausting through the open grille cloth extended around the corner (to carry the line of the speaker and break up the projection into the room).

The unit itself is, fundamentally, a Klipsch folded horn bottom with a modified Electro-Voice Patrician top, a four-way system.

The second speaker system is a specially designed four-way system utilizing exponential wood horns throughout, with the exception of the tweeter. Performance of the second system is quite similar to the first, despite a slightly higher horn cut-off frequency in the low bass folded horn. This design is quite representative of the task of audio design for a specific shape (available space) and associated architectural requirements. Æ

* *577 E. Avery St., San Bernadino, California.* Designer of the equipment shown on the cover of the September issue.

Fleetwood TV enclosed in cabinet to make artificial corner for Klipsch-type speaker.

Realistic Audio Engineering Philosophy

NORMAN H. CROWHURST*

The author presents the why's and wherefore's of the Unity-Coupled circuit which is the basic difference between McIntosh and other amplifiers, and according to the author it exemplifies the progressive approach to amplifier design.

THERE SEEM TO BE two basic approaches to the design of an amplifier. In one a price is decided upon, according to the intended market, and then different circuits are investigated, with careful cost comparisons, to find out how good the amplifier can be made within the price already fixed upon. This approach may lead to extremely competitive pricing of amplifiers but it is not conducive to progressive design. Instead design is tied to old-established readily-obtainable components, and research into new components is to be avoided.

Progressive design cannot be restricted by "what has always been done." The original unity-coupling patent broke away from accepted circuitry, and required one special component to do it—the bifilar-wound output transformer. Pentodes (or tetrodes) had become established as the most efficient way to achieve output power. Operated in Class B, the efficiency is extremely attractive. But certain distortions were previously "inherent" to this kind of circuit. Unity coupling resulted because its inventor did not accept their inherent nature, but found an effective way to eliminate them.

This article does not aim to tell you that the McIntosh line of amplifiers is the best. The often-asked question about which is the "best" amplifier is incapable of an *unqualified* answer. The McIntosh approach is one very good way to make amplifiers whose performance rates high, and it exemplifies the realistic engineering philosophy. But before getting into the real "meat," one minor, but common, source of confusion needs clarifying; the words "unity coupling" are applied to more than one circuit. Beside the circuit discussed here, a variety of single-ended push-pull also has this name.

The so-called single-ended push-pull method of operation uses two tubes in the output, connected in series between B+ and B−. (*Fig.* 1). In the quiescent condition, with no signal passing, half of the total B-supply voltage is across the upper tube and half across the lower tube. Driving the grid of one tube positive and the other negative causes the voltage distribution to change. Interposing a load between this center tap point and ground reference, which is at the same a.c. potential as either B+ or B−, causes a variation in current through the two tubes as well as a variation of voltage across them. In this way, by suitable matching, each tube works with a load line very similar to operation in normal push-pull.

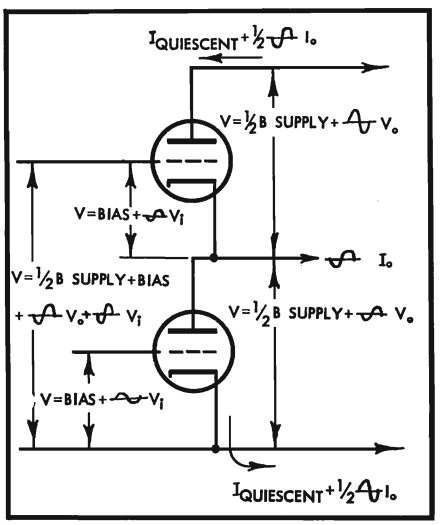


Fig. 1. Signal and supply current relationships in the so-called single-ended push-pull circuit. This also has been called "unity coupled," but is not to be confused with the circuit so named in this article.

One major problem arises with this circuit because the reference point for the upper-tube grid is not ground while that for the lower one is. This means that the drive excursion provided for the lower tube has to be just the necessary grid drive, while that for the upper tube has to be the grid drive in addition to the audio output voltage. Thus an *unbalanced* phase splitter is needed. This produces a circuit much more susceptible to distortion than is the true push-pull arrangement, even when the correct load resistance is applied to the output. Practical operating conditions, of course, never apply the true load resistor for which the amplifier is designed, but a loudspeaker, in which the load impedance deviates with frequency and includes reactive components. With this kind of a load, one tube produces all the output, while the other produces all the distortion.

Some variations of the single-ended push-pull circuit use a feedback compensating arrangement that readjusts the grid drive to the two tubes to balance out for this variation. However, even with such arrangements, the basic circuit introduces more distortion than the conventional push-pull arrangment.

The redeeming feature in the claims made by the designers of the single-ended push-pull circuit is the large amount of feedback that can be applied, due to avoidance of the hitherto necessary output transformer. This design permits as much as 40 db of over-all feedback to be applied. Thus, even with distortion figures in the region of 40 per cent, it is possible to end up with a resultant distortion in the region of 0.4 per cent, which looks quite an acceptable figure. But this figure overlooks two important facts: (1) the nominal figure of 0.4 per cent distortion is only obtainable *working into a resistive load,* such a circuit must inherently produce much more distortion when practical loads are applied; and (2) even the 0.4 per cent is relatively high distortion.

The idea that avoidance of the output transformer has automatically freed us of many of the distortion problems that have come to be regarded as coincident with this component is mere wishful thinking. Unity coupling, however, is built around a rather special kind of output transformer.

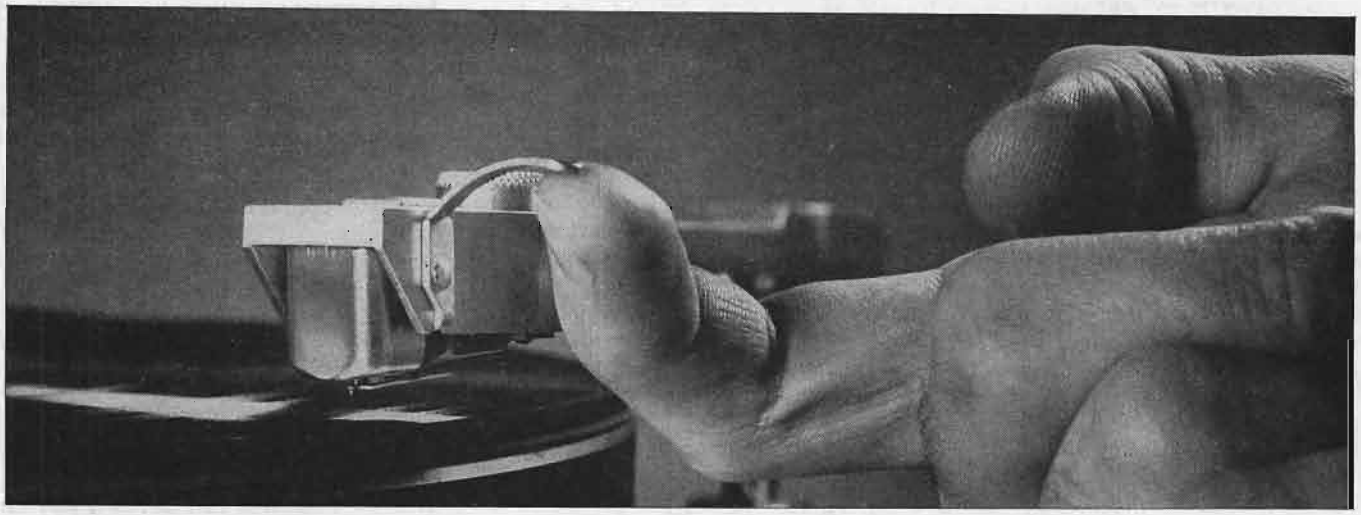
Class-B Operation

For some time now it has been realized that the most efficient output tube to use is a pentode or beam tetrode, and further, the most efficient way of using a pair of output tubes is to work them in class B, or as near to this condition as possible, so that the quiescent current is

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

General Electric's all-new VR-22 Stereo Cartridge

Outstanding in all four critical areas....



A masterpiece of stereo cartridge design and manufacture, the VR-22 is outstanding in all four critical areas of stereo cartridge performance: *Channel separation*—Up to 28 db for maximum stereo effect. Nothing higher on the market! *Response* — Smooth and flat for superior sound from 20 to 20,000 cycles (VR-225), 20 to 15,000 cycles (VR-227). *Freedom from hum*—triple-shielded against stray currents. *Compliance*—Tracks precisely, not a trace of stiffness. Hear it at your dealer's soon.

VR-225 with .5 mil diamond stylus for professional-type tone arms, **$27.95***. VR-227 with .7 mil diamond stylus for record changer or turntable, **$24.95***.

TM-2G Tone Arm—a professional-type tone arm designed for use with General Electric stereo cartridges as an integrated pickup system, **$29.95***.

*Manufacturer's suggested resale prices.

Acclaimed by the experts!

Oliver P. Ferrell
Editor
Hi-Fi Review

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

Wm. A. Stocklin
Editor
Electronics World

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

C. G. McProud
Editor and Publisher
Audio

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

For the finest monaural performance, too: the VR-22 or the famous VR-2.

Audio Components Section, Auburn, N. Y.

GENERAL ELECTRIC

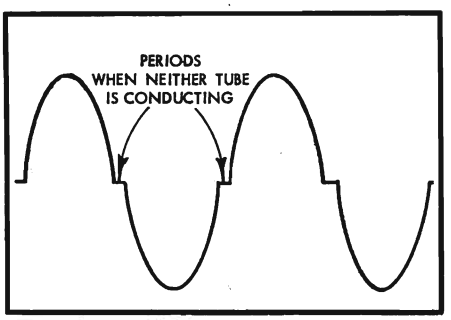


Fig. 2. Effect of overbias of class-B output tubes on waveform, showing crossover distortion.

quite low and large plate current excursions are only drawn when there is a large audio signal.

One of the problems of class-B operation is that incorrect bias can produce a form of distortion known as crossover distortion. This is due to the fact that transition from operation with one tube in one half cycle to the other tube during the other half cycle is not a smooth one. Crossover distortion shows up when the tubes are over-biased so there is a short period during which neither tube conducts current. This produces the waveform shown at *Fig.* 2.

In the early days of class-B operation much was said about this form of distortion, although it proved to be fairly easy to eliminate it by careful attention to bias arrangment. Some of the early class-B amplifiers, using transmitting type triodes with higher-than-normal plate-supply voltage, and extra high grid bias to match, were extremely efficient amplifiers in the higher wattage ratings. However, these amplifiers required extremely carefully designed drive as well as output transformers and a very well regulated plate supply. And the use of at least two transformers in the amplifier rendered them difficult for application of any degree of feedback, although the distortion of well-designed units was not more than that of well-designed class-A amplifiers of the period.

Improved tube techniques led to the use of pentodes and beam tetrodes more extensively as output tubes and circuits employing these could certainly deliver a bigger output more efficiently than their earlier predecessors. The one fly in the ointment about using beam tubes or pentodes in class-B operation proves to be the so-called "notch" distortion. This has been confused with crossover distortion but it is not the same thing. To some extent it is due to *similar* causes. Both distortions occur with tubes biased to operate in class-B.

While notch distortion proves almost impossible to avoid with pentode or beam tetrode output tubes, using normal transformer construction methods, it is not limited to these tube types. The lower plate resistance of the active tube in a push-pull triode circuit can contribute to the damping of the notch oscillation, which will not happen in the pentode circuit. The notch is excited by the sudden transfer of plate current from one half of the primary winding to the other, which triggers the resonance of the inactive winding, between its self-capacitance and the leakage inductance to other circuits, the secondary with its load, and the other half primary with its tube plate resistance.

The leakage inductance resonating with primary capacitance is damped only by the load resistance on the secondary (usually in between the two primaries) and by the plate resistance of the tubes in shunt with the effective resonant circuit. (*Fig.* 3). Plate resistance in a class-B circuit has a widely fluctuating value and in effect becomes almost open circuit at the crossover point, which stimulates the resonant circuit at the point where it is shock excited, especially when the exciting frequency becomes higher so as to approach more closely the resonant frequency.

For this reason, with even a moderately well-designed output transformer an amplifier employing pentodes or beam tetrodes in class-B push-pull would produce notch distortion at frequencies from 3000 cycles and up. It might be thought that over-all negative feedback would successfully eliminate the notch. But this does not occur, because the resonant frequency of the notch itself is also at a point where the feedback stability characteristic approaches its marginal condition. This means that, at best, the feedback will not improve the notch distortion and, at worst, it may considerably exaggerate it.

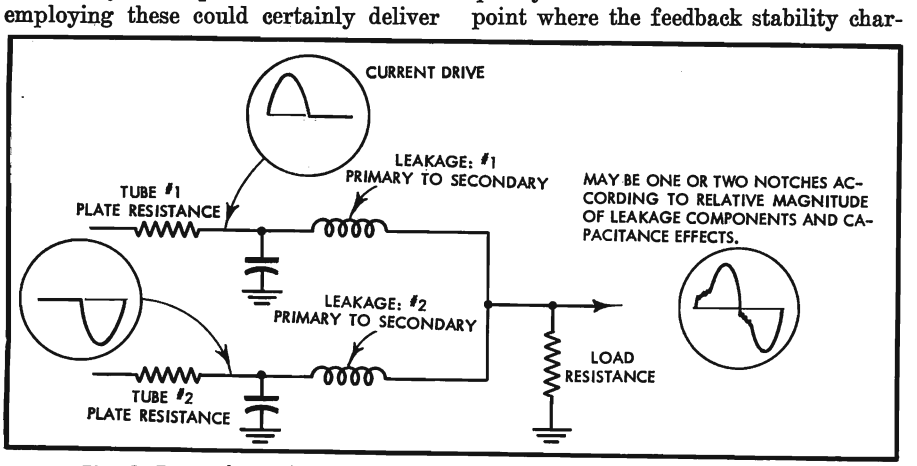


Fig. 3. Equivalent circuit of the quantities that cause "notch" distortion.

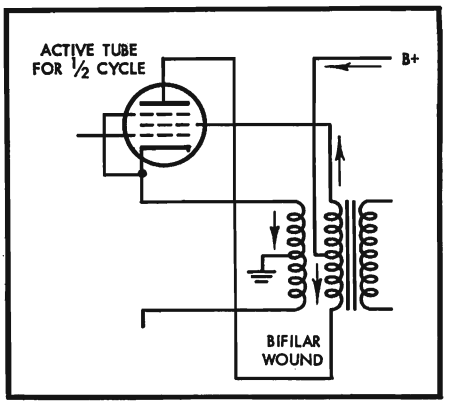


Fig. 4. How the bifilar-wound, unity-coupled circuit avoids the leakage flux transfer impulse that causes notch distortion. As plate current is equal to cathode current minus screen current, the effective current in both half-windings (regarding the bifilar pair as a unit) is always equal.

Eliminating Notch Distortion

How then can notch distortion be eliminated from this kind of output circuit? Two steps can be taken towards this end: (a) to bring the resonant circuit causing notch distortion nearer to critical damping; (b) to eliminate the excitation of the notch, due to the effective transfer of current suddenly from one winding to another.

Using straight pentode class-B operation, it might be possible to reduce primary capacitance by careful winding procedure. But this would merely push the notch frequency (i.e. its sharpness) out further, by raising the resonant frequency and correspondingly raising the point of marginal stability, where feedback ceases to help.

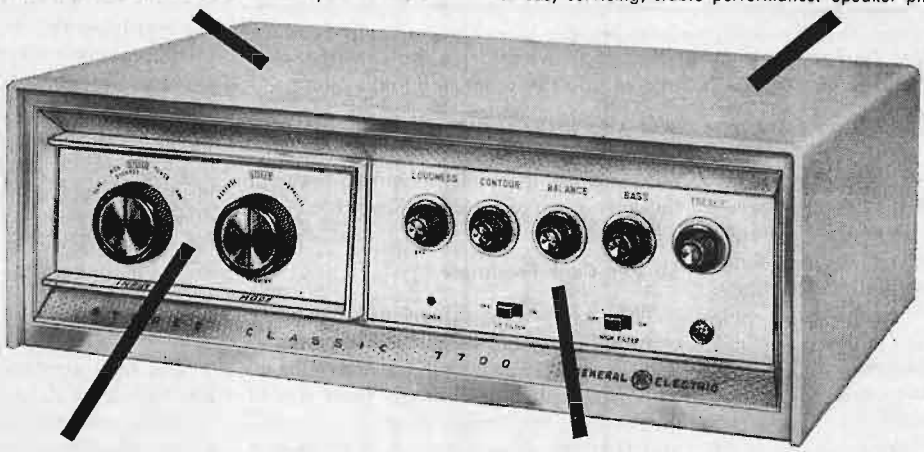
Reducing the leakage inductance, on the other hand, will increase the damping provided by the load. While this might conceivably eliminate notch distortion *into a resistance load,* it might reappear when a reactive speaker load is used.

Excitation of the notch occurs due to leakage inductance *between halves* of the primary, so that transfer of current from one half to the other induces a voltage kick in this inductance. Part of the solution, then, rests in eliminating or minimizing the leakage inductance between halves of the primary winding. Adequate results could probably be obtained by reducing the referred leakage inductance between primary halves to a small fraction—in the region of 1/10—of the leakage inductance between the primary and secondary. This method is necessary for a transformer intended for ultra-linear operation, if the ultra-linear

new General Electric stereo amplifier

Power: 56 watts (28 watts per channel) music power. More than enough to drive even low efficiency speakers. Response flat (±0.5 db) from 20 to 20,000 cycles, with less than 1% distortion. Channel Separation 40 db.

Soundly engineered: Power tubes at the extreme back for more ventilation, cooler operation. U. S. tubes used throughout. Advanced circuitry for easy servicing, stable performance. Speaker phasing switch at rear.



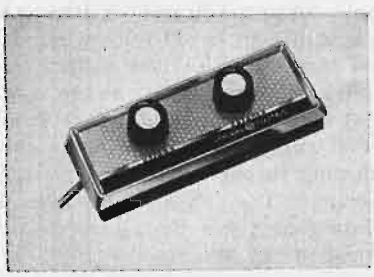
Nine inputs and four outputs: controlled quickly and functionally with two multi-purpose controls. For stereo and monaural cartridges, tape heads and tuners. Gives you flexible command of inputs and complete selection of speaker combinations.

Sensitive music controls: Loudness: combined with power on-off. Contour: for automatic bass boost at low volume. Balance: continuously variable to "off" on either channel. Bass and treble: dual concentric type to adjust channels together or separately for use with non-matching speaker systems.

56 watts of power, soundly engineered, a versatile beauty. From front to back, a remarkable achievement at $189.95*

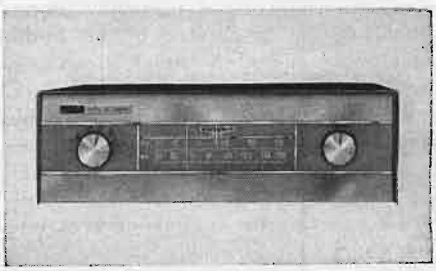
Designed for beauty and value: Featuring a recessed front panel, the G-7700 comes complete in a beige vinyl case, the G-7710 in a white vinyl case. The price is a modest **$189.95***, including case. (The G-7600 delivers less power, 20 watts per channel, has nearly all the above features. In saddle brown vinyl case **$139.95***.)

*Manufacturer's suggested resale prices.



Remote Control RG-1000. Two knobs permit adjustment of channel balance and volume up to 30 feet from amplifier — without moving from your chair. 30 foot cord included. **$14.95***

FM-AM Tuner, Series FA-15. Receives even weak signals with unusually low distortion, hum and noise level. Drift-free. Visual meter for pinpoint FM center channel tuning and optimum AM signal tuning. RF amplifier stage in both FM and AM increases sensitivity. FM multiplex jack for stereo adaptor. Built-in AM antenna; FM dipole included. Colors match General Electric amplifiers. **$129.95***



See and hear the General Electric Amplifiers and Tuners at your Hi-Fi dealer's now.

Audio Components Section, Auburn, N. Y.

GENERAL ELECTRIC

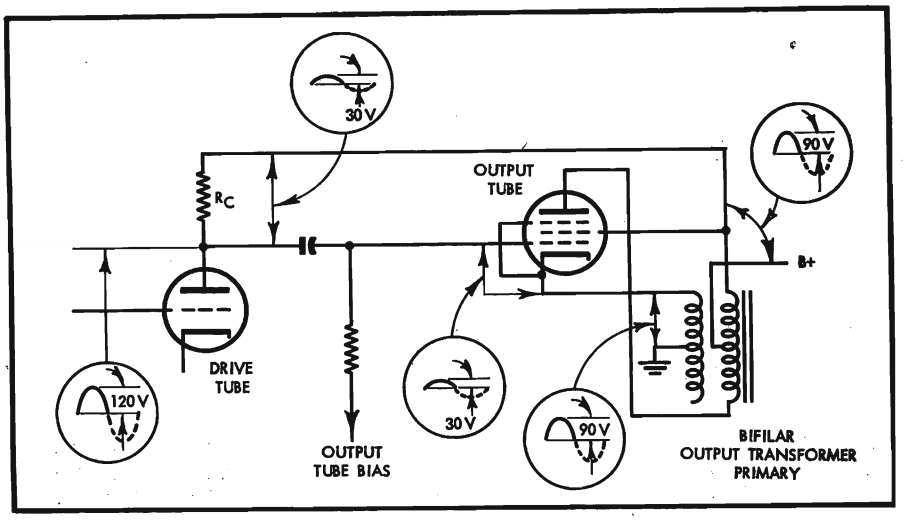


Fig. 5. How the bootstrap circuit works, by making the screen swing help produce the required grid drive. Dashed portions of the small waveforms indicate the part during which the output tube shown is inactive and the other one takes over.

counterpart of notch distortion (an even worse animal) is to be avoided.

However, the approach adopted by McIntosh is more of the "brute force" type, by reducing the leakage inductance between primary halves to vanishing point with the use of bifilar windings. At the same time the use of unity coupling makes a double step to prevent any kind of load from allowing even a suspicion of notch distortion to return. (See *Fig.* 4).

In the first place the significance of the term "primary half" is changed. The primary winding is divided, not in two parts as in the normal push-pull, but into four parts. The whole of the winding connected in the cathode circuit is wound bifilar with the whole of the winding connected in the plate and screen circuits. In this way an equal number of primary turns is interposed between cathode and ground as that between plate or screen and B plus. The cathode and screen of each tube are connected to the same end of the bifilar pair while the plate is connected to the opposite end. As the two windings are wound in such close proximity as to be virtually only one winding, this means that each of the tubes is effectively connected across the whole of the primary winding. When, during one peak of an audio signal, only one of the tubes is conducting, the whole of the primary winding, in effect, is carrying the current of this tube, one half of one of the bifilar windings carrying the plate current, while the other half of the other bifilar windings is carrying the cathode current (see *Fig.* 4).

This means the effective leakage inductance between the circuit that conducts during alternate half cycles, when transition takes place from one tube to the other, is so small as to be negligible. Leakage inductance between primary and secondary, of course, forms one of the parameters for the design of the over-all feedback network, but this does not introduce any form of notch distortion, because it is not interposed between these two output tubes themselves.

50 Per Cent Feedback

The second advantage of the unity coupling arrangment is that it provides what may be called 50 per cent feedback. This means that the β of the plate circuit of the combined tubes is effectively 0.5, and half the output voltage is developed between cathode and ground and half between plate and B+. This reduces effective plate resistance "seen" by the combined primary of the transformer to a point that constitutes more-than-critical damping of the resonance primary capacitance and leakage inductance at all points on the waveform, and into all kinds of output load.

As with other circuits of this type, a very large grid swing is required to provide the necessary grid-to-cathode drive voltage, in addition to the cathode-to-ground half of the output voltage. This cathode degeneration also provides from 12 to 15 db under nominal load, according to tube type and operating conditions chosen, of linearization. This results in a damping factor between 4 and 5 before any over-all feedback is applied (this will be slightly modified as we shall see later, by the drive arrangement).

An interesting point to note here—not exclusive to this circuit—is that the damping factor of a pentode output stage, calculated on the usual basis of on-load gain, is approximately independent of the plate resistance of the tubes. A gain reduction, onload, of 4:1 (12 db) yields a damping factor of 4. The gain reduction of the circuit without the load would be at least 20 db greater than the calculated figure, because the gain of the tubes with open-circuit plate loading rises this much.

There are two advantages to linearizing an output stage in itself rather than by over-all feedback. Use of a tightly coupled arrangement, such as this, makes the degree of linearization practically independent of output loading. With normal pentode operation, changing the output loading can change the feedback from its nominal 20 db or so, up to over 40 db—without taking into account possible phase effects. Utilizing this method gets the damping factor above unity without any risk, and stabilizes the over-all feedback to within a db or so (and phase to a few degrees).

The other advantage is that use of over-all feedback to linearize a distortion basically produced by the output stage *deliberately distorts* the waveform handled by the *relatively* linear part of the amplifier (by as much as 40 per cent in the example quoted earlier). By linearizing the output stage *as an entity,* which is achieved by the use of a circuit such as unity coupling, this problem does not arise. Then the over-all feedback can be used to reduce the residual low-order distortion present in the output circuit to an even lower percentage and to get an even higher damping factor.

Grid-Drive Problems

The next problem with this circuit is the high grid-drive voltage required because of the cathode degeneration. The drive swing required is much more than that normally available at the plate of a preceding push-pull driver stage. The simplest way to overcome this problem (and by far the best) is to use the so-called boot-strap circuit. By coupling the top end of the driver plate resistors to the end of the primary winding of the transformer that swings positive when the grid drive requires to be positive, a form of positive feedback is achieved. (*Fig.* 5).

Assume the grid drive required, from grid to cathode, to be 30 volts and the output voltage per tube 90 volts from cathode to ground and 90 volts from B+ to plate or screen. This means the grid requires a total swing of 30+90 or 120 volts. But by returning the plate-coupling resistor to the 90 volts swing point, there is still only a 30-volt swing developed across it. This means the *effective* value of the resistor, from the viewpoint of the driver plate, is four times its actual value, because the audio current flowing through the actual resistor is accompanied by an audio voltage at the plate four times the audio voltage developed across the resistor itself.

From the d.c. point of view, the drop in the resistor is just that due to its actual value, because the d.c. voltage at each end of the plate and screen winding of the output transformer is sensibly the same as B+. Consequently this positive feedback effect enables a dynamic load line to be employed on the drive tube of

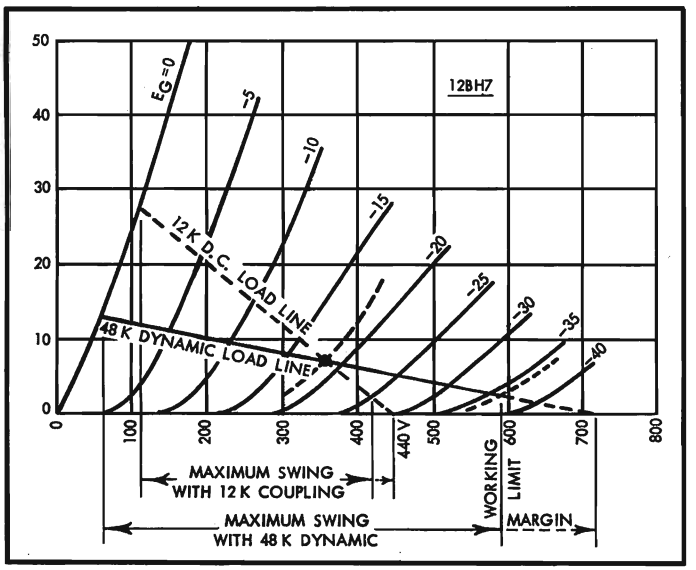


Fig. 6. Operating conditions actually used in the 12BH7 for the MC-30 amplifier, showing how the bootstrap increases the available swing the tube can handle, by a factor much more than it increases its gain.

four times the d.c. value, in this particular example. In other cases it may be more or less according to the degeneration produced in the cathode circuit of the output stage.

This improves the available swing in two steps. First it increases the operating plate voltage and current by allowing a lower actual value of resistor to be used. Then it increases the available audio swing by raising the *effective* value of this coupling resistor. This is illustrated by means of dynamic load lines in *Fig.* 6.

Another way of viewing this is that in a sense now the driver stage only has to provide the grid-to-cathode swing in its plate circuit, instead of the complete grid swing. This being the case one would imagine at first sight that the positive feedback would undo some of the beneficial results of the negative feedback. The reason this does not happen is that the positive feedback is not effectively so great as the negative feedback, although at first sight it might appear this way, because of the change of the effective value of resistance in the plate circuit of the driver tube. Also the positive feedback is not materially dependent on output loading, as is the negative feedback.

In this particular case the plate resistance of the drive tube is in the region of 7500 to 8000 ohms and the plate coupling resistor is 12,000 ohms. This means the realizable *gain* of the tube, without positive feedback, would be approximately 3/5 of its amplification factor. So increasing the *effective* resistance of the plate coupling resistor by positive feedback can only increase the gain of the drive stage by a maximum of 5/3 (assuming the effective value is increased to infinity).

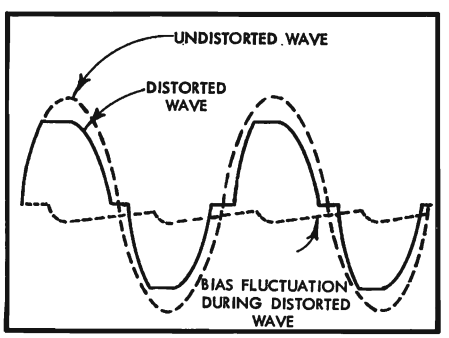


Fig. 7. Kind of distortion often produced in a fixed-bias amplifier, due to grid current biasing back.

Bootstrap Circuit

While this bootstrap circuit only increases the available *gain* of the drive stage by approximately 50 per cent it increases its available *swing* to considerably more than double, because it virtually extends the region of linear operation by allowing a greater grid input swing to be effective. The steeper slope of the 12,000-ohm load line runs into cutoff much sooner than the shallower slope of the 48,000-ohm load line.

The plate resistors for the bootstrap drive circuit need to be of adequate power rating, because the increased efficiency of the circuit raises the available plate-circuit dissipation. They also need to have close tolerance to maintain uniform operating points.

It has often been noted that class-B output circuits often do not *seem* to give so much output as circuits using nearer to class-A operation, using automatic or cathode-bias circuits. The reason for this is traced to what happens when overload begins to occur. The automatic-bias circuit self-compensates for overload by producing cathode degeneration of the overload component of the signal. With fixed-bias circuits, which have to be used for class-B operation, the cathode circuit returns to ground. If the grids make any excursion positive at all, this will produce a negative charge momentarily on the coupling capacitor from the driver plate. This will invariably overbias the tubes for a period of more than the average audio cycle and thus produce quite noticeable distortion very quickly.

Usually the grid resistor has to be of fairly high value to prevent loading down the drive stage. This is still true with unity coupling. Although a 12,000-ohm resistor produces an effective value of 48,000-ohms due to the positive feedback, the grid resistor has to be returned virtually to ground (actually to fixed bias negative) and consequently its effective value is the same as its actual value. If a large value resistor, in the region of 330k, which is usually recommended for this position, is used, the biasing-back effect will last for at least a cycle of the audio waveform, consequently the next excursion through crossover will show crossover distortion, as illustrated at *Fig.* 7.

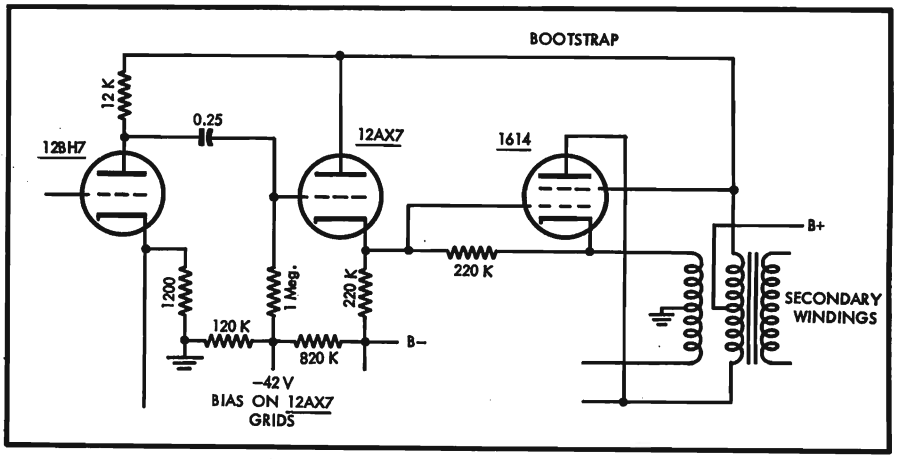


Fig. 8. Interposing a cathode follower (the 12AX7) between the bootstrap drive (12BH7) and the output tube (1614) grids completely prevents the kind of distortion shown in Fig. 7.

This can be avoided by using a capacitor value such that the discharge time is shorter than one period of the audio waveform but this would mean an excessive low-frequency loss due to the combination of coupling-capacitor and grid-resistor values. This may be offset to some extent by the over-all negative feedback, but it increases the demand on

The verdict is in!

DUAL-1006
combination stereo turntable/changer
TESTED AND ACCLAIMED THROUGHOUT THE HIGH FIDELITY AND MUSIC INDUSTRY

CONSUMER PUBLICATIONS

Hi-Fi Systems

"... best unit in its class, regardless of price ... must be seen to be believed ... one of the gentlest record drops we have ever seen ... electrical tests indicate rumble characteristics as good or better than those specified for broadcast-type turntables."

Modern Hi-Fi

"... the DUAL is an outstanding machine ... it shows a uniformly high level of performance in every respect ... standards were exceptionally high in each critical testing area, especially in such vital aspects as wow, rumble, flutter and hum."

QUALITY CARTRIDGE MANUFACTURERS

Fairchild

"... we put your machine through an extensive laboratory check ... we congratulate you on (its) excellence ... tracking was perfect ... automatic operation consistent and reliable ... truly does justice to and amply meets the requirements of top quality stereo cartridges."

Pickering

"... tests included all customary measurements ... including 'torture tests' designed to show up any malfunctioning ... it came through with flying colors ... tracking is all we could ask for...trip mechanism functioned smoothly ... our unqualified approval ... you have a beautifully simple and efficient product."

Full reprints of current and forthcoming evaluation reports will be sent upon request.

TECHNICAL PUBLICATIONS

Edward Tatnall Canby in Audio

"... the first time I saw it, I couldn't believe my eyes ... the DUAL is absolutely silent in use; the motor is so quiet you must put your ear to the table to hear it ... rumble and pitch steadiness are absent and excellent respectively ... real manual automation ... it will do more things that please me ... than any changer so far."

Electronics World

"... one of the best stereo record changers we have seen to date ... the wow and flutter is as low as in some professional-type turntables ... we suggest that anyone who is interested in a changer for stereo hi-fi operation make sure that the dealer demonstrates this one for you."

MUSIC PROFESSION PUBLICATIONS

Downbeat

"... brand new sleeper ... very high quality ... excellent facilities for manual operation ... arm adjustment easier than on any other machine ... well worked-out arrangement for off-on manual playing ... they seem to have thought of everything."

Billboard

"... I have been giving the player a real workout ... and I must say that it passes every test. It's as good as I thought it was and as good as you claim. In short, it is tops."

You will find the DUAL-1006 only at selected authorized United Audio dealers.

united audio
PRODUCTS OF DISTINCTION
202-4 East 19th St., N.Y.3, N.Y.

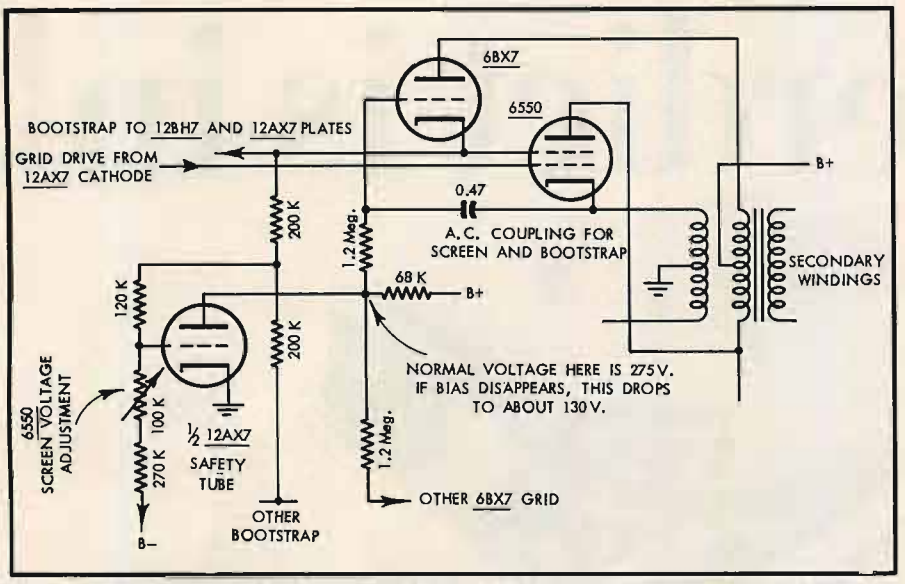


Fig. 9. Addition of another cathode follower (6BX7) to feed the screen of the output tube (as well as the bootstrap) enables unity coupling to be applied to tubes using pentode operation with different quiescent plate and screen voltages.

the driver stage at the low-frequency end to an impossible degree.

The only positive way to eliminate this effect is to have the output tube direct coupled to the tube that immediately drives it. This is possible by using a cathode-follower stage interposed between the bootstrap drive stage and the output tube grid. The driver stage can then be resistance/capacitance coupled to the grid of the cathode follower stage and everything works quite happily.

The cathode-follower stage is bootstrapped as well, which enables a low-current high-mu tube, such as a 12AX7, to be used to good advantage (*Fig.* 8). Although the actual resistance, from cathode to the negative return point necessary to provide the correct operating condition for the tube, is of value 220k, the effective a.c. resistance at this point is in the region of 600 to 1000 ohms—the effective cathode resistance of this tube operating as a cathode follower.

Direct bias for the output tube is controlled by the grid bias of the cathode-follower stage. To achieve this the negative voltage provided for the cathode return of the cathode follower is potted down by two resistors so that the negative point for the grid circuit is just right for the output tubes.

Just one more refinement to be necessary. Before the tube starts to conduct, during warm-up, the cathode of the 12AX7 and the grids of the output tubes are at the maximum negative potential of this return point, because there is no current flowing through the cathode resistor of the 12AX7. This means the cathode/heater potential of the 12AX7 can be excessive. To avoid this possibility a further resistor of 220 ohm is connected between cathode of the cathode follower and cathode of the output tube, thus forming a voltage divider to limit voltage during warm-up. In operation this will only have small audio voltage across it, and consequently represents negligible audio loading.

One more circuit has been developed for use with the unity-coupled output stage to enable it to be applied to tubes that can give considerably more output by operating the plates at much higher potential than the screens. To achieve this, a further cathode follower tube is inserted in the screen feed to the output tubes. The grid for this cathode follower derives its audio voltage from the cathode of the tube it feeds, while the d.c. potential is supplied through a separate control tube, half of a 12AX7, which combines a safety function, making the screen voltage drop almost to zero in the event the grid-bias voltage should disappear for any reason. This action is illustrated in the partial schematic of *Fig.* 9.

The feedback arrangement of the unity-coupled amplifiers is pretty much in conformity with general feedback practice, utilizing a resistor with phase-correcting capacitor from the secondary of the output transformer back to the pre-phase-splitter cathode.

The Output Transformer

In some of the more modern unity-coupled amplifiers, the output transformer has been elaborated somewhat from the simple bifilar arrangment originally used for providing just loudspeaker impedance tappings. For some applications a 70-volt or 600-ohm tapping is required. One method of achieving this was take tappings from the primary side, utilizing the section connected to ground in the cathode circuit. A 70-volt output could be achieved by using the ground point and a suitable tapping, while the 600-ohm output requires two tappings, or in some instances a connection to the tube cathodes. (*Fig.* 10).

A disadvantage of this method for some systems is that the 600-ohm or the 70.7-volt circuit, as the case may be, is permanently attached to the amplifier ground, because it uses the actual cathode winding. To overcome this disadvantage, so that ground isolation can be achieved when necessary, either for hum reduction in the system or to conform with system regulations, the output transformer is stepped up from *bi*filar windings to "*tri*filar" windings. In this way a section of the transformer, wound at the same time as the primary, is used for the high-voltage outputs, 70 volts and 600 ohms, while a separate winding, wound bifilar with the secondary, is used for the feedback. This enables the secondary also to be isolated. In some instances parts of the secondary are also wound trifilar to enable other combinations of impedance to be achieved, not so readily possible with just a single winding.

There is one more important feature improvement in the unity-coupled circuit from the original arrangment. This is a device to improve the transient-handling capacity of the amplifier. Because the amplifier uses resistance smoothing, the impact of a transient alters the supply voltages. These voltage changes can put an asymmetrical transient through the system, because they get referred to the single-ended part of the amplifier.

To overcome this effect, a "long-tailed" splitter is used in which the grid return for the second half of the inverter is not coupled directly to ground, but through a time-constant circuit that produces an

(*Continued on page 113*)

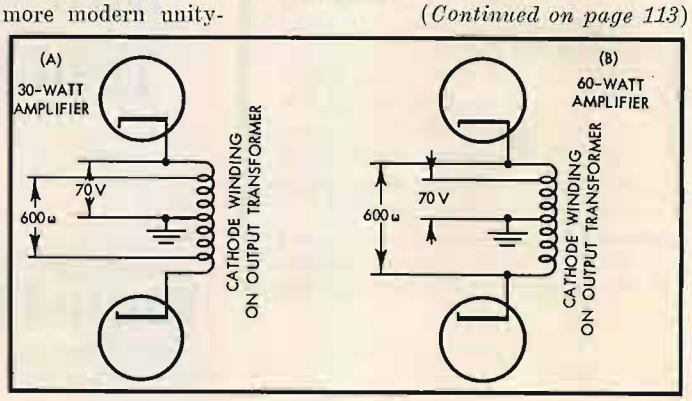
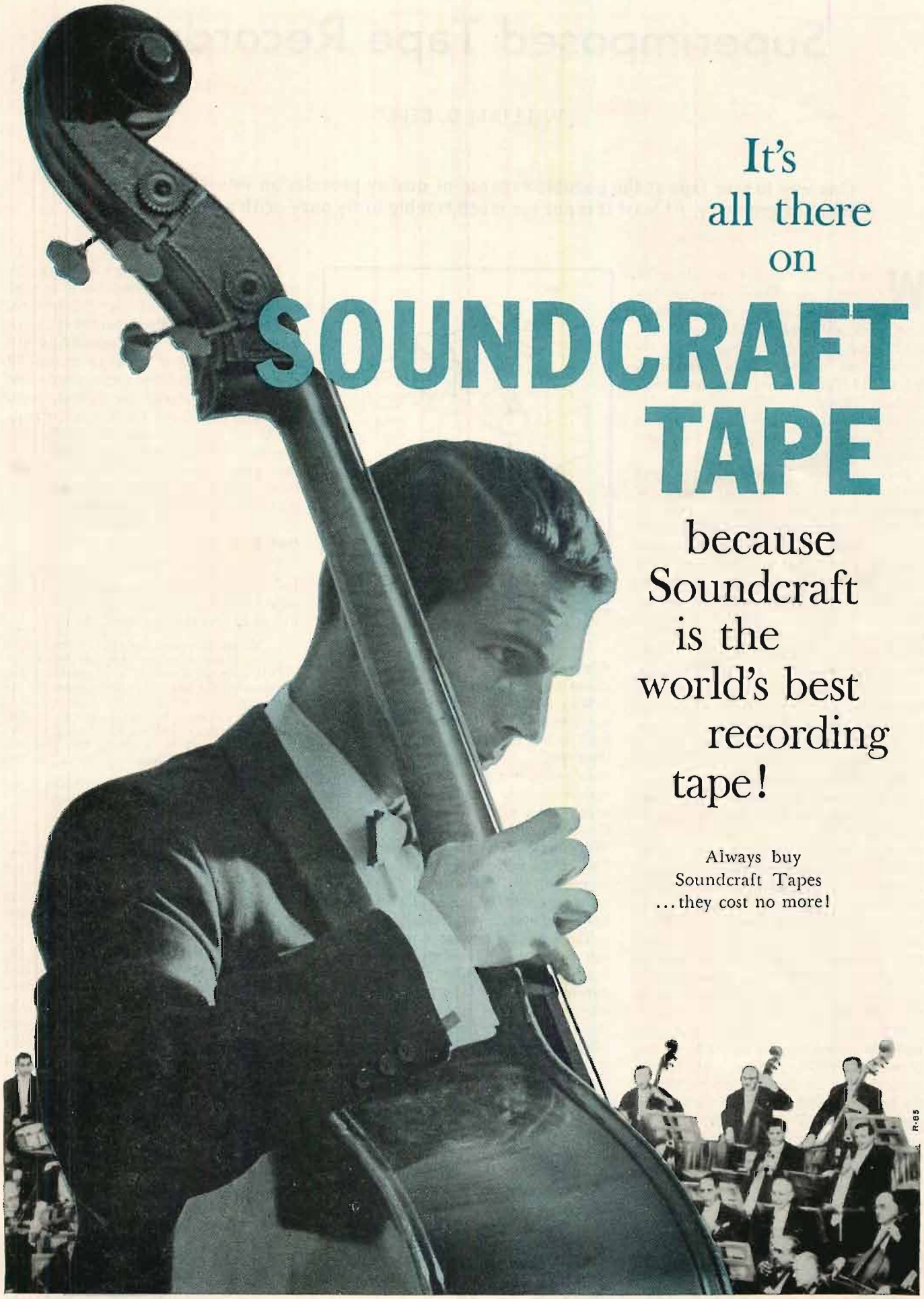


Fig. 10. Different ways of picking off 600-ohm or 70-volt outputs, according to power and impedance of the output circuit. In some professional types, these tappings are separated by trifilar winding.



It's
all there
on

SOUNDCRAFT TAPE

because
Soundcraft
is the
world's best
recording
tape!

Always buy
Soundcraft Tapes
...they cost no more!

REEVES SOUNDCRAFT CORP., GREAT PASTURE RD., DANBURY, CONN., CHICAGO: 28 EAST JACKSON BLVD., LOS ANGELES: 342 N. LaBREA, TORONTO: 700 WESTON RD.

Superimposed Tape Recording

WILLIAM D. BELL*

One way to save tape at the possible expense of quality provides an interesting experiment in geometry. At least it is not too much trouble to try out—with a little ingenuity.

WHAT WOULD YOU SAY to making 10 different recordings, one on top of the other, on a ¼-inch magnetic tape with a conventional single-track head? And then playing *any* of the recordings at will? Sounds impossible, doesn't it? Yet, at least two computing-machine laboratories have independently discovered this recording trick—a method you can try for yourself on your own tape machine.

Recording multiple tracks on the same section of tape is easy, of course, if separate heads are employed and the tracks are kept separate. This was the method used in an elaborate system, built by Ampex for Les Paul and Mary Ford, which recorded eight tracks on one-inch tape. With separate record, erase, and playback controls for each track, this Ampex-built machine was ideal for the multiple recording techniques for which Les Paul is famous.

However, recording separate and distinct tracks on different parts of the tape is not the method I am describing here. Rather, one track is recorded right on top of another, as stated before.

The guided-missile people also record several separate channels of data on one track. Each measuring transducer modulates an audio tone of restricted band width. A number of transducer signals are then mixed and the composite signal radioed to a ground receiving station. The tape-recorded signal can then be played back through appropriate filters and each separate signal isolated. Thus, this telemetry method works because there is no overlap of the frequencies of the various channels. Again, this is not the method described here.

What, then, is the method that permits multiple recordings to be made on top of each other? The answer, quite simply, is to change the angular orientation of the head gap with respect to the tape for each recording. To play back, a recording is selected by choosing the same angular position for the head as was used for the original recording.

Alignment

In normal operation, the head gap is accurately aligned at right angles to the tape. Ampex claims in its literature that this azimuth angle is held to plus or minus a single minute of arc.

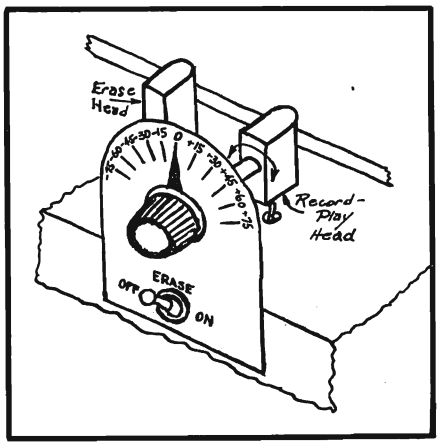


Fig. 1. Diagram of the basic arrangement of the tiltable head. It would be preferable if the head were mounted closer to the indicating scale, however.

Why is such an accurate manufacturing specification imposed? What if the head is not accurately perpendicular to the tape?

In reply, if a tape recorded on an accurate machine is played back on one with a bad azimuth angle adjustment, the signal strength will be reduced. Worse yet, there will be distortion. In fact, if the azimuth angle is deliberately increased, the output will become increasingly garbled until it finally can no longer be heard.

These are the reasons a recorded tape can sound horrible when played on a home machine. While you can indignantly return the tape to the dealer, it may be that the playback machine is the villain. If the azimuth angle of the playback head is out of adjustment, then it can't possibly sound right. By the same token, if the head on the machine that made the original recording is out of adjustment, then the tape will sound poor on any well-aligned playback equipment.

Recognizing this alignment problem, a logical question is: what happens if a tape is both recorded and played back on the *same* machine, when the azimuth is not critically adjusted? As the great number of inexpensive tape machines clearly shows, reproduction is surprisingly good.

Just how far the azimuth angle can be modified is demonstrated by a special modification supplied by Rangertone, Inc. An extra head is mounted on stock machines with the gap *parallel* to the tape! The head is used to record 60 cps along with either single-channel or two-channel material on ¼-inch tape. Although the 60 cps track is in the middle of the tape, the standard heads, perpendicular to the tape, don't even "see" the special track. The purpose of this third track is to synchronize tape playback exactly for movie making.

How to do it—

The above facts furnish a background for understanding the phenomenon of superimposed tape recording. If you'd like to experiment yourself, do this:

1. Mount the record-playback head on a pivot along with an angular pointer or indicator. *Figure* 1 is a suggested plan, although the head should be closer to its mount.
2. Fix the erase circuit so it can be disabled with a switch. Obviously, re-recordings can't be made if the previous information is erased.

That's all there is to it! Recording procedure is as follows:

1. Erase the tape.
2. Disable the erase circuit.
3. In separate steps, record different material, always rewinding and starting over at the beginning of the tape. In doing this, remember to set the azimuth angle to a *new* position for *each* recording.

What angles should be used? That depends upon your heads, tape speed, and other factors. A good trial value is increments of 15 deg. Thus, if we call the perpendicular position 0°, then we can record at −75°, −60°, −45°, −30°, −15°, 0°, +15°, +30°, +45°, +60°, and +75°.

After a tape has been multiple-recorded, how is playback accomplished?

1. Set the indicator on the head to the angular position that will select one of recordings.
2. Play back and listen!

"Tune in" the Program You Want

You'll soon discover that on playback you can "tune" the head to an accurate

(*Continued on page 113*)

* *Route 8, Box 923, Tucson, Arizona.*

the "fourmost reasons" why Audax Paraflex* is *not* "just another speaker system."

George Silber, *as President of Rek-O-Kut and its new Audax Division* has been a pioneer in the manufacture of the highest quality components. In Audax Speaker Systems. you will find the same uncompromising standards that have made Rek-O-Kut StereoTables the most respected brand in high fidelity.

Saul White, *well known design engineer and writer* on transducers and inventor of the patented Paraflex foam compound suspension, the greatest step towards the reproduction of *natural* sound.

Tom Mulligan, *representing the great Union Carbide Company* who researched and developed the Dynel fabric adapted by Audax for its "Acoustiscreen."

George Nelson, *one of America's greatest industrial designers,* brilliantly styled the enclosures and developed the Dynel three-dimensional "Acoustiscreen" grille.

TWO MODELS now at your dealer's — CA-80 System, 12" x 12" x 24", **$99.95.** CA-100 System, 15" x 12" x 25", **$139.95.**

*PAT. APP. FOR

PARAFLEX

Write for free catalog and specifications, to:
AUDAX Division of the Rek-O-Kut Co., Inc.
38-19 108th St., Corona 68, N. Y. Dept. A9

Name_____
Address_____
City_____ State_____

SPEAKERS BY AUDAX

Export: Morhan Exporting Corp., 458 Broadway, New York 13, N. Y. Canada: Atlas Radio, 50 Wingold Avenue, Toronto 19, Ontario RA-8

The Technique of Measuring IM Distortion in Audio Amplifiers

LEON KUBY*

Although there are as yet no official industry standards for IM measurement, the methods have been used for years in other fields. The author shows the pitfalls to be avoided and gives a specific method for valid measurements.

THE PROBLEM of arriving at a standard for measuring intermodulation distortion in audio amplifiers has, for the most part, been resolved by the high-fidelity industry. There remains, however, the problem of conveying this information and the proper measurement technique to the audio technicians and electronically oriented high-fidelity enthusiasts. Careful investigation has disclosed that a surprising number of audio men are not aware of the discrepancies in the methods they use when making IM distortion measurements. This could prove damaging, for these findings are often conveyed to the public and definite conclusions are opinionated from them. An inaccurate measurement conceivably could condemn a fine high-fidelity instrument even though the intentions of the person taking the measurement were unswervingly honest.

There are two standard forms of IM distortion measurement. The SMPTE (Society of Motion Picture and Television Engineers) and the CCIF (European Standards) are currently used. Since the instrumentation of the CCIF method is far more complex and the findings often misleading, it has become an accepted industry practice to use the SMPTE method for measurement.

With the CCIF method two high-frequency tones of equal amplitude spaced relatively close to each other are introduced into the amplifier. The difference of the two frequencies will appear as a first-order IM product in the output, together with the original frequencies. The ratio of the low-frequency and high-frequency energy is then expressed as a percentage of distortion.

In the SMPTE method a low-frequency signal (anywhere in the range of 30 to 100 cps) is introduced into the amplifier, together with a high-frequency signal of one quarter the amplitude of the low-frequency signal. In the amplifier the high-frequency tone will act as a carrier being amplitude modulated by the low-frequency tone in relation to the intermodulation characteristics of the amplifier. Since every amplitude-modulated signal carries sidebands, these sidebands of the high-frequency signal will be present in the amplifier output. The IM analyzer detects the relative magnitude of the sidebands and expresses them as a ratio to the carrier. This ratio represents per cent IM distortion.

* *Harman-Kardon, Westbury, N.Y.*

Power Measurement

Before becoming involved in the actual procedure of measuring intermodulation distortion, we must first discuss certain aspects of the measurement of power output of an amplifier. Although the measurement of power output appears to be relatively simple, it is loaded with pitfalls which may result in very large errors. Here are some of the factors to be considered carefully in making this measurement:

The line voltage must be carefully controlled with a variable voltage transformer and an accurate voltmeter. Variations of as little as 2 or 3 volts in the line voltage will result in major discrepancies in power readings—easily as much as 10 per cent. Example: By controlling the a.c. line voltage at 117 volts, a given amplifier may indicate a clean 20 watts of power output. By raising the a.c. line voltage to a carefully controlled 120 volts, the same amplifier may now deliver 25 watts of clean power output.

The load placed across the amplifier output terminals must correspond accurately to the amplifier impedance markings. Either a precision resistor with a 50-watt rating or a variable resistor adjusted on an accurate bridge is required. Power is then determined by measuring the voltage developed across the resistor—again, this voltage must be carefully monitored. Any error in the voltage measurement will be squared when converted to a power measurement. The standard home-built VTVM for audio measurements, for example, often has an inaccuracy of from 5 to 10 per cent when operating properly. An error of 10 per cent in voltage may reflect itself as a 21 per cent error in the VTVM, which performs entirely within manufacturer's specifications, and come up with a power measurement on a 20-watt amplifier that may fall anywhere between 16 and 24 watts. Granted that a variation from 16 to 24 watts is equivalent to a variation of less than 2 db and is inaudible. However, expressed in watts, it sounds like a great deal.

Summarizing the minimum instrumentation necessary for accurately measuring power output of an amplifier, the following equipment is necessary:

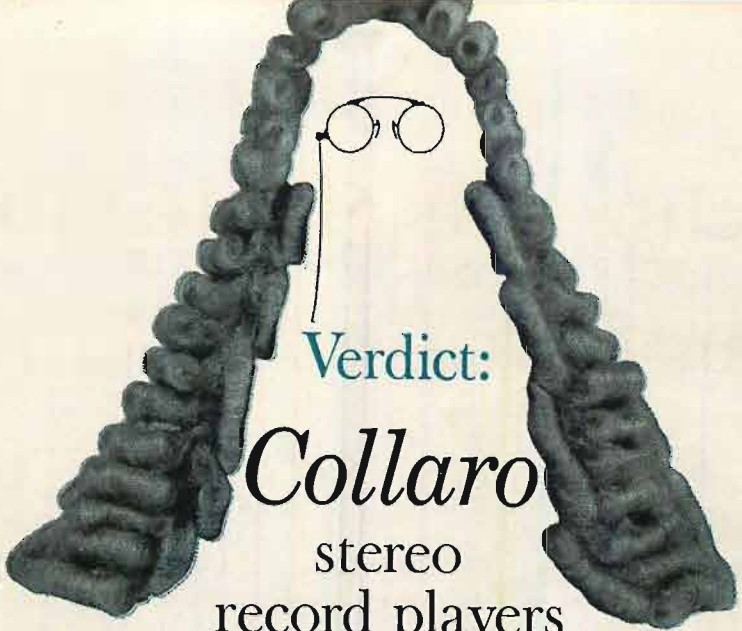
1. A variable voltage transformer to adjust the a.c. line voltage.
2. An accurate voltmeter to monitor the a.c. line throughout the power measurement.
3. A precision 50-watt resistor, or means to measure the accuracy of this resistor.
4. An additional calibrated a.c. voltmeter and an a.c. voltage standard.

If all these requirements can be met, it is possible to take a fairly accurate, repeatable power measurement.

IM Distortion Characteristics

The IM distortion versus power output curve of an amplifier is a familiar one. The distortion usually rises gradually as the power increases, until it reaches a point close to rated power output. There the curve suddenly changes slope and rises rapidly. Driving an amplifier beyond its rated power output causes the amplifier to become overloaded. This produces very high distortion and causes the curve to assume the shape just described. Unfortunately, we are concerned with measuring the distortion right at the knee of the curve, and that is why it is important to measure the power output of an amplifier with extreme accuracy. To cite an example: An amplifier rated at 20 watts may show 0.5 per cent IM distortion at 19 watts, 1.5 per cent distortion at 20 watts, and 9 per cent distortion at 21 watts. IM measurements at low power can be carried out with less difficulty, but even these measurements are of at least equal importance to those taken at rated output. Since a high-fidelity amplifier reproduces mostly at normal room-listening level, distortion at this level

(*Continued on page 71*)



Verdict:

Collaro

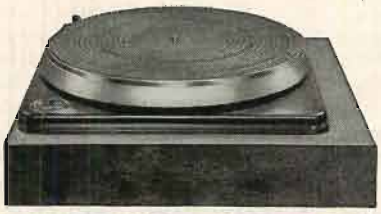
stereo record players are innocent of rumble, wow, flutter

or any noises that interfere with enjoyment of music

The Constellation, Model TC-99—$59.50

The Continental II, Model TSC-840—$49.50

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



Transcription Turntable, Model 4TR-200—$49.50

Manual Player, Model TP-59—$29.95

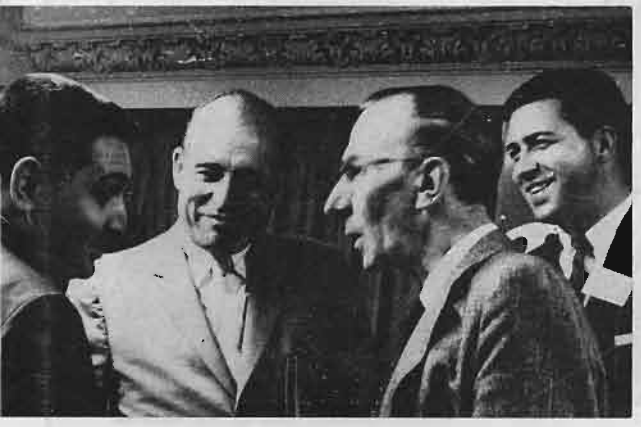
ROCKBAR *Corporation*

Every Collaro stereo record player is built with typical British attention to every detail. They are precision engineered and rigidly tested to give truly professional performance and the ultimate in operating convenience. Here are some of the more important features that make Collaro the logical choice for stereo or monophonic records. • Performance specifications exceed NARTB standards for wow, flutter and rumble — with actual performance test reports accompanying each model TC-99. • Extra-heavy, die-cast, non-magnetic turntables (weighing up to 8½ lbs.). Extra-heavy weight is carefully distributed for flywheel effect and smooth, constant rotation. • Shielded four-pole motors are precision balanced, screened with triple interleaved shields to provide extra 25 db reduction in magnetic hum pick-up. • Detachable five-terminal plug-in head shells (on TC-99, TSC-840, TSC-740, TP-59) provide two completely independent circuits, guaranteeing ultimate in noise reduction circuitry. • Transcription-type stereo tonearms are spring-damped and dynamically counterbalanced to permit the last record on a stack to be played with virtually the same low stylus pressure as the first. • All units are handsomely styled, available with optional walnut, blond and mahogany finished bases or unfinished utility base. There's a 4-speed Collaro stereo record player for every need and budget! Prices slightly higher in the West. For free catalog on the Collaro line, write to: **Rockbar Corporation, Dept. A-10 Mamaroneck, N. Y.** (*Not shown. Similar in appearance to The Coronation.)

Harvey E. Sampson, Jr., manager of the new display room, at the control center.

Professional Audio Room Opens

Open house marks presentation of first display room devoted solely to professional audio equipment in Harvey Radio Company's well known New York store. Broadcast and recording engineers welcome permanent demonstration facilities.



Above, the lighter side of audio as exemplified, l. to r., by Robert A. Strome of Ampex Corporation; William H. Miltenberg, chief engineer, manager-recording, and E. V. B. Kettleman, manager, custom recording, RCA-Victor Record Division; and Mr. Sampson. Below, l. to r., W. Oliver Summerlin, vice-president of Pulse Techniques, chats with Ralph H. Schlegel, audio pioneer and treasurer of the Audio Engineering Society.

INTENDED PRIMARILY to serve the needs of broadcast and recording engineers, a new operating display of professional audio equipment was opened recently in New York by Harvey Radio Company. Known as the Professional Audio Room, the display is complete in every respect and will be maintained on a permanent basis, with new items being added and obsolete ones replaced in keeping with advances in the audio equipment industry.

On exhibit and in operation are such diverse items as Ampex tape recorders, including the Model 300-3 three-track machine, Ampex tape duplicating equipment, the new Fairchild stereo limiter and cutter, Pultec program equalizers, the Audio Instrument intermodulation meter, microphones, amplifiers, booms, attenuators, and a host of other accessories of interest to the professional audio engineer.

The Professional Audio Room is under the direction of Harvey E. Sampson, Jr., director of the company's industrial sales division. At a dedication ceremony attended by many prominent engineers, Mr. Sampson said, "For a long time we have felt that there has been a need for some kind of operating showroom where audio engineers could not only see current equipment but also put it through its paces. In this room we have established just such a facility."

On this page are pictured but a few of the many engineers who were present at the opening of the Professional Audio Room.

Above, l. to r., Donald R. Plunkett, president of Fairchild Recording Equipment Corporation and of the Audio Engineering Society, discusses diversity of audio interests with Lou Burroughs, vice-president of Electro-Voice, Inc. Below, l. to r., caught in a moment of reflection are C. J. LeBel, president of Audio Instrument Company and AES secretary, and Prof. Vladimir Ussachevsky, widely known audio authority associated with Columbia University.

BOGEN STEREO HIGH-FIDELITY COMP

DB230A Stereo Control Center and Dual 30-Watt Amplifier—Here is realism that becomes an emotional experience. The DB230A distributes 60 clean watts of power through its two channels. It offers every control for the stereophonic or monophonic reproduction of sound from any music source. The DB230A incorporates newest advances in circuitry including such exclusive Bogen features as Controlled Positive Feedback and Speaker Phasing Switch.

Output Power: 60 watts (two 30-watt channels) music waveform. **Harmonic Distortion:** less than 1% at 60 watts. **Frequency Response:** 20 to 20,000 cps ±0.5 db. **Noise and Hum** (referred to rated output): Fund.: 85 db; Low Level Inputs: 55 db; High Level Inputs: 75 db. **Output Impedances:** 32, 16, 8 and 4 ohms. **Tubes:** 15. **Controls:** Input Selector, Loudness, Lo Filter, Hi Filter, Stereo-Mono, Balance, Power, Phasing, Cartridge (Stereo, Mono), Speaker Selector and separate Bass, Treble and Volume for each channel. Critical filaments are DC powered. 15" x 5¾" x 13⅝".

DB230A $189.50
CEG Enclosure and Legs $8.00

DB212 Stereo Control Center and Dual 12-Watt Amplifier—With this single unit you can precisely control all stereo sources (tapes, FM-AM stereo broadcasts and stereo discs!) and feed them through the self-contained dual 12-watt amplifiers to your two speaker systems. The DB212 can be used as a 24-watt monophonic amplifier. You may also use the DB212 as a stereophonic preamplifier-control unit with its 24 watts as one channel and another monophonic amplifier as the second channel. The exclusive "Speaker Phasing Switch" eliminates the "hole-in-the-middle" effect that sometimes occurs in stereo.

Output Power: 24 watts (two 12-watt channels) music waveform rating. **Harmonic Distortion:** less than 1%. **Frequency Response:** 20 to 20,000 cycles ±1 db. **Noise and Hum** (referred to rated output): Tuner, Aux, High Tape—70 db; Mag, Low Tape—50 db. **Output Impedances:** 4, 8 and 16 ohms. **Tubes:** 9. **Sensitivity:** Tuner, Aux, High Tape 0.25 v; Mag, Low Tape—8 mv. **Controls:** Selector (Tape, Phono, Radio, Aux), Function (off, mono, stereo), Speaker Inversion, Volume, Balance, Bass, Treble, Hi Filter (flat, 4 kc), Lo Filter (flat, 100 c), Speaker Phasing (2 positions), Power. **Dimensions:** 15" x 4¾" x 12¼".

DB212 ..... $119.95
BEG Enclosure and Legs $7.50

ST662 Stereo FM-AM Tuner—The ST662 offers tremendous versatility to every critical listener. It can be used for stereo or monophonic broadcast reception. It also includes built-in provision for adding FM Multiplex stereo reception. A separate IF stage for AM minimizes the possibility of crosstalk between channels. Easy, precise tuning is assured with Magic Eye tuning indicators on both FM and AM channels with superb Automatic Frequency Control on FM. The ST662 is an ideal companion to the DB230A or DB212 stereo amplifiers.

Frequency Range: FM: 88-108 mc; AM: 520-1640 kc. **Selectivity:** FM: 180 kc, 3 db down; AM: 10 kc, 3 db down. **Sensitivity:** FM: for 30 db quieting: 1.25 μv at 75 ohm input, 2.5 μv at 300 ohm input. AM: Terminal Sensitivity —5 μv for 20 db S/N. **Frequency Response:** FM: 20 to 18,000 cycles ±0.5 db, AM: 20 to 4,500 cycles ±1½ db. **Antenna(s):** Built-in. **Noise and Hum** (referred to rated output): FM: 60 db down from 1 v output, AM: 55 db down from 1 v output. **Output:** Cathode follower. **Tubes:** 12 (plus 3 crystal diodes). **Controls:** Selector (power, stereo, AM, FM, AFC defeat), AM, FM Tuning. **Dimensions:** 15"x4¾"x12¼".

ST662 ..... $189.50
BEG Enclosure and Legs $7.50

ST442 Stereo FM-AM Tuner—A versatile, sensitive tuner, the ST442 brings you distortion-free FM, AM, and Stereo FM-AM listening in a single smartly styled, moderately priced instrument. Typical of famous Bogen quality, the ST442 provides a tuning meter to assure precise FM and AM tuning, automatic volume control on each channel and a built-in provision for Multiplex adapter controlled on the front panel. The ST442 also features Cathode Follower output and Automatic Frequency Control. The ST442 is an ideal companion to the DB212.

Frequency Range: FM: 88-108 mc; AM: 520-1640 kc. **Sensitivity:** FM: 1.5 μv —30 db quieting at 75 ohm input, 3.0 μv —30 db quieting at 300 ohm input; AM: Loop Sensitivity, 100 μv/meter, 20 db S/N; Terminal Sensitivity: 3 μv/meter, 20 db S/N. **Frequency Response:** FM: 20 to 18,000 cps ±0.5 db; AM: 20 to 4,500 cps ±1.5 db. **Antennas:** FM: built-in line antenna; AM: built-in ferrite loopstick; provision for external antennas. **Tubes:** 9 (plus 3 diodes). **Controls:** Selector (stereo FM-AM, FM, AM, Multiplex), AFC out, AM, FM Tuning, Power. **Dim.:** 15" x 4¾" x 12¼".

ST442 ..... $149.50
BEG Enclosure and Legs $7.50

SRB20 Stereo Receiver—This new Bogen stereo receiver is years ahead in value and performance. A superb all-in-one stereo instrument, the SRB20 is a highly sensitive FM-AM stereo tuner, a versatile stereo audio control center, a magnificent 20 watt (10 per channel) stereo amplifier, and it's yours for a price you'd expect to pay for a comparable tuner alone! A triumph in engineering and styling, the SRB20, with its beautiful gold-colored front panel is equally at home on a shelf or installed in a console.

Output Power: 20 watts; (two 10-watt channels), music waveform rating. **Frequency Range:** FM: 88-108 mc; AM: 520-1640 kc. **Frequency Response:** 20 to 20,000 cycles, ±1 db. **Antennas:** built-in FM and AM antennas; provision for external antennas. **Noise and Hum:** FM: —58 db; AM: —48 db. **Output Impedances:** 4, 8 and 16 ohms. **Tubes:** 16, plus 3 crystal diodes, incl. 1 matched pr. **RF Usable Sensitivity:** FM: 4 μv; AM: 250 μv per meter—loop sensitivity. **Audio Sensitivity:** Mag: 4.5 mv; **Signal-to-Noise:** 45 db. **Crystal/Aux:** .5 v; **Signal-to-Noise:** 60 db. **Distortion:** FM: 1.5%; AM: 3%; Phono (Mag): 0.6% at continuous power output. **Controls:** Function Selector, Dual Vol., Bass and Treble; FM, AM tuning, Power, FM-AFC, AM-Multiplex. 16½" x 5½" x 12½".

SRB20 ..... $199.50
ENB1 Enclosure and Legs $8.50

STP52 Stereo Tuner-Preamplifier—Here is a stereo high-fidelity FM-AM tuner and stereo control center that offers superb sensitivity and selectivity. It has cathode follower outputs which permit you to separate it from your power amplifiers. Its freedom from hum is remarkable. Tuning is easy with an advanced Bogen-designed flywheel drive. Front panel controls permit selection of music source... and there is facility for easy adaptation to Multiplex. Separate bass and treble controls for each channel. Dual volume controls provide easy one-hand balancing. The STP52, with its stylish gold front and compact size, will be attractive on a shelf or in a cabinet.

Frequency Range: FM: 88-108 mc; AM: 520-1640 kc. **Frequency Response:** 20 to 20,000 cycles, ±1 db. **Antennas:** built-in FM and AM antennas; provision for external antennas. **Noise and Hum:** FM: —58 db; AM: —48 db; Phono: Mag.: —60 db, Crystal: —70 db. (DC on filaments of preamp. input.) **Output Impedances:** 4, 8 and 16 ohms (low imp. cathode follower). **Tubes:** 13, plus 3 crystal diodes, incl. 1 matched pr., selenium rectifier. **RF Usable Sensitivity:** FM: 4 μv; AM: 250 μv per meter—loop sensitivity. **Audio Sensitivity:** Mag: 4 mv; Signal-to-Noise: 45 db. Crystal/Aux: .5 v; Signal-to-Noise: 60 db. **Distortion:** FM: 1.5%; AM: 3%; Phono (Mag): less than 0.5% at rated output, 2 volts. **Controls:** Function Selector, Dual Volume, Bass, Treble; FM, AM Tuning. Off-On, FM-AFC, AM-Multiplex. **Dim.:** 16½"x5½"x12½".

STP52 ..... $159.95
ENB1 Enclosure and Legs $8.50

BOGEN STEREO RECORD PLAYERS

B50 Series—For stereo or monophonic use. Features 29 to 86 r.p.m. continuously variable speed control plus click stops at the 4 popular speeds. Four-pole, heavy duty, constant-velocity motor and balanced, weighted, rubber-padded 11¾" turntable reduce "wow" to less than 0.5%, keep "hum" and "rumble" to similarly negligible levels. Feather-drop, flip-switch operated arm has plug-in head. Vibration isolators supplied. **Dim.:** 14½" x 3½" x 12½".

B50-16LCS (with plug-in head, less cartridge).....$40.40
B50-16R (with Ronette ceramic stereo cartridge, diamond styli).....$57.50
B50-16XDS (with G.E. VRII cartridge, diamond/sapphire styli).....$59.75
Other cartridges available.
PB5 Mahogany-Finish Base.....$4.80

B60 Series—Bogen's new series of turntables-with-tone-arm is precision-made like Swiss watches.

Both models in the series feature click stops at the 4 popular speeds, plus continuously variable speed control from 29 to 86 r.p.m. Each has a four-pole, heavy-duty, constant-velocity motor and balanced 11¾" rubber-padded turntable. Professional-style arm has plug-in head. Arm is raised and lowered by flip-switch in unique cueing arrangement to minimize record and stylus damage, and features micrometer-type, easy-to-read weight adjustment gauge. Completely wired for stereophonic and monophonic high-fidelity systems. Vibration isolators supplied. **Dimensions:** 15" x 3½" x 13".

B60 Record Player. With precision steel turntable. Wow and flutter are less than .25% at 33⅓ r.p.m., even better at faster speeds. With phenolic 4-pin head (less cartridge).....$49.95

B61 Record Player. With non-ferrous, extra massive (7¾ lbs.) turntable to provide practically no measurable hum, wow or flutter. With phenolic 4-pin head (less cartridge).....$54.95

PB6 Walnut-Finish Wood Base for B60 and B61.....$5.25

BOGEN-PRESTO TURNTABLES

TT3 Professional Quality One-Speed Turntable—The Bogen-Presto TT3 turntable plays stereo or mono 33⅓ r.p.m. records to perfection. Its precision, heavy-duty hysteresis motor is the basis of a belt drive system that virtually eliminates rumble, wow and flutter. The easily cleaned "radial-ridge" mat affords perfect traction and gentle handling of your precious records. Has built-in strobe disc for speed-accuracy checking. **Turntable Weight:** over 5 lbs. **Dimensions:** 16" x 6" x 12".

TT3.....$59.95
PB7 Walnut-Finish Base.....$13.95

TT4 Professional Quality Three-Speed Turntable—Three speeds; precision-made throughout; wow, flutter and rumble are virtually nonexistent. Balanced 11⅞" cast-aluminum turntable and constant-speed hysteresis motor. Interchangeable idler wheels disengage in "off" position to prevent flats. Complete with built-in strobe disc, retractable 45 r.p.m. spindle, and easy-to-clean rubber "radial-ridge" mat. Perfect for stereo or monophonic use. **Turntable Weight:** over 5 lbs. 14½" x 7" x 12".

TT4.....$99.50

TT5 Same as above with broadcast-studio-type hysteresis motor.....$129.50

B60 Series Aluminum Head and Cartridges—Special aluminum plug-in heads for the **B60** and **B61** as well as the **PA1** arm are available with or without cartridges as listed below.

H4 Aluminum Head (less cartridge).....$4.00
H4-PSO (with Pickering 371 stereo cartridge, diamond stylus).....$31.85
H4-RSD (with Ronette BF-40D stereo cartridge, diamond stylus).....$20.23
H4-SSD (with Shure stereo cartridge, diamond stylus).....$26.00
H4-GM (with G.E. VRII mono cartridge, sapphire stylus).....$11.75
H4-GMD (with G.E. VRII mono cartridge, diamond stylus).....$21.55
H4-RM (with Ronette mono cartridge, sapphire stylus).....$5.95

PA1 Professional Quality Tone Arm—The PA1 tone arm is ideally suited for use with the TT3 and TT4 turntables. It features a micrometer-type, easy-to-read weight adjustment gauge and aluminum plug-in head that will accommodate all standard cartridges. The 4-pin head fastens to the arm by means of a specially designed pressure-contact locking arrangement that insures perfect contact.

PA1.....$24.95

VALUE ON A BUDGET... *Challenger Components* BY BOGEN

VALUE ON A BUDGET... *Challenger Components* BY BOGEN

RC412 Stereo Receiver—The RC412 receiver is an all-in-one stereo amplifier, stereo control center and stereo FM-AM tuner...at a remarkable price. Dual volume controls permit one-hand balancing of the two channels. The RC412 also has a built-in provision for a Multiplex adapter.

Output Power: 12 watts (two 6-watt channels) music waveform rating. **Frequency Range:** FM: 88-108 mc; AM: 520-1640 kc. **Frequency Response:** 30 to 15,000 cps ±1 db. **Antennas:** built-in FM and AM antennas; provision for external antennas. **Noise and Hum:** FM: −58 db; AM: −48 db; Phono: Mag: −45 db; Crystal: −55 db. **Output Impedances:** 4, 8 and 16 ohms. **Tubes:** 15 (plus 3 crystal diodes). **Distortion:** FM: 1.5%; AM: 3%; Phono (Mag): less than 1% at continuous power output. **Controls:** Function Selector, Dual Volume, Bass, Treble, FM Tuning, AM Tuning, Power, FM-AFC, AM-Multiplex. **Dimensions:** 16½" x 5½" x 12½".

RC412.....$169.50
ENC1 Enclosure and Legs.....$8.50

TC322 FM-AM Stereo Tuner—The sensitive TC322 receives stereo FM-AM, FM or AM broadcasts. It features: AFC, provision for Multiplex adapter, Automatic Volume Control, illuminated dial scale, extremely low price. The TC322 is an ideal companion to the AC220. Comes complete with enclosure.

Frequency Range: FM: 88 to 108 mc; AM: 520 to 1640 mc. **Selectivity:** FM: 5 μv, 30 db quieting, 300 ohm input; AM: loop sensitivity: 150 μv/meter, 20 db S/N; terminal sensitivity: 7 μv, 20 db S/N. **Frequency Response:** FM: ±1 db, 20 to 15,000 cps; AM: ±1.5 db, 20 to 3,500 cps. **Tubes:** 8 (plus one crystal diode). **Antennas:** Built-in. Provision for external antennas. **Controls:** Power, AM, FM, AFC, Multiplex, AM, FM Tuning. **Dim.:** 13⅞"x4½"x7¼".

TC322.....$109.50
Leg Kit, ML1.....$1.85

AC220 Stereo Control Center and Dual 20-Watt Amplifier—An astonishing value, the AC220 features low-noise preamp, low distortion, dual volume controls, loudness switch, channel reversing switch, provision for tape deck, mono-stereo mode selector. The AC220 is compatible with other Bogen components. Comes complete with enclosure.

Output Power: 20 watts (two 10-watt channels), 18 watts at better than 2% music waveform rating. **Frequency Response:** ±2 db, 40 to 16,000 cps. **Sensitivity:** Mag: 4.5 μv; Aux and Tuner: .35 v. **Hum:** Mag: −50; Aux: −60; Fund: −70. **Output Impedances:** 4, 8, 16 ohms. **Tubes:** 8. **Tone Control:** ±10 db @ 50 c and 10 kc. **Controls:** Selector (mag, aux, tuner), Bass, Treble, Coaxial Volume, Power, Loudness, Mode, Channel Reverse. 13⅞"x4½"x7¼".

AC220.....$79.95
Leg Kit, ML1.....$1.85

Catalog No. 512 **Litho. in U.S.A.**

PONENTS

All high-fidelity components are *not* alike. With Bogen, you're assured of the ultimate in faithful sound reproduction because Bogen knows how to build the best...staffs more experienced engineers...has made more specialized sound equipment for more years than any other high-fidelity manufacturer. You can *hear* this engineering excellence...in its brilliant achievements! And this technical artistry, confirmed by hundreds of thousands of customers, is complemented by superb styling that's equally at home on mar-proof legs or custom-mounted in consoles. From any point of view, Bogen is a sound investment well made.

PR2 Stereo Preamplifier-Control Center—A remarkable performer for the discriminating listener. Ideal companion to the DS265 or DS225. In addition to outstanding specifications, the PR2 features unique position-indicator lights.

Frequency Response: ±1 db, 20 to 20,000 cps. **Output:** 2 v from cathode follower (per channel). **Distortion:** less than 0.4% at 2 v output. **Noise and Hum** (below rated output): Mag and Tape −55 db; Aux, Tuner and Multiplex −65 db; Mic −60 db. **Sensitivity:** Aux, Tuner and Multiplex: 350 mv; Mag and Tape: 4.5 mv; Mic: 4 mv. **Tubes:** 6. **Controls:** Input Selector (Mic, Tape, Mag, Tuner, Aux, Multiplex), Mode (Stereo Reverse, Left Channel Only, Right Channel Only, Stereo Normal, Monophonic Left, Monophonic Right), Power, Loudness, Phase, Hi Filter, Lo Filter, Monophonic Phono (all cartridges), Individual Volume, Bass and Treble for each channel. DC on heaters of input tubes. **Dimensions:** 15" x 4½" x 8".

PR2 ..... $89.50
DEG Enclosure and Legs $7.50

DS265 Stereo Power Amplifier—The ultimate in powerful, distortion-free amplification. Perfect for the new high-compliance speakers. Use the DS265 with the new PR2 or STP52. Comes complete with enclosure.

DS225 Stereo Power Amplifier—Similar to the DS265, except for power output, the DS225 offers superb reproduction over the entire listening range, and costs less than monophonic amplifiers of comparable performance.

Power Rating: DS265: 130 watts (two 65-watt channels); DS225: 50 watts (two 25-watt channels); music waveform. **Distortion:** less than 0.5% at rated output. **Frequency Response:** 20 to 20,000 cps ±1 db. **Noise and Hum:** −85 db below rated output. **Input Sensitivity:** 2 v for rated output. **Input Impedance:** 100,000 ohms. **Output Impedances:** 4, 8, 16 ohms. **Controls:** Power, Output Power Limiting Switch (DS265). **Tubes:** DS265: 10; DS225: 9. DS265: 17¼" x 7¾" x 9"; DS225: 17¼" x 7¾" x 6½".

DS265 ..... $149.50
DS225 ..... $79.95

Dimensions refer to complete components, excluding legs and knobs (dimensions given as width x height x depth). All prices and specifications subject to change without notice.

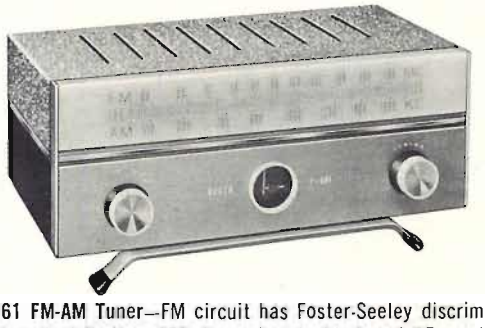
Prices slightly higher in Alaska, Arizona, Arkansas, California, Colorado, Hawaii, Idaho, Louisiana, Mississippi, Montana, Nevada, New Mexico, Okla., Oregon, Texas, Utah, Wash. and Wyoming.

MONOPHONIC COMPONENTS

DB130A 35-Watt Amplifier-Preamplifier—The most famous amplifier in modern high-fidelity history. Features include inputs for all sound sources, 7-position phono equalization, switch to permit monitoring a recorded signal directly from a tape recorder while actually recording, and exclusive variable damping factor circuit.

Output Power: 35 watts. **Music Waveform Rating:** 50 watts. **Harmonic Distortion:** 0.3% at rated output. **Frequency Response:** 15 to 30,000 cycles ±0.5 db. **Noise and Hum** (referred to rated output): Fund.: −85; Mag.: −60; Tuner: −80. **Output Impedances:** 4, 8 and 16 ohms. **Tubes:** 8. **Controls:** Power, Volume, Bass, Treble, Variable Loudness Contour Selector, Input Selector (Phono, Radio, Tape, Aux), 7-position Record Equalizer, Damping Factor, Lo Filter, Hi Filter, Speaker Selector Switch, Tape Monitor, Aux Adjuster, Hum Adjuster. **Dimensions:** 15" x 4¾" x 12¼".

OB130A $129.50
BEG Enclosure and Legs $7.50



T661 FM-AM Tuner—FM circuit has Foster-Seeley discriminator, dual limiter, AFC, low-noise double-tuned RF amplifier, low-noise mixer, two IF stages, stable oscillator; AM offers 10 kc whistle filter, high gain ferrite loopstick. Automatic volume controls and tuning meter on FM and AM. Provision for Multiplex adapter is built-in.

Frequency Range: FM: 88-108 mc; AM: 530-1640 kc. **Selectivity:** FM: 180 kc, 3 db down; AM: 10 kc, 3 db down. **Sensitivity:** FM: 1.25 μv, 30 db quieting, 75 ohm antenna; 2.5 μv, 30 db quieting, 300 ohm antenna; AM: Terminal Sensitivity: 5 μv, 20 db S/N. **Frequency Response:** FM: 20-18,000 cycles, ±0.5 db; AM: 20-5,000 cycles, −3 db. **Antenna(s):** Built-in. **Noise and Hum** (referred to rated output): FM: −60 db; AM: −55 db. **Output:** Cathode follower. **Tubes:** 10 (plus 3 crystal diodes). **Controls:** Selector (power, AM, FM, AFC defeat), Tuning. **Dim.:** 12"x4¾"x12¼".

T661 ..... $139.50
AEG Enclosure and Legs $6.00

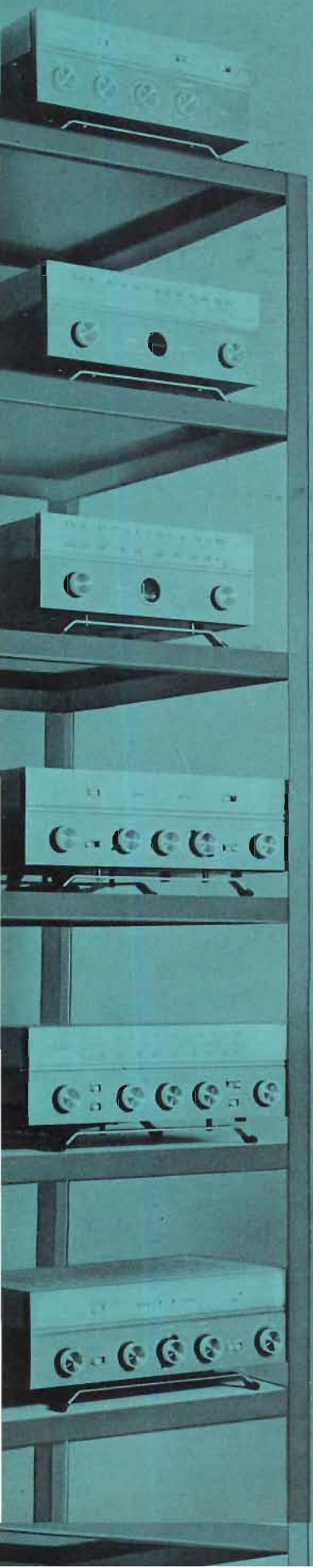
RB115 High-Fidelity FM-AM Receiver—On a single compact chassis, the RB115 combines radiation-proof superheterodyne tuner, 15-watt power amplifier and complete preamplifier. It provides inputs for tape recorder, phono and other sources...gives flexible control of loudness, speakers, scratch and rumble. Adapts for stereo.

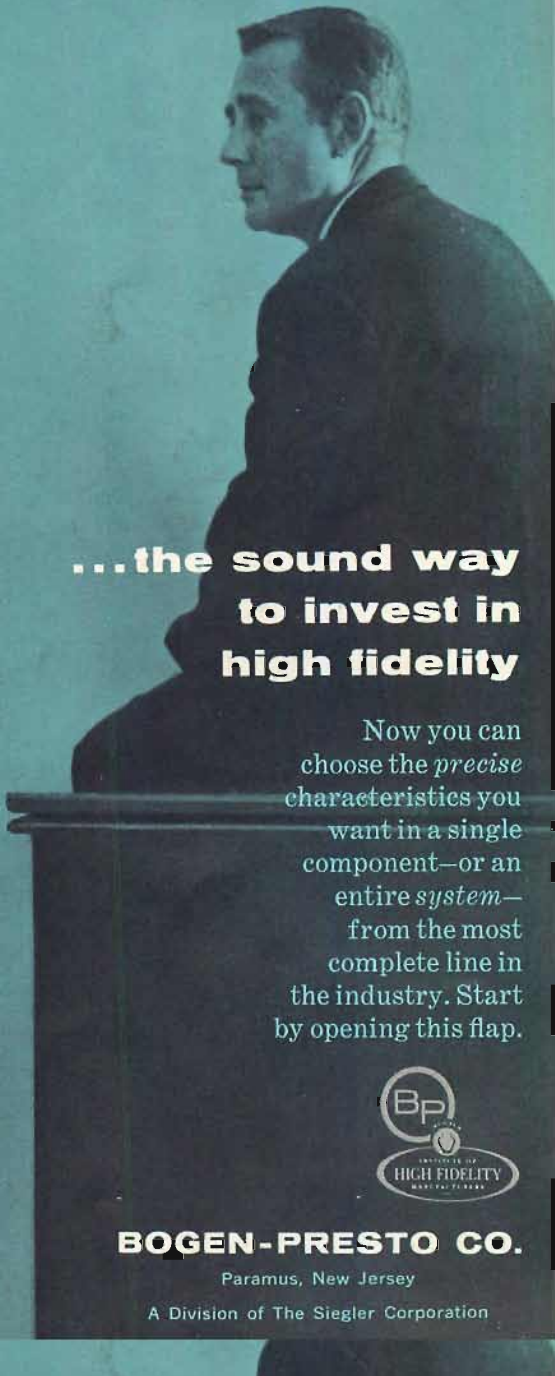
Output Power: 15 watts. **Peak Power:** 30 watts. **Tone Burst Rating:** 21 watts. **Harmonic Distortion:** 2% at rated output. **Frequency Range:** FM: 88-108 mc; AM: 520-1640 kc. **Selectivity:** FM: 180 kc, −3 db; AM: 8 kc, −3 db. **Frequency Response:** FM and Phono: 20-20,000 cycles ±1 db. AM 20-4,500 cycles −3 db. **Antenna(s):** Built-in FM and AM antennas. **Noise and Hum:** −55 db. **Output Impedances:** 4, 8 and 16 ohms. **Tubes:** 13 (plus 3 crystal diodes). **Sensitivity:** FM: 3.5 μv for 30 db quieting; AM: 5 μv for 20 db S/N. **Controls:** Selector (with 3 equalization positions); Volume, Bass, Treble, Lo Filter, Hi Filter, Loudness, Speaker Selector, Tuning. **Dimensions:** 15" x 4¾" x 12¼".

RB115 ..... $159.50
BEG Enclosure and Legs $7.50

Left Channel Only, Right Channel Only, Stereo Normal, Monophonic Left, Monophonic Right), Power, Loudness, Phase, Hi
offers 10 kc whistle filter, high gain ferrite loopstick. Automatic volume controls and tuning meter on FM and AM.

HIGH-FIDELITY COMPONENTS





...the sound way to invest in high fidelity

Now you can choose the *precise* characteristics you want in a single component—or an entire *system*—from the most complete line in the industry. Start by opening this flap.

BOGEN-PRESTO CO.

Paramus, New Jersey

A Division of The Siegler Corporation

IM MEASURMENT TECHNIQUE

(*from page 64*)

contributes heavily to the characteristic tone quality of the amplifier.

When we measure power output we are primarily concerned with the amount of energy the amplifier is capable of feeding into the speaker. With a single-tone input to the amplifier, this is a relatively simple concept. Most voltmeters, although they respond to the "average" voltage, are calibrated in rms and will give an accurate indication only with a pure sine wave. However, the complex wave form required for IM measurement (a mixture of a low frequency with a high frequency) will result in grossly incorrect meter indications, due to the discrepancy between "average" and "rms" values.

No direct power measurement, therefore, can be obtained in this way with a two-tone IM signal.

Since the asymptote of distortion-free reproduction in an amplifier is determined by the "peak" of the possible grid swing, it has become an industry practice to establish reference levels for output power based on "peak" value. This method affords suitable correlation of the measurements of various amplifier characteristics, such as harmonic distortion, square-wave response, and intermodulation distortion.

It is, therefore, not possible to feed the composite signal from an IM analyzer into the amplifier and monitor the output with a simple power meter, yet how many audio fans and technicians measure IM in this manner? The figure is astounding.

As a last note, before describing a specific method of measuring IM distortion, it is necessary to impress the importance of the proper use of the oscilloscope. At all times and for all measurements, an oscilloscope should be connected across the amplifier load. Without the scope you are literally working blind and can never be quite sure what is being measured. With an oscilloscope you may observe faulty hookup, excessive hum, or distortion in output measurement; and make the proper corrections.

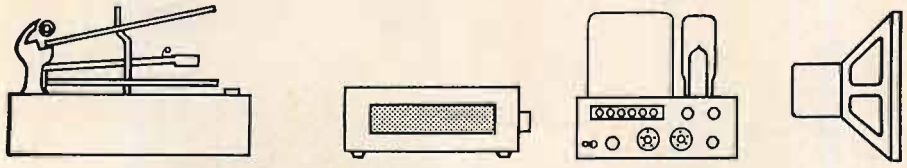
Measurement Method

Use the following as a basis of the *proper* method of measuring intermodulation distortion in a 20-watt amplifier feeding into a 16-ohm load.

1. Adjust the line voltage to the specified value and monitor with a voltmeter throughout the measurement.
2. Feed a single-tone oscillator into one of the high-level inputs and monitor the output of the amplifier on the oscilloscope.
3. Adjust the tone controls so that the amplifier is flat beyond the range of the IM analyzer (such as 60 to 6000 cps).
4. Turn the loudness control to maximum and turn off all auxiliary controls as contour, rumble, scratch, and so on.
5. Use the formula $P = E^2/R$ to arrive at the proper voltage reading for a specific power level. For a 20-watt output into a 16-ohm resistor, the voltmeter across the resistor should measure 17.9 volts.
6. Adjust the oscillator level at 1000 cps so that the output voltmeter indicates the computed value. In this case, it will be 17.9 volts.
7. Adjust the vertical gain of the oscilloscope, connected across the load, until the peaks of the output sine wave touch two well-defined gradation lines on the oscilloscope face mask. The pattern should cover a major portion of the scope screen. This establishes the "peak" reference for the actual IM measurement. At this point, also make sure that the sine wave is undistorted and is not flattened at the end. IMPORTANT: Do not alter the vertical gain of scope thereafter. This method applies for power levels below amplifier clipping. IM distortion measurements should not be made above the clipping point because most available instrumentation, although calibrated for rms, reads average voltage values. Great errors will be introdnced unless the output signal contains fairly clean sine waves.
8. Replace the oscillator with an IM analyzer signal. Adjust the 4-to-1 relationship of the low- and high-frequency signal in accordance with the operation manual of the analyzer. The proper relationship of the two signal amplitudes should be checked on the oscilloscope again.
9. Adjust the level of the IM input signal to the "peak" reference on the oscilloscope. The pattern should again fall precisely between the same two gradation lines on the mask.
10. Follow the remainder of the instructions of the IM analyzer and complete your measurement.
11. Repeat this procedure several times over an extended period of time. If you come up with a group of corresponding measurements, you have in all probability produced an accurate IM measurement.
12. NOTE: if your amplifier has an output-tube balance control, adjust this control for minimum IM indication.

It is almost impossible to make a proper IM measurement without an oscilloscope unless you have a tremendous amount of experience with your particular amplifier and your test equipment. It may be theoretically possible to make an IM measurement without an oscilloscope, but you would need a very carefully computed conversion chart to convert the indications on a power meter to the true peak value of a complex wave, and you will have to leave a great deal to chance. Æ

EQUIPMENT PROFILE



THE SARGENT-RAYMENT LINE

Sargent-Rayment is one of the oldest names in high-quality radio receivers, and with the company's expansion into the field of amplifiers its reputation continues. The models we have observed are the stereo tuner, SR-1000; a stereo preamp, SR-2000; and a stereo power amplifier consisting of two 50-watt units on the same chassis, SR-5100, and performance is excellent in every respect. There are several other models, also.

Figure 1 shows the SR-1000 tuner, an AM-FM-stereo model which combines high sensitivity with superb tone quality. In fact, the frequency range and lack of distortion on AM provide a signal so close to FM that it is difficult to tell the difference when both channels are tuned to the same station and an A-B comparison is made. This is especially desirable with AM-FM stereo broadcasts, for many tuners have an AM response which is so limited as to affect the entire stereo illusion. This is definitely not the case with the SR-1000. The low distortion of the AM section is largely due to S-R's two-tube detector circuit, and the specifications claim 0.45 per cent distortion at 100 per cent modulation—an extremely low figure. The over-all AM circuit is comparatively simple in that it consists of only four tubes—a 6BE6 oscillator-mixer, a 6BA6 i.f. stage, and 6AL6 and half a 12AU7 as the two-tube detector. A ferrite loopstick is affixed to the rear of the unit, and in spite of having no r.f. stage, the sensitivity is claimed to be 20 μv. The i.f. transformers have tertiary windings which are switched in and out of the circuit to give wide-band reception, and a 10-kc trap provides better than 60 db of attenuation at 10 kc to eliminate the interstation whistle.

The FM section employs a gold plated "frame-grid" tube in a cascode input stage, a mixer, two i.f. stages, a limiter, and a ratio detector, with the oscillator and a.f.c. stage combined in one tube. The specifications claim a sensitivity of 0.85 μv for 20 db of quieting, which is borne out by the fact that practically every station that can be heard at all will limit. Drift is entirely negligible, and in the BROAD position—a.f.c. on—the set may be given hot and cold cycling with the same station coming in every time "right on the button."

Four controls are mounted on the panel—AM and FM tuning, a broad-sharp switch, and a four-position selector with OFF, AM, FM, and STEREO positions. Level-set controls are located on the rear apron of the chassis.

Stereo Preamp

The SR-2000 preamplifier, *Fig.* 2, is of the same size and similar in design to the tuner—both being rather modern in appearance. There are two sets of stereo phono iuputs, three high-level stereo inputs, and a tape-head input. Two outputs are provided for normal use, and two more are connected ahead of the tone controls to feed a recorder. In addition, two monitor inputs are furnished, which may be connected to a tape amplifier, permitting the user to monitor a recording while it is being made (on a three-head machine). The monitor connection comes after the recorder output jack and just ahead of the tone controls.

The circuit employs two dual triodes and a pentode-triode in each channel. A selector switch chooses the input, with three high-level inputs, two separate phono inputs, and a tape-head input with positions for 7½, 3¾, and 1⅞ ips. Separate tone controls are provided for each channel, and contonr and loudness controls are ganged, with a balance control to adjust channel balance. The SEPARATION control is a potentiometer which blends the two channels to a greater or lesser degree, with a switch to eliminate the pot from the circuit entirely when no blending is desired.

Push-button switches actuate the scratch and rumble filters, reverse channels, reverse phase on one channel, and switch to monitor or normal, as desired. The main selector switch is illuminated, and its ten positions give almost complete control of all the unit's functions. The two positions for each phono input select between the RIAA curve for 33- and 45-rpm records and the exact AES curve for 78's. The loudness control consists of ganged Centralab Senior Compentrol sections, and with the separate volume control it is possible to get almost any degree of compensation at any listening level. In actual practice, the loudness control is set to maximum and the volume control is adjusted for a good room volume—then the listening level is controlled thereafter by the loudness control alone.

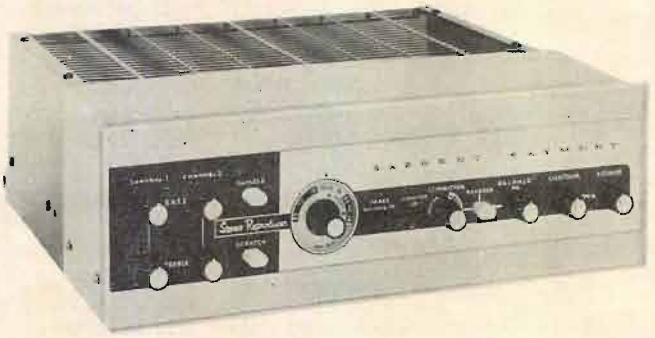
For a one-volt output, input signals required are: 1 mv on phono, 2 mv on tape and .05 volts on the high-level inputs. Dual level-set controls are provided at the outputs of the preamp stages for phono and tape head signals, and at the inputs for the three high-level inputs, and at the recorder-feed jacks. The phase-reversing switch is the simplest of arrangements—it connects the output of one channel to either the cathode or plate of a split-load "cathode-follower" type of output stage. In the normal position, the output connects to the cathode, and the stage acts like a cathode follower; in the reverse position, the output is connected to the plate, and plate and cathode resistors are similar (not exactly alike, since the feedback circuit effectively shunts the plate resistor).

The SR-5100 is a cool job—that is, it runs at a comparatively low temperature. The circuit consists of a 7199 pentode-triode as gain and phase-splitter stage driving two EL34's in each channel. Separate input volume controls are provided, as are d.c. balance controls on the output stages, which work with fixed bias. Outputs are provided for 4, 8, and 16 ohms, and a socket is mounted on the chassis to furnish power to the SR-2000 control unit.

The amplifier puts out its rated 50 watts at less than 1 per cent IM distortion, according to our own measurements, and on a square-wave test no rounding was observed up to 9000 cps and no overshoot was apparent. Hum and noise measured 69 db below 1 watt. The damping factor is stated in specifications as 11, resulting in an output impedance of roughly 1.5 ohms.

Performance of these three units is judged as well above average, and the neat modern appearance is well in keeping with current decorating practice. K-22

Fig. 1 (left) Sargent-Rayment SR-1000 stereo tuner, and Fig. 2 (right) SR-2000 stereo preamplifier.



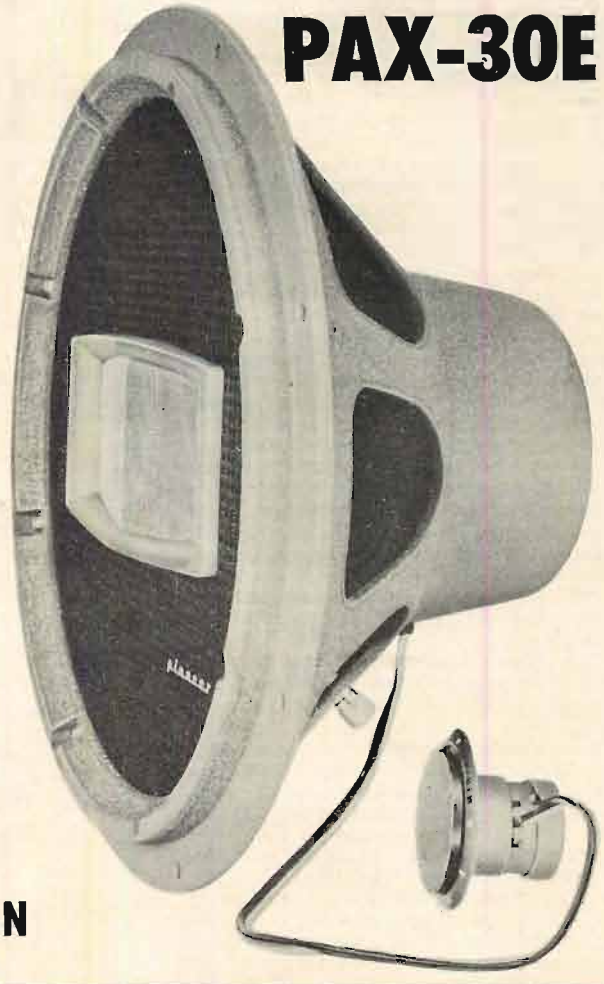
pioneer

UNBELIEVABLE BASS RESPONSE FOR A 12-INCH SPEAKER

PAX-30E

The PIONEER PAX-30E is a revolutionary 12-inch two-way speaker with a fantastic response range that reaches, in the low frequency range, all the way down to 20 cps and in the high range, as high as 16,000 cps. The woofer cone paper is formed of a composite SARAN material, used for the first time in the PAX-30E, that produces clean well-damped bass response down to the lowest audible limits of sound. For unexcelled dispersion of high frequencies, two cone-type tweeters are mounted facing outwards at the optimum angle, to provide natural concert-hall quality response. The stamped metal grill serves the dual purpose of preventing modulation distortion and also protecting the woofer cone; hence there is no need for any additional grill on the enclosure.

The PAX-30E may be mounted in an enclosure far smaller than the standard size enclosures used for similar size speakers, and yet will still reproduce extreme bass frequencies far beyond the low frequency response of other 12-inch speakers.



SPECIFICATIONS

Moving coil impedance :	16 ohms
Resonance frequency :	20 – 35 cps
Frequency response :	20 – 16,000 cps
Maximum power input :	20 watts
Sensitivity :	102 db/watt

FUKUIN ELECTRIC, TOKYO, JAPAN

5 OTOWACHO 6-CHOME, BUNKYO-KU, TOKYO

Fig. 3. Jensen "Galaxy" Bass-center unit, shown on ST-972 accessory floor base.

JENSEN "GALAXY II" STEREO SPEAKER SYSTEM

Combining a practical arrangement of loudspeakers in such a way as to feed both channel signals below 1000 cps to a single low-frequency speaker and feeding the high frequencies separately to small units which may be disposed around the room wherever decor and sound reproduction dictate, this system offers quality and economy in the same package.

It is often argued that a system which mixes the low frequencies and feeds them from the center while the highs are fed from more conventional stereo positioning does not compare with two complete separate speaker systems, and to a certain extent we would subscribe to this attitude. We still believe that a good large speaker is better than a good small speaker, too. However, we must recognize that not every home has the space nor every listener the inclination for two large speaker systems, and it is for this reason that many manufacturers have devoted considerable time and expense to developing systems which will be sufficiently unobtrusive to satisfy the eye yet produce sound that will satisfy the ear. This is particularly true with stereo.

The Jensen "Galaxy II" consists of a bass-center unit and two "Satellites." The former, *Fig.* 3, is a duct-loaded housing 12½ in. wide, 10½ in. deep (at the ends; it curves outward slightly in the center), and 24 in. high. The speaker itself is a high-compliance dual-voice-coil 8-in. cone. Also inside the enclosure—which is just over 1 cu. ft. in net volume—is the dividing-network unit which feeds the high frequencies to the two Satellites, while the low frequencies are fed to the two separate coils on the low-frequency cone.

Each Satellite accommodates two small cone speakers—a 6-in. unit for the mid-frequency range and a 3½-in. unit for the highs. The smaller speaker is fed from the terminals of the larger through a 1-μf capacitor. The housing, shown in two positions of use in *Fig.* 4, measures 7½ × 11½ in., and is 4 in. deep over the back cover.

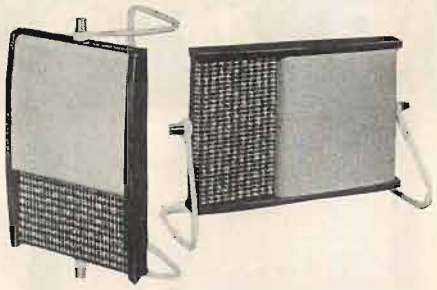


Fig. 4. Jensen S-21 "Satellite" speaker; left, in wall mounting position; right, for shelf mounting.

In use under a variety of placements, we find that the stereo effect is excellent, and at close listening distances somewhat better than two separate speakers placed at the usual spacing in a room. Since the natural overlapping of tweeter and woofer speakers in each channel will place some of the sound at a point midway between the Satellite and the bass-center unit, there is a feeling of full coverage. Furthermore, as one walks around the room the illusion of stereo persists, with less localization than is usually noticed as one or the other of two conventional stereo speakers is approached.

The impedance of the Galaxy system is 16 ohms on each channel. Connections are made to four terminals on the rear, allowing for use with separate amplifiers and four wires, or where a common ground connection is available, three wires may be used. The two Satellite units simply plug into jacks provided on the terminal board of the bass-center unit.

In addition to being available completely finished, the Galaxy II is offered as a kit, with the housings for the Satellites, dividing network unit, coupling capacitors, cords with plugs attached, the enclosure vent tube, and all five speakers being included. It is only necessary to construct the enclosure, of suitable volume, mount and connect all speakers, and the job is done.

We believe that there are many applications where the Galaxy II would be an ideal choice for a speaker system—so much depends on available space and this design provides a remarkable amount of flexibility of installation. **K-23**

UHER UNIVERSAL TAPE RECORDER

"Such a little piece of machinery that does so much" is the comment of one who first saw this recorder in operation. It is small, measuring 12-3/16 × 9-5/8 × 5-5/16 in. deep and weighing *only* 17 pounds, but it packs a lot of functions into its neat housing. The Universal, *Fig.* 5, is the first of a number of Uher models to reach these shores from Western Germany, and while it has some limitations for the highest quality of music recording, it does many other things that could be considered desirable. Because of its small size, the largest reel it takes is 5 in., but at its slowest speed, 15/16 ips, this means eight hours of recording time for one reel of double-play tape, using both tracks.

In its normal functions, the Uher Universal records and plays back monophonically at 3¾, 1⅞, and 15/16 ips. It is push-button operated, with record, playback, rewind, fast forward, and automatic playback selected at the touch of a finger. Separate controls are provided for record and playback volume; on the record level control there is a switch, engaged by simply lifting the knob up slightly, that gives automatic volume or modulation control—particularly useful for dictation, for example. No matter how loud or soft the sound is, the recorded signal remains about the same. Lifting the playback volume control knob cuts out low-frequency response to give greater clarity to speech. The power switch and speed selector are combined into one knob which is turned to the right to turn on the a.c. power, and in the off position it may be raised or lowered to select the speed. The input selector is another knob, choosing between pickup, microphone, or radio inputs. Two additional push buttons serve to stop the unit—one momentarily, and the other to release all operating buttons and apply the brakes.

Most of the mechanical operations are performed by magnets within the unit, which permit a wide variety of extras, such as remote controls on a typewriter for dictation, or simply by external switches, or by means of the Synchro-Akustomat, of which more later. The motor, which drives the capstan flywheel by means of an idler, is a hysteresis unit, and the drives for rewind and fast forward come from the motor shaft through belts to an intermediate point, with the magnets actuating the mechanism for its various functions. It is

Fig. 5. Uher Universal tape recorder, removed from protective carrying case.

IT'S WHAT'S RIGHT HERE THAT'S ALWAYS COUNTED!

M-49b
NEUMANN CONTINUOUSLY ELECTRONICALLY VARIABLE DIRECTIONAL PATTERN MICROPHONE SYSTEM
NOW $495

KM-54a
NEUMANN HYPER-CARDIOID MINIATURE MICROPHONE, DESIGNED WITH TV AND FILM IN MIND
NOW $410

U-47 (U-48)
NEUMANN "STUDIO" MICROPHONE SYSTEM
NOW $365

KM-56
NEUMANN MINIATURE CONDENSER MICROPHONE SYSTEM
NOW $465

COMPLETE TECHNICAL SPECIFICATIONS WILL BE PROMPTLY FURNISHED UPON PROFESSIONAL REQUEST.

Gotham Audio sales co. inc.
2 West 46th Street, N. Y. 36, N. Y. COlumbus 5-4111

Fig. 6. Uher "Synchro-Akustomat"—the black box full of magic.

possible, for example, to depress the fast forward button while rewinding—the machine simply stops, and then starts again in the opposite direction. It is also possible to depress the play or record buttons while rewinding—and if you are familiar with tape recorders you know that when you engage the idler against the capstan during a rewind you almost always break the tape—but not so on the Uher. The machine stops, *then* the operating magnet moves the idler against the tape and capstan, and the playback proceeds. In the automatic playback position, and with metallic strips or silver paint on the ends of the tape, the machine will play through the reel, stop, rewind, stop, and then play the reel through again, continuing this operation as long as it is turned on. With the standard microphone one has all the controls at his finger tips. The machine may be stopped, rewound, and started in either playback or record modes just as often as desired.

The most engaging features of the machine come with the connection of the "Synchro-Akustomat," the box of black magic. This unit, shown in *Fig.* 6, plugs into the recorder. It consists of a dual triode and a relay, with circuitry necessary for its functions. The selector switch on top is labeled Aufnahme (record), Wiedergable (playback), and Stop-Start. In the latter position, the machine is first set up and turned on. In a moment, the reels stop turning. In the presence of any sound, the Synchro-Akustomat starts the recording (eliminating the first syllable of speech, of course, so you soon learn to start each sentence with "uh") which continues as long as the sound does, then stops it again. (We used this feature one night to prove we do not snore, only to be told that we hadn't on that particular night.)

In another application, the switch is turned to Aufnahme, a push-button cord is plugged into the unit, and another cord is connected from the Akustomat to a motor-driven projector. One simply shows his slides once, narrating them as he goes along (each push of the button changes the slide and puts a tone in the vicinity of 25 cps onto the tape). For playback, throw the switch to Wiedergabe, and the machine does the talking and slide changing all by itself. When combined with a repeating changer, such as one of the Kodak Cavalcade series, the Uher in the automatic playback position will run through a batch of slides, move the tray back to the beginning, and repeat the entire procedure indefinitely—ideal for display presentations. The Synchro-Akustomat is an "optional accessory," and not everyone would have need for it, but for those who do it is most effective.

Another accessory is the transistorized "mixing desk," *Fig.* 7, which can serve as a complete control for a variety of recording tricks. It is equipped with four inputs, with different gain and impedance conditions, ranging from low-impedance microphones or pickups to high-impedance sources with outputs ranging from 0.15 mv to 100 volts. The unit employs three OC603 transistors, two serving as preamplifier stages for the low-level inputs and a third as the output stage of the mixer. The combining circuits operate at compartively high levels, and feed into the last transistor stage. Each input has an off-on pushbutton so one or more may be connected as desired. Power for the transistors is furnished by a self-contained 9-volt battery which is turned on when a plug is inserted into the output jack. Current consumption from the battery is between 3 and 4 ma, and the noise level measured 64 db below the output signal.

Other accessories available for the Uher include various types of microphones, headphones, and remote control units, and several different types of cord-and-plug assemblies may be had for different applications.

In performance, the response is essentially flat from 30 to 15,000 cps (at 3¾ ips) when the bias is adjusted for American tapes. At the lower speeds, response is down 5 db at 9000 and 4500 cps respectively. The speech filter drops the 30-cps response about 15 db. Flutter and wow are stated to be 0.3 per cent, and hum and noise measures 43 below normal signal level.

The machine is so well built that we are anxiously awaiting the stereo models, which have the added advantage of accommodating 7-in. reels and of running at 7½ ips. In the meantime, the Universal does its many jobs well and interestingly. **K-24**

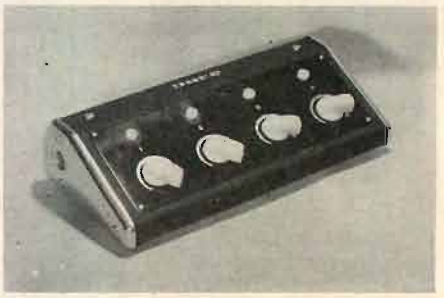


Fig. 7. Uher transistorized four-channel mixer.

COLLARO "CONSTELLATION" RECORD CHANGER

The latest model in the record-changer category is Collaro's "Constellation," shown in *Fig.* 8. Each new changer brings its own particular set of features, and with them some differing characterities. The Constellation employs a heavy-duty four-pole motor, which drives a die-cast non-magnetic turntable platter weighing 6½ pounds. The result is a very low flutter and wow content —measuring less that 0.15 per cent total. Using a non-magnetic turntable eliminates the possibility of variation in stylus force as records pile up and raise the pickup further away from the platter. This machine operates at all four speeds and handles 7-, 10-, and 12-in. records in any order—assuming, of course, that all are for the same speed. The ball thrust bearing runs between two hardened steel washers which seat on rubber bearing surfaces. Both a.c. and output cables are furnished already attached, with different colors indicating the channels of the two output cables. The plug-in head has five terminals, and the fitting is mechanically sound—a metal tongue on the head engages firmly with a spring-loaded slot in the arm. The unit measures 12 x 12½ in., and extends 2⅝ in. below the motor board.

The knob at the left controls the speeds, with a small lever underneath the knob switching from manual to automatic operation. The right knob serves to turn in the unit on and off, or to reject the next record. The mechanism is of the center-drop type, with a dog in the spindle slipping the next record off a step. Selection of set-down point is governed by a feeler lever adjacent to the arm mounting, and an overhead stabilizer keeps the record stack level. Cycling time, after tripping, is 8 seconds at any speed of the turntable.

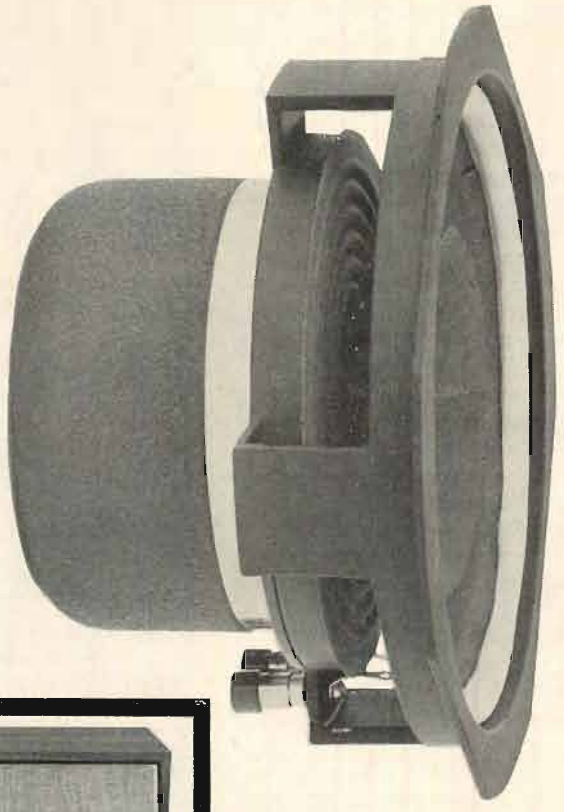
By our method of measuring—or at least comparing—rumble, this unit is down 34 db, with the NARTB standard set at −35 db for professional turntables. This seems adequately close for changers, which have not yet reached the figures modern stereo turntables do, but unless they are used with the finest speaker systems which extend well below 30 cps, the rumble is seldom a factor.

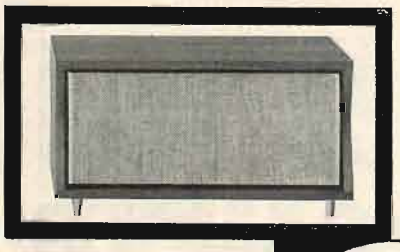
In operation, the test changer performed consistently and satisfactorily. In the manual position, operation is practically the same as with any single-play turntable, and the arm is completely free to be placed on the record anywhere one wishes, or to be picked up at will without affecting the operation. The Constellation is attractive in appearance, and continues to perform well. **K-25**

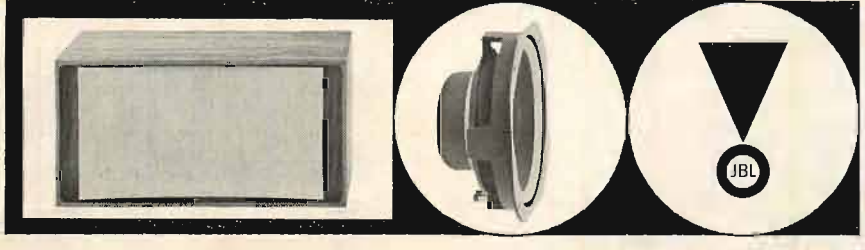
Fig. 8. Collaro "Constallation" record changer.

NEW TRANSDUCERS

for infinite baffle installation







Introduction of the new JBL Linear-Efficiency Loudspeakers has been met with overwhelming demand. It is apparent that many audio enthusiasts have been impatiently waiting for a truly precision-made driver engineered for sealed enclosure and wall installation. The super 8″ LE8 is a full range loudspeaker which gives response from 30 to 15,000 c.p.s. that is smooth, clean, and accurate far beyond that delivered by any other speaker of this size ever made. Partly responsible is a silver impedance compensating ring in the magnetic circuit that controls power drawn by the voice coil at high frequencies. The LE8 makes an ideal replacement speaker because enclosure dimensions are not critical, and acoustical requirements can be readily met. An enclosed volume of only two cubic feet, or more, is recommended. The two-way Linear-Efficiency System Kit, JBL Model S5, shown in the smaller illustrations, includes JBL Model LE10 Low Frequency Driver with free air cone resonanceof 15 c.p.s.; JBL Model LX3 Dividing Network for crossover at 1,000 c.p.s.; JBL Model LE30 High Frequency Driver, a completely new 5½ octave direct radiator. These three units form an integrated, perfectly matched, electro-acoustical system. They must be used together. All LE drivers have a new type mounting flange that permits mounting *from the front*, as well as the rear, of the baffle. Handsome new enclosures for LE units are the Dale, Madison, and Minigon. Write for free technical bulletins describing these extraordinary new transducers.

JAMES B. LANSING SOUND, INC.
3249 Casitas Ave.
Los Angeles 39, Calif.

DEFENSE and the HI-FI BACHELORS

(*from page 48*)

unless you recorded it, for use here at the school, and especially for playback upon reassignment to sea duty after graduation. But record it how?

And Now—Tape

Considering everything, there was only one answer—tape. Among other things, there was the dynamic-range and frequency-response capability of tape. For men many of whom would soon return to sea, on craft designed for military utility and not for carrying excessive personal gear, there were other items in favor of tape, not least among them light weight. But most important of all: you could safely play tape on a vessel rolling, pitching, vibrating and even pounding in heavy seas—while under such conditions a jarred needle would quickly ruin records, especially the new and expensive stereo discs.

That was that. Tape entered quickly.

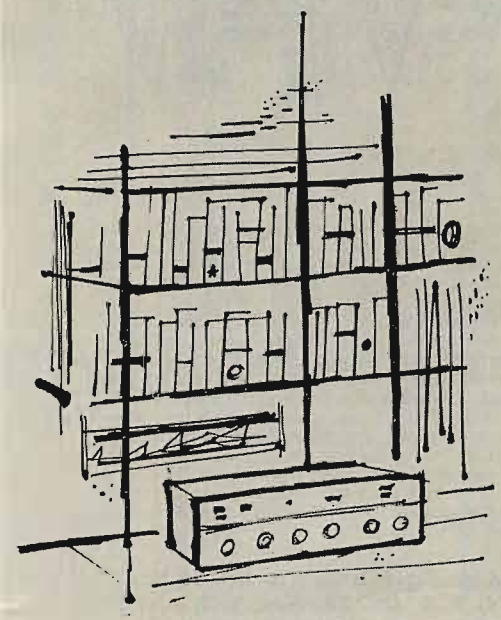
First on the scene was an Ampex A-122, acquired by one of the audio fans encouraged by Lt. St. Ville. Here, too, future sea duty considerations were a factor—the equipment had to be physically rugged as well as electronically and mechanically tops. St. Ville's installation soon followed with an Ampex 601-2 portable stereo recorder. A few stereo tapes were available on the market. More were recorded from the AM-FM broadcasts. Listeners in the BOQ room became more frequent and more numerous. Here was sound reproduction of a quality they had never even dreamt of before. But the quest for perfection had by no means yet come to an end: if two speaker systems sounded this good, wouldn't *three* systems sound even better? Here was a chance to find out, perhaps the last chance for a while—for at sea the large, cumbersome speakers were one item that would have to meet compromise. But smaller, shelf-mounting types could take their place and be more than adequate for the limited spaces aboard ship—and then some, as they were to discover long before sea duty.

The answer was an Acoustic Research AR-1W woofer with a JansZen 130 electrostatic tweeter, provided by another student and placed atop Lt. St. Ville's piano. With the Hartsfield left in its original corner position, the home-made bass-reflex speaker was placed equidistant between the two side systems. With the side speakers carrying separate stereo channels, some of each channel was fed into the center speaker at a level a few db below that of the side systems. The three speaker systems were then phased as the earlier two had been, with the use of a 50-cps tape. To feed the center system, an additional preamplifier (a McIntosh C-8) and McIntosh-60 power amplifier were acquired. A home-made electronic mixer, constructed by a lieutenant majoring in electronics, was then installed to provide a balancing facility between the three pre-amplifiers and the speaker systems.

With the increase in popularity of this BOQ room came an increase in the demand for system flexibility. To satisfy this demand, a third tape recorder (another Ampex 601-2) was acquired. This introduced a new series of complications, which will be described next month.

(*To be continued*)

With five shelves of recorded tapes available, both the 601-2 and the A-122 Ampex machines are busy.



A NEW MEANING FOR EXCELLENCE

The new Harman-Kardon Chorale

MODEL A260
60 WATT
STEREO
HIGH FIDELITY
AMPLIFIER

In its incomparable performance, magnificent sculptured styling and advanced design—the Chorale literally creates a new meaning for excellence. It alone provides all nine of the most wanted features *for stereophonic high fidelity reproduction.*

1 *Power Output:* Delivers 30 watts of power (each channel) at 20-20,000 cycles *at less than ½% harmonic distortion.* Can easily drive the most inefficient speakers.

2 *Exclusive New Third Channel Speaker Selector:* Provision for third channel speaker for local or remote stereo systems. Also permits simultaneous operation of virtually any combination of speakers in local or remote installations.

3 *Friction-Clutch Tone Controls:* Permit adjustment of bass and treble tone controls separately for each channel. Once adjusted, controls lock automatically to provide convenience of ganged operation.

4 *Tone Control Defeat Switch:* Eliminates tone control phase shift (present even when controls are flat) insuring clean, authentic sound reproduction.

5 *Silicon Diode Power Supply:* Provides unusually uniform B+ regulation for unrivaled low frequency and transient response.

6 *Illuminated Push-Button On/Off Switch:* Permits amplifier to be turned on and off without upsetting careful setting of controls.

7 *Speaker Phasing Switch:* To maintain proper low frequency response and eliminate "hole-in-the-middle" effect.

8 *Impedance Selector Switches:* Select 4, 8 or 16 ohms for each channel.

9 *Separate Rumble and Scratch Filters:* Eliminate annoying phonograph rumble and record hiss.

Distinguished in every respect—The Chorale, with its handsome satin gold escutcheon, is truly the definitive amplifier for the age of stereo.

The Chorale, Model A260 . . . **$199.95**
Optional Enclosure, Model AC60 . . . **$12.95**
Prices slightly higher in the West

FOR CATALOG OF COMPLETE LINE WRITE
HARMAN-KARDON, DEPT. 100, WESTBURY, N. Y.

harman kardon

Record Review

EDWARD TATNALL CANBY*

TELEFUNKEN SPECIAL

Beethoven: String Quartets in E Flat, Op. 74 ("Harp"); Op. 127. Tatrai Quartet. **Telefunken TCS 18025/26 stereo**

Three bucks apiece ($2.98) for these and they are bargains, along with others in this new Telefunken release (via London). The mono versions sell for $1.98, at rock bottom.

The playing of this quartet is excellent, on a par with the very best elsewhere. The group is Hungarian, recent refugees, and they perform with that superb fire and drive that has been typical of Hungarian musicianship these many years. They are fully capable of projecting these advanced and relatively difficult works, the Opus 127 being one of the famous Last Quartets. Their tone is big and warm, their ensemble perfect, their interpretation easy and natural, with warmth and drama but not a bit of sentimentality. I'd put them down as one of the best Beethoven groups on records, at any price.

There are several reasons why discs of this sort might be launched at the low $1.98 level. The players aren't "big-name"—not yet, at least. The recordings could be elderly, perhaps not quite brand new and on the way to musical obsolescence. Or the technical quality might be substandard in some way.

There are plenty of older stereo recordings that never got issued in stereo form when the original releases broke forth, up to four years or more ago and presumably many of these are now a glut in the backlog of unreleased stereo material, ripe for low-priced release. That's worth keeping in mind.

It's true also, as you'll soon discover if you look about, that many of the less famous orchestras and performers who until recently have rated regular pricing are now being demoted, so to speak, to the bargain price level. Price war? Most likely. Bargains galore, in any case. Take it from me, this Tatrai Quartet plays big-league music, whatever the price they go for.

As to technical quality, the low-priced specials are likely to vary more radically—both towards good and bad—than the expensive discs. These Tatrai Telefunkens are beautifully miked in a solid, natural liveness, but the recorded sound does have a slight grainy quality, not quite clean, which is of course most noticeable in the inner grooves. It varies from record to record in this whole Telefunken series; here, the Op. 74 Quartet seems to me definitely more grainy in sound than the Op. 127, which is not far from perfect. No surface noise or irregularity, as far as the ear is concerned. If the material of the disc itself is substandard in any way, it doesn't show. I haven't made wear tests and don't intend to at the price.

Beethoven: Symphonies #1 and #8. Bamberg Symphony, Hamburg State Philharmonic, Keilberth. **Telefunken TCS 18004 stereo**

Beethoven: Symphony #4. Hamburg State Philharmonic, Keilberth. **Telefunken TCS 18024 stereo**

One of these offers two complete symphonies, the other only one—though on other labels the Fourth can be had on a single side complete. Don't jump to conclusions, though. This matter of when to cram more music onto a side and when to stretch it out thin is anything but simple. Beethoven just didn't have the foresight (as seemingly Mozart and Haydn did) to write his symphonies to fit the ideal LP record. There is inevitably, then, the choice between a bargain-length disc, two complete symphonies plus the risk of substandard quality and inner-groove trouble, or a seemingly skimpy disc, short-sided, that offers optimum groove quality. In the above you have one of each type.

These are far from second-rate readings, as the low-low price, $2.98, might suggest. Telefunken is a major German label of ancient lineage and these orchestras are excellent, if perhaps not crack (the Hamburg seems to me to play more smoothly here). Both the conductor and the players know the Beethoven tradition entirely too well to tamper with it via eccentricities; the music is presented easily and with authority. The records are top bargains in music and no two ways about it.

As for sound quality, it is not unlike that of the Beethoven Quartets reveiwed above. The over-all acoustics and balance are excellent, the stereo effect modest but worthwhile, but the sound is very slightly grainy in texture, mainly in the loud portions. Not enough to bother any musical ear.

Again it is hard to guess just why this celebrated German label is offered up at $1.98 and $2.98 (stereo) whereas its distinguished competitor, Deutsche Grammophon, is at this writing still priced at five and six dollars or more per disc. Dramatic price cutting must be at least a partial answer. All part of the big stereo competition.

Tchaikowsky: Nutcracker Suite; Serenade for Strings. Symph. Orch. Belgian Nat. Radio, André. **Telefunken TC 8001**

I received this one in the dollar-ninety-eight mono form (it's also available in stereo) and at the price I can only be amazed. The Belgian orchestra and its conductor have earned a top reputation among the younger orchestras that have been born in the new radio age. André is a particularly good interpreter of French-school music and, in this case, he gives a bright, lively, French-style reading of the two Tchaikowsky works, avoiding any suggestion of the heavy, thick pomposity that so often gets into the Serenade, playing the "Nutcracker" neatly and with precision.

The sound is somewhat dry, in the French manner (less live than the German recordings) and rather intimate in effect; perhaps it is from a radio studio. Again, there is a very slight grainy quality, scarcely enough to detect even on the fanciest hi fi. It won't bother you at $1.98.

Mozart: Symphony #38 in D, Symphony #39 in E Flat. Bamberg Symphony, Keilberth. **Telefunken TCS 18013 stereo**

Bravo! These Mozart symphonies are the finest I've heard in a long, long while, done to perfection just the way I, for one, think they should be. They are neither too fast nor too slow, but natural and alive, easy and unforced, the sound just intimate enough, yet impressive and as big as the music needs. The expression is reverent and intense throughout, the best of the musical sense is projected without fuss and feathers, with the most careful attention to detail. Mozart speaks wonderfully for himself in these terms. I'd rate these the best recordings of the two symphonies I can remember hearing in recent years—and at $2.98 for an excellent stereo effect!

The recorded sound in both seems at first to be a bit dull, the highs lacking in brilliance; but oddly enough, this effect disappears as you listen. The strings are simply less steely, recorded in a more quiet, well-balanced manner, than in some of our close-up "hi-fi" modern recordings. Inner grooves display a good bit of graininess on both sides and the loudest parts throughout aren't entirely clean, but these are very minor objections, given the lovely playing and the excellent acoustical effect of the music.

Dvorak: Slavonic Dances, Op. 46 Nos. 1, 3, 4, 5, 8; Op. 72, Nos. 1, 2, 4, 7, 8. Bamberg Symphony Keilberth. **Telefunken TCS 18015 stereo**

These joyous, bouncing, sweetly sad dances are a problem today for our ears that are used to a leaner, drier mixture—Dvorak's orchestrations are thick-textured and dense, almost too turgid for clarity. They liked it that way in those days (and they didn't have to cope with stereo).

The later dances of Op. 72 seem to come through more clearly, on side 2, than the Op. 46 items of side 1—though both sets are familiar enough. Dvorak's writing grew more direct and clear as he progressed. In most of his earlier works you will find a certain over-complexity and thickness which tangles the ear in too many strands of thought at once. Later on, he learned to be orchestrally dramatic—witness the New World Symphony.

There's poetry and animation in the playing here but it strikes me that the sound is too Germanic, and not enough Czech. That is, there is almost too much sweetness, too soft; the bounce and spring of Czech dancing is weakened. Not bad—but more bounce to the ounce and a trace less sugar would make these still better for the listening.

Big, broad stereo liveness, thick as the music itself. Once again, a slight graininess in the sound.

FOR KIDS AND OTHERS

Piccolo, Saxie and Company. Narr. Victor Borge; Text: Jean Broussolle, Music Andre Popp. **Columbia CL 1233**

It's been a long time since "Tubby the Tuba." Tubby had the virtues of brevity—on 78 rpm—as well as newness and sparkle, relatively speaking. This long, two-sided LP record contains more of the same in what is now a very well-worn tradition. Victor Borge narrates the happy story of the families of musical instruments, with musical illustrations by Mr. Popp involving the usual vast, slick professional orchestra plus modern one-world additions such as the Balalaika, the Hawaiian guitar and, of course, the currently fashionable Latin-American instruments.

It's all in good fun—too good. Everybody has a perfectly *wonderful* time, the humanized instruments are constantly on the edge of joyful hysteria and life is just a bowlful of synthetic roses, musically speaking. As for human pathos—Hans Christian Andersen style—there's not a trace; only the slightly old-maidish Miss Harp has any personality at all and she doesn't have much. Is this the

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

the original and positive sound reproduction techniques necessary for true high fidelity are presented on

AUDIO FIDELITY® RECORDS

the highest standard in high fidelity

The romantic music of gay Vienna captured in all of its tuneful beauty by the artistry of Jo Basile and his accordion.

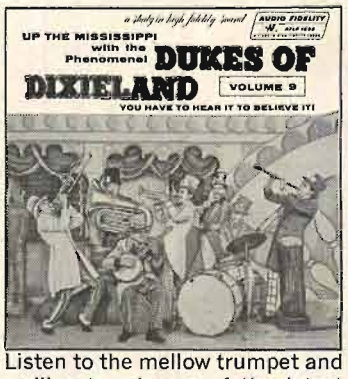
AFLP 1868/AFSD 5868

Jo Basile and his accordion are ideally suited for the rich and graceful mood of the sophisticated tango.

AFLP 1869/AFSD 5869

Jo Basile brings his skillful artistry to the haunting beauty of Italian song favorites for your listening pleasure.

AFLP 1871/AFSD 5871

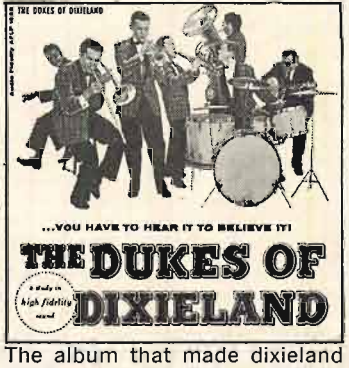


Listen to the mellow trumpet and wailing trombones of the latest and most phenomenal of Dukes of Dixieland recordings

AFLP 1892/AFSD 5892

Join the phenomenal Dukes of Dixieland as they march along ON BOURBON STREET in true New Orleans fashion.

AFLP 1860/AFSD 5860



The album that made dixieland as played by the Dukes of Dixieland. You have to hear it to believe it! **AFLP 1823/AFSD 5823**

An informative and fascinating demonstration of stereophonic reproduction including sounds of cannons, fire engines and sports cars. STEREO ONLY. **AFSD 5890**

A shining example of the remarkable clarity and realism is heard with the artistry of Leon Berry at the Giant Wurlitzer.

AFLP 1844/AFSD 5844

The brilliant highs and dynamic lows of the theater organ are musically displayed by the versatile Al Melgard.

AFLP 1887/AFSD 5887

FREE

Complete illustrated catalogs of the entire Audio Fidelity library are available from:
Audio Fidelity, Inc., Dept. A-10, 770 11th Ave., New York 19, N. Y.

HEAR the fabulous 1st Component Series

The finest classical performances available in stereophonic high fidelity These recordings reproduce in proper balance and spatial relationships the musical elements as heard only before in the concert hall.

SUGGESTED PRICE — $6.95 EACH 12 INCH STEREODISC
SUGGESTED PRICE — $5.95 EACH 12 INCH LONG PLAY

ALL ALBUMS EXCEPT AFSD 5890 ARE AVAILABLE BOTH MONOPHONICALLY AND STEREOPHONICALLY

influence of our fine TV technique? I suppose so.

As music appreciation (introducing the Instruments of the Orchestras) the record has at least a nominal merit. The instruments do play for us, one after the other and together, in hi fi—from the piccolo right down to the low "bazzoon," as Victor Borge calls it. (This last character is a gruff old geezer whom you may have met before in a classic called "Peter and the Wolf.") The music itself is expertly eclectic-modern, well written and often quite melodious. Once in a blue moon it is even original, as in the offstage passage where the woodwind family are heard hidden in the tree tops of a forest. (That idea, incidentally, struck me as one of the more intriguing novelties in the story—the woodwinds living in a wood. Get it?). Here and there, the treatment is momentarily quite lovely.

Even the text is occasionally brilliant. The harp is the butt of some tricky remarks—"Old Miss Harp shook herself like a wet dog, and hundreds of notes came off like drops of water"—and even the sprightly piccolo, up in his woodwind forest-top, is able to let loose a peel of music so that "a cascade of notes tumbled down a tree." Clever.

As for Mr. Popp, the composer, he simply must be Hungarian. No other nationality could provide such a muchness of expertly contrived movie-style music, not to mention some quite convincing Hungarian goulash (musically speaking) when the orchestra, on one of those State department-sponsored world tours, visits Hungary. (It goes to Siberia too but politics are avoided; everybody jumps out and has a sleigh ride and a snow ball fight.)

Conclusion: Sometimes clever, always expert, mostly platitudinous and much, *much* too long for its shallow content, both as to story and music. Too much of a muchness.

Prokofiev: Peter and the Wolf.
Britten: The Young Person's Guide to the Orchestra. Cyril Ritchard, narr. Phila. Orch., Ormandy.
Columbia MS 6027 stereo

Cyril Ritchard, of the foggy, croaky voice, does a rather offhand and somewhat hasty "Peter" here, but his innate storytelling ability comes through and makes this an effective version—especially in view of the innately excellent accompanying ability of the ever-willing Philadelpiha Orchestra. I've often observed it before; it happens again here: the "Philly" can do a slick but utterly convincing job on almost any standard classic you can name and the sound is never tired, never forced, always fresh. Don't know how they do it.

Needless to say, stereo helps "Peter" even though there is no special attempt at stereo trickery. It makes the music more alive, more immediate, helps the voice to stand out clearly. Worth it, just for that.

The "Young Person's Guide" is here presented without narration, one of its alternative forms. The record must have been, therefore, a marriage of commercial convenience—for the Britten score would be more effective here with its own proper narration, also by Mr. Ritchard.

Martha Schlamme sings Jewish Folk Songs, Vol. 2. Orch. conducted by Robert DeCormier.
Vanguard VSD 2032 stereo

Time was when the folk song, leaving its native heath, invariably found itself an "art" accompaniment, for piano or even orchestra, and a singer to sing it in an art-trained voice. The "originals," as sung down in the valley or up on the mountain, were considered much too crude for all but local-yokel ears.

Nowadays, everybody and his small brother and sister sings folk music through the nose, to guitar or banjo—and the "original" folk music style has spread far and wide with mixed results, some good, some painful. But Martha Schlamme is of the old school; she sings her Yiddish songs to a relatively elaborate orchestral accompaniment and her voice is simply a fine voice. Indeed (since she was born in Vienna) it has a certain Viennese touch to it, out of Schubert. The combination, with songs of Jewish ancestry, is highly musical and very pleasant to listen to—though it is far removed from the sort of folk music that comes out of Israel these days.

If you know the famous "Songs of the Auvergne" as set by Cantaloube and recorded by the celebrated Madeleine Grey many years ago (also by Susan Reed), you will find similarities here. The orchestral accompaniments are miniature tone poems on their own, full of graceful counterpoints and well turned harmonies, often with little introductions, for atmosphere. The singing is personal, lyric, intimate. People who know the tunes will be especially pleased, but others will find the music at least as enjoyable as the "Auvergne" collection.

Wilde: The Picture of Dorian Gray (abridged). Read by Hurd Hatfield.
Caedmon TC 1095

Beneath the foppish bulk of Oscar Wilde there was a personality as strong as spring steel. In this excellent condensation of the "Picture" you will find, in the same way, beneath the la-de-da exterior and the polished accent, the "my *dear* Lord Henry . . . you'll have tea, of course" and all the drawling decadence of the so-called *fin-de-siècle* manner—one of the most spine-chilling horror stories of the nineteenth century, to rank with anything of Edgar Allen Poe. Brrrr!

Mr. Hatfield played the part of the eternally youthful Dorian Gray in the movie of a while back. His reading is expertly done, the whole drama shaped with, so to speak, a lift of the eyebrow here and there, a tiny hesitation, a bit of drawl; you'll start listening with diffidence but if you stick out the first side you'll be pinned to your chair in fascination, to the end.

Boris Karloff Reads "The Ugly Duckling" and Other Tales by Hans Christian Andersen.
Caedmon TC 1109

Here's a fine sequel to the wonderfully entertaining Karloff records that came earlier from Caedmon, apt for young and old folks, full of charm and humor.

This is one of the Andersen translations that preserves a good deal of what is said to be a somewhat slangy and down-to-earth tone in the original Andersen tales. (Too many versions in the past were over-elegant, in the Victorian manner.) Karloff goes along with the idea with gusto. Delightful! Not corny, but just quite wonderfully folksy, and the serious impact of the stories is the greater for it. Great man, old Andersen, touching on the most profound feelings we have, in the simplest and most imaginative ways.

Billy Faier—Travelin' Man. With guitar and banjo.
Riverside RLP 12-657

The teen-age kids will go for this hot and heavy and maybe some of you graybeards will sort of enjoy it too.

Faier is no mountain billy goat; he's one of those new-fangled folk singers that start in the big city and learn their folk songs from records and other folk songsters—or maybe via TV. Pete Seeger began that way (more or less) don't forget. Anyhow, Faier traveled and listened and now he sings and plays, and it really doesn't matter too much whether he's doing a good imitation or pouring out the real thing, straight from grandpappy.

The Faier voice sings with a modicum of pitch, about as well as you or I could do it, no better. At first he doesn't really seem to be very musical. But his fingers can fly, on the banjo or guitar and he has both a vigorous dramatic personality and a fine sense of style, within his own limits. And he relishes the words and stories. I began by being bored, ended up quite enchanted (except for the last number on Side 2, which is pretty sad). A good folk showman, and the recording is life-like, too.

It's interesting that Faier says in so many words that his source for no less than four of these songs were records; he gives the actual recordings. (Two more were out of books, dolled up according to his own fancy). This is the way that folk music is passed on these days, not by "word of mouth" but by the sound of recording, freed of both time and space. Even the dead can pass on folk songs, now, to the quick. Lead Belly, for instance.

Guess I'll pass this record on to a young folk singer next door, aged 14. He'll have it all memorized in no time. And if *he* makes a record someday. . . .

BIG MODERN

Stravinsky: Threni (Lamentations of Jeremiah) 1958. Columbia Symphony Orch., Schola Cantorum, soloists, conducted by Stravinsky.
Columbia MS 6065 stereo

Hey—what a difficult piece! And yet here is Columbia going all-out to record it, with the composer in charge, as Columbia has done in the past for a long, long series of Stravinsky works. I own the ancient 78-rpm Columbia recordings, under Stravinsky, of the "Histoire du Soldat" and "Symphony of Psalms," issued in the early Thirties. The series has been almost unbroken since (except for a time when RCA lured Stravinsky away—then threw out all the resulting recordings after Columbia got him back). Interesting for us all, even those who think maybe this music isn't exactly pops stuff.

It isn't; but then neither was his "Sacre de Printemps" and I'll bet every one of you has had that piece on your hi-fi turntable at one time or another. These things tend to mellow with time; we all get to like them sooner or later. Getting there sooner—say, right now—isn't so different from getting your new Chevy the day after it comes out. A certain risk involved, but there's excitement, too, being in on something new before the rest catch up.

So with these "Threni" (threnodies) settings of sections from the Lamentations of Jeremiah. Forbidding music on first acquaintance, but if you will follow the words, if you know a bit about the traditions of these texts and their many settings by past composers, over the centuries, you'll begin to get interested. For instance, the Hebrew letters that set off the verses of the moving lamentation—"*How does the city sit solitary, that was full of people! How has she become a widow, that was great among the nations . . .*"—the letters that stand as gate-posts, Aleph, Beth, Caph, Heth, Teth, Lamed and the rest, are set to expressive music that invariably laments on its own, as a chorus of grief. Stravinsky sets them here, as did Lassus, Thomas Tallis, Couperin, centuries ago. So, too, with the titles, which are also set to music—"This is the Lamentations of Jeremiah the Prophet"—like a stately musical entrance-way to the body of the work; Stravinsky does that, too.

And if you know a few of the older works by this composer, you'll find here many familiar aspects of his style. The seemingly ungainly jumps of the singing voice for instance, up, down, up down; the "speaking" chorus, half-whispering a sentence in a sort of march time; the piercing octave tones in the orchestra that set off and regulate the vocal parts. The Symphony of Psalms is in this music and also "Renard," that ultra-humorous, half-animal piece about the fox and the silly rooster, that dates from some forty years ago.

Yes, this is Stravinsky's version of "twelve-tone" music, à la Schoenberg. But it still sounds like Stravinsky and you need not think for an instant about the tone row and the musical mathematics—you should not.

Yes, the singing here has a stilted sound and probably *is* somewhat stilted and forced—this is a new sort of music, a new piece, and performers must grope in it, reading the notes and fumbling for the new sense. Inevitable—Beethoven's Ninth probably sounded the same way on its first performance. Even so, I maintain that the "Threni" isn't beyond most of us even now, if we are the sort who won't be put off by the first unintelligibility. I've heard it just twice and I've already found places that seem to me quite beautifully expressive.

Stravinsky: Ebony Concerto (1946); Symphony in Three Movements (1946). Woody Herman & His Orch.; London Symphony, Goossens.
Everest SDBR 3009 stereo

This is relatively easy stuff from 'way back in 1946. Woody Herman plays the Concerto

with his present band, as he played it first in 1946; it is written for saxes, trumpets, trombones and other such "jazz" instruments, plus a few standard instruments and a guitar, but it isn't jazz and never was. Just Stravinsky, writing dry, oddly colored music for jazz-band instruments.

The boys sort of flounddered through it in the 1946 version (I had it on 78) and they still flounder a bit today; but I was interested to find that a group of teen-age music students thought this was just terrific stuff, without any explanation or persuasion, when I played the record for them. Your kids'll like it, even if you don't, probably.

The Symphony on the other side is bigger and more classic, a piece that goes down very easily for the most part—it was in his most affable symphonic period. Harsh and strong, as well as lyric, the big orchestra is always a pleasure to hear in Stravinsky's sharp colorations and rhythms.

All praises to Everest for a top-rank recording of both pieces in every sense. Fine sound, fine stereo, close-up and dry for the jazz band, larger and more resonant for the Symphony. I haven't heard from Everest since this release—I earnestly hope the company has continued the excellent start it made with its first classical offering.

Bartok: Concerto for Orchestra. L'Orch. de la Suisse Romande, Ansermet.
London CS 6086 stereo

This is an amazing work—astonishing simply in that it is already an accepted and even quite popular classic, though it was composed in 1943. To be sure, many a symphonic piece of that and later years is heard with regularity, but—Bartok! Bartok is no ordinary composer.

My own feeling is that this music's superior force and exquisitely calculated language strike through to the average listener because of the curious combination of new and old that is in the Bartok idiom. The outside of the music, so to speak, is conservative and familiar, in the grand line from Mozart and Beethoven. There are themes, there is color, contrast, an almost Romantic expressiveness, of a sort that sits easily with most of us—it is immediately accessible. Yet the music also has that extraordinary tension, an almost demoniac, cat-like, super-voltage agility, which is uniquely typical of Bartok and which expresses our own 20th century as no earlier Romantic music could do. It's a potent combination, this.

The Ansermet reading is a stereo re-do, as the recent Fritz Reiner Chicago Symphony version for RCA was, too (though the older Reiner version was on Columbia with a different orchestra). These two performances would seem in a way to represent the two facets of Bartok in their respective emphases. Reiner's recording has the high tension, the electrical, hair-raising voltage; Ansermet's, relatively, emphasizes the more familiar lyric and coloristic qualities, in a less intense but equally absorbing presentation.

My own preference is for Reiner—but maybe this is because I first got to know the music via his older recording. (It is still the best of all, I think, especially the relatively dry, close-up microphoning that brings out the solo qualities of the instruments, as per the tile of the music. But with respect to quality, it is far out of date.) If you own Reiner—buy Ansermet by all means, and vice versa; the two versions add up to more musical enlightenment than either by itself.

Hindemith: Mathis der Maler.
Bartok: Divertimento for String Orch. (1939). Philharmonia Orch., Silvestri.
Angel S 35643 stereo

The Bartok Divertimento is a splendid companion listening piece to the Concerto for Orchestra of four years later, composed in a similar idiom—but this performance strikes me, for all its expertness, as an oddly addled one. It just doesn't seem to be making sense. I have the strange feeling that the musicians—or the conductor—simply don't know what it's all about. Could be, though I'll admit it seems unlikely, from this famous band. The effect is relatively plodding and heavy, where

intimacy, lightness, and electricity should be evident. The sense flounders, where it could so easily be luminous.

Hindemith's much weightier "Mathis" Symphony responds far better to these performers. It is a tone painting in detail here, aided by the excellent Angel stereo sound. Accurate playing, transparently balanced ensemble and lucid recording together make this the least ponderous and the most expressive "Mathis" I can remember.

CONCERTO

Beethoven: Piano Concerto #4 in G. Mozart: Piano Concerto #25 in C, K. 503. Leon Fleisher; Cleveland Orch., Szell. **Epic BC 1025 stereo**

Epic has a winning team in Leon Fleisher and Szell. Fleisher's recent Brahms Piano Concerto, the First, is one of the finest recordings ever made of that difficult work, and Szell was with him. Columbia had better look to its laurels, lest the subsidiary company get out in front.

Fleisher worked for some time with Artur Schnabel. You can hear it in his sober, wonderfully musical Beethoven, with never an affectation, a fine sense of architecture, phrasing and Beethoven drama, worthy of the old man himself. In circumstances like this, Szell rises to extraordinary heights as a classic conductor, for the sort of team work that makes this series outstanding.

The late-Mozart concerto (only 20 years before the Beethoven and employing the same "V-for-Victory" motive) is one that isn't often heard, why I could not say. It is big, massive, surprisingly near to Beethoven in texture. The Szell orchestra here plays with less than the usual Mozart suavity, the ensemble somewhat tight and a bit breathless, but perhaps the concerto can stand it. (It's odd how clearly different the American orchestral Mozart sounds from the European tradition of playing.) Fleisher, too, plays Mozart with vaguely less suavity and polish than we find in the leading Mozart pianists in Europe—Clara Haskil, Lili Kraus—but he, too, gives the music a power that it can take; it is a big concerto, Mozart's biggest.

There's an odd and persistent theme in the first movement that starts as the Marseillaise, the first notes, just like the "1812" overture of Tchaikowsky. Pure happenstance, I suppose.

Solid, close-up stereo in the American manner, the music spread to right, left and middle in no uncertain terms, doubtless via three-channel original recording.

Beethoven: Piano Concerto #1 in C. Robert Goldsand; Frankfurt Opera Orch., Bamberger. **Urania USD 1035 stereo**

Here is a solid, workmanlike playing of the second of the Beethoven concerti (published as number One) that for once makes it sound like real Beethoven—not imitation Mozart. This is happening to many of the early Beethoven works, that used to be patronizingly labelled—and played—as "Mozartean." Now we understand that the big, bluff, forthright Beethoven was really there all the time. He's there in this record all right.

Goldsand is a fine Romantic pianist; his playing is strong, well shaped and perfectly controlled. The Frankfurt orchestra goes along well with Bamberger's solid interpretation. The whole concerto is on the slow side, weighty and impressive.

Mozart: Violin Concerti in G, K.216; D, K.218. Francescatti; (Columbia Symphony Orch.), Walter. **Columbia MS 6063 stereo**

These two Francescatti-Walter recordings bring us top-quality Mozart in a rather old-fashioned style of presentation. Bruno Walter, on his part, does the orchestral music in what is now a relatively massive manner, with a big-orchestra sound and a somewhat Romantic approach, playing up many a detail with *rubato* (slowing-down for effect), in contrast to the prevailing straight-ahead way of doing Mozart favored by younger conductors. The Walter tempi are on the slow side, too, taking time to emphasize the contrasts in expression between movements.

As for Francescatti, he plays increasingly in what might be called a Kreisler-Heifetz style, with a tight, emotional vibrato and a great deal of outward involvement in the musical line. This, too, is not exactly high-style, today; the preferred Mozart treatment is the ineffable, pure, classic line, somewhat remote and impersonal but all the more poignant.

Don't misunderstand me—both these men play their respective ways with conviction and tremendous musicianship. I merely register the fact that the Mozart style here, in comparison with many other recorded performances, is somewhat off the beam for current Mozart taste.

Haydn: Trumpet Concerto. Mozart: Flute Concerto, K. 314. Schumann: Adagio and Allegro for Horn. L'Orch. de la Suisse Romande, Ansermet. **London CS 6091 stereo**

This is an odd pot-pourri of somewhat unusual solo pieces with orchestra. Two of them, the Mozart and Haydn, go well together but the third, the ultra-Romantic Schumann piece, mixes in pretty badly. Oysters and sugar.

Ansermet's Mozart is for rather full orchestra (as per the recorded sound) but the playing is light and expressive. The flute, André Pépin, is excellent, and equally excellent is the wise microphoning that places the instrument well away from your ear and at a suitably low volume level. This is as it should be, now that we have the somewhat more literal space-feeling of stereo. A close-up flute is particularly unpleasant in sound, in any case, what with breathiness and assorted spitting!

The familiar Haydn Trumpet Concerto is unusually well done, not only in the sharp, genuinely edgy trumpet tone color as here recorded (and it's loud, as a trumpet should be in comparison to a flute) but also in the stylistic sense; this is real Haydn, in both trumpet and orchestra, rather than the narrowly conceived virtuoso solo playing that is the music's usual fate in most performances.

As for the Schumann horn work, it is one of those intense, turbid, over-wrought pieces that the composer turned out more often than he was able to express himself unequivocally and easily, as in the famous works. It is good music, decidedly, and very warm, sincere, personal. But the effect is somehow too complex, unfocussed, as was, too often, Schumann's own mind. Takes a good deal of listening to get the feel of it and, as I say, the mixture with Haydn and Mozart is unfortunate.

The fine trumpet is that of Paolo Longinotti and the equally versatile horn is Edmond Leloir. M. Ansermet himself orchestrated the Schumann; it was orlginally written for piano and horn. I suspect my above remarks could be applied to the original, though the piano doubtless makes for greater clarity and simplicity of presentation.

Mendelssohn: Violin Concerto in E Minor. Prokofieff: Violin Concerto in G Minor Heifetz; Boston Symphony, Munch. **RCA Victor LSC 2314 stereo**

I dunno. Somehow these eternally repeated playings of the same old pieces get more and more tired as time goes on, though Heifetz is still a world leader on the fiddle and the Boston is a mighty fine orchestra. The Heifetz-Munch combo has seemed particularly unfortunate, of late.

Yes, the Mendelssohn is played very well, very expertly, very fast. But I found it excruciatingly dull and I can't put all the blame on the composer, for being too often played. It would be hard to put a fiddler's finger on what's really wrong—it *is* a good performance, even at top speed. It just doesn't inspire. Somehow, the same feeling has carried over to the relatively less often played Prokofieff—or maybe it's my fault for having tried the Mendelssohn first. It, too, seems perfect, yet tired. It shouldn't, since it's a lovely, if slightly sentimental concerto!

Ah well—you'd better try the record out for yourself. It may knock you over dead with excitement, for all I can say.

Bonporti: Concerti a quattro, Op. 11, Nos. 4, 5, 6, 8. I Musici. Epic LC 3542

The lovely recorded sound of these "I Musici" string recordings for Epic easily makes up for the lack of a stereo version; don't let that get in your way for a moment.

(A good sound-trick for stereo owners is to un-phase your two speakers when playing mono records, thus spreading the music out instead of concentrating it at a point midway between the speakers. Just reverse the wires to one speaker—a permanent switch for this, double-pole, double-throw, is a good idea.)

Bonporti is another of the innumerable "re-discovered" composers that come to us from the so-called Baroque period, and he is by no means a minor has-been. It is astonishing how much reputable music was composed in those days by the hundreds of men whose names and works disappeared from later musical performance. Now that we are delving into every corner of that period (and recording a tiny fraction of the enormous quantity of music available in score) we have found a goodly number of really excellent "unknowns" easily worthy of our interest. Bonporti is one of them.

He was a quite original and fresh musical mind, within the rather strict Italian "Baroque" style of the day—the time of Vivaldi and, of course, Bach and Handel up north. He shows himself an excellent and lyric craftsman, rather gentle and sweet, a bit introspective, where Vivaldi was relatively brash, masculine, dramatic. His melodies are lovely, he foreshadows a kind of Romanticism that only Bach could equal at the time, but which is actually closer to the *"stürm und drang"* of Germany a half-century later, of which Haydn and K. P. E. Bach are expressive proponents in some of their music. Bonporti has a whimsical side, too, that is enjoyable.

"I Musici" are only a handful of players, a dozen or so, but they record in a pleasing liveness that gives their playing orchestral body; only a certain difficulty in telling the solo players from the "orchestra" detracts from their performance. (Most recordings make the difference blatantly obvious!) Their present series for Epic, evidently a joint Italo-Dutch project directed by a joint Italo-Dutchman named Vittorio Negri Bryks—some name!—seems to me more scholarly, more mature and more effective than their earlier work for other record companies. I'd suggest buying up every one that comes out. (The project's official name is "Monumenta Italicae Musicae"—Monuments of Italian Music.)

PRECISION

Mendelssohn: A Midsummer Night's Dream. Schubert: Rosamunde. Amsterdam Concertgebouw, Szell.

Epic BC 1023 stereo

Orchestral precision—wow! The Amsterdam Concertgebouw has had a half-century reputation for fabulous orchestral virtuosity; here it shows that it still is one of the most brilliant playing groups in existence.

The familiar Mendelssohn and Schubert scores (the usual orchestral excerpts) are turned out with a neatness and precision as I have seldom heard—the well known Scherzo goes so fast that you'll hold your breath waiting for a mistake or a blur, yet every note is crystal clear, the effect unhurried. The same goes for the rest—fabulously accurate orchestral ensemble throughout.

Epic exported its own Mr. Szell for this recording and he brings with him an unaccustomed jolt of modernity to these well-worn items. His tempi are fast—too fast for Rosamunde—the music fairly hums with energy. Mendelssohn benefits from start to finish; the briskness suits his style and there is not the slightest sacrifice of clean, informed playing. But Schubert's comfortably Viennese lyricism bounces with what might be described as an almost Czech verve (Szell comes from there originally). Sounds like the dances from "The Bartered Bride," good fun but not exactly Schubertian, as we know him today, at least.

(*Continued on page 92*)

CHARLES A. ROBERTSON*

STEREOPHONIC

Hal Singer: Blue Stompin'
Prestige Stereo 7153
Lou Donaldson: Blues Walk
Blue Note Stereo 1593

The summer months were the occasion for the entry, made for the most part with items already issued in monophonic form, of these two labels into the stereo lists. The present examples, typical of the small-group jazz specialized in by each company, are being considered here for the first time. Besides pointing up some personal preferences of the respective company heads, they illustrate the diligence of Bob Weinstock and Al Lion in uncovering and developing talent. The process, in both instances, is guided more by faith than passing enthusiasms or fashionable trends.

Hal Singer timed his return to jazz, after spending nine years in the wilderness of rhythm and blues, to coincide with the visit to this country of Albert J. McCarthy, a critic who was duly impressed and is recording him for the British trade. A disciple of Coleman Hawkins and Don Byas, he made manifest an immense vitality during an appearance on Art Ford's television show and Weinstock determined to give him the opportunity to display his tenor sax in the mainstream setting best suited to it. His blues style, however, harks back to an apprenticeship served in the romping territorial bands of Nat Towles, Lloyd Hunter and Jay McShann, when they toured the Southwest two decades ago.

Nothing in the intervening years has cooled the warmth of his feeling for the idiom and the stamp of authenticity is on the four original blues performed here. As collaborator, Charlie Shavers is drawn into the same orbit, playing a soulful open or muted trumpet that is well mated in stereo to the other horn. Shavers does a takeoff on *As Long As I Live,* and Singer rhapsodizes on *With A Song In My Heart.* But the compelling bottom-bass figure, whipped up by bassist Wendell Marshall and pianist Ray Bryant on the title tune, establishes the tone of the set. Even drummer Osie Johnson discards the polite methods which make him the darling of most studios.

Lou Donaldson follows the blues side of Charlie Parker, where his main competitor on alto sax is Julian Adderley. Although apt to be less florid and more selective as to style, he also likes to paraphrase popular standards. In selecting a line to define the album title, he almost upsets the theory that Blue Note is indifferent to such events as the opening of a film called "Porgy and Bess." His choice results in what is undoubtedly the most basic performance, among the attendant flow of releases, of *A Woman Is A Sometimes Thing.* And if you need convincing that these borrowings even out in the end, listen to Louis Armstrong and Earl Hines in their duet on *Weather Bird,* recorded long before Gershwin decided it should be called *Summertime.*

Rag Barretto, a congo player who concentrates on jazz rhythms rather than Latin American effects, complements the regular drummer, Dave Bailey, throughout the session. Their teamwork is a feature of Donaldson's other blues, and stereo defines the varied tonality of their exchanges clearly in opposing channels. The leader's ballad style is given strong support by pianist Herman Foster on *The Masquerade Is Over,* and *Autumn Nocturne.* His aptitude for swift passages meets the test of Denzil Best's *Move,* before bassist Peck Morrison paces everyone through a closing theme which proves to be a new guise for *Honeysuckle Rose.*

Although both companies instituted a program of taping sessions in stereo a good two years ago, a hesitancy to get in the swim was finally overcome when a distributor demand began to develop early this year. Rudy Van Gelder, who soon will be sending along the product of a brand new studio, engineered the dates and cut the masters. A comparison with the Coleman Hawkins on World Wide, perhaps the best of the releases issued last summer when Van Gelder introduced the Fairchild stereo cutterhead, finds that recording standing up fairly well. A greater playing time is achieved today, but a glance back to a year ago prompts the general observation that some of the boons of stereo are unpublicized.

They are especially noticeable in the jazz and popular field, where often a monophonic version is tailored to fit the limitations of cheap consoles, or car and table-model radios. When relieved of this obligation, an engineer can do a job that will entice those skeptical ears still unattracted by the more obvious stereo charms. No company is going to proclaim this factor and admit that some of its product is less than perfect, but it weighs heavily on the stereo side of the balance.

Morton Gould: Doubling In Brass
RCA Victor LSC LSC2308

No better choice to herald the "Miracle Surface" on this record can be imagined than a Morton Gould fanfare. As his *St. Lawrence Suite* was first played last summer at the dedication of the Robert Moses Power Dam, it should be ceremonious enough to introduce a development that promises to be of lasting value to the record collector. If not, his symphonic ensemble becomes a military band and should do the trick on six Sousa marches. He also furnishes fresh arrangements of *Dixie, American Patrol,* and *Yankee Doodle.*

A new anti-static ingredient, 317X, is credited with the improved surfaces and is being incorporated in all RCA Victor releases. It is warranted to repel dust, help prevent surface noise and insure faithful sound reproduction. Our test stopped short of spreading the contents of a vacuum cleaner bag on a record, but did include a quantity of cigarette ash. Try holding a treated disc vertically and flick a cigarette within an inch of it. Some particles will be attracted, as by an ordinary disc, but then are repulsed and shoot off into space. Next place it in a horizontal position and use it as a tray for precooled ashes. A quick shake will remove most of them and the remainder can be blown from the grooves by a five-year-old capable of handling the candles on his birthday cake.

In the absence of any small fry, buy another copy and play the composer's new reading of *Jericho.* The section where the walls come tumbling down may push enough air through your speaker system to restore a pristine gleam, providing thereby a simultaneous demonstration of the power of decibels and chemicals. Memories of Mercury's 1812 cannon are ressurected by this passage, and it is undoubtedly one that will come to the attention of audio show visitors this fall. It is to be hoped that soon other companies will be able to mix a similar additive into their pressing material. Now, if Victor would consider used Gruve Guards as fair exchange.

Fletcher Henderson All Stars: Cool Fever
Urania Stereo USD2012

The history of this recording is eventful, but its circuitous route to stereo disc is too long to relate here. It stems from the 1957 Great South Bay Jazz Festival, where Rex Stewart assembled the Fletcher Henderson All Stars for the first time. Shortly thereafter, they were able to recreate the highlights and enthusiasm of the program in a studio, playing the Henderson arrangements of *Sugarfoot Stomp, Wrappin' It Up,* and *King Porter.* A second concert was recorded on the scene in 1958, with many of the same musicians, and released by United Artists.

Stewart plays one of his throbbing trumpet concertos on *Rex's Tune,* and a mention of other worthwhile efforts would involve the remaining sixteen men. Also heard are *Round About Midnight, A Hundred Years From Today,* and *Honeysuckle Rose.* It was perhaps the first attempt to record a big band in stereo. At least, it is the earliest that has been successfully transferred from tape to disc and is currently available. As such, it holds considerable audio interest, and will be valuable in the future. Any collector shonld find a place for it on the shelf among his other firsts.

Billie Holiday with Ray Ellis and Orchestra
M-G-M Stereo E3764

During the last years of Billie Holiday's life, one of her few gratifying artistic associations was with Ray Ellis, a musical direcrector who clothed her flagging voice in the first sympathetic and understanding dress it had received in a long time. Besides encouraging her to try material other than the songs most often requested by night club patrons, he provided arrangements which hark back to early days of her career. It is fortunate that alliance is preserved in stereo, both in the current release and one on Columbia to date, as the qualities which made her the greatest jazz singer of her time may be more closely scrutinized.

A twelve-piece string section is present on some numbers and the pleasure the singer always derived from this accompaniment is reflected on *Don't Worry About Me, All The Way,* and *Just One More Chance.* But her best work was done with a small band, and there is one at hand to launch her into *Baby Won't You Please Come Home, All Of You,* and *Sleepy Time Down South.* Because her range at the time was almost nonexistent in comparison to what it was once, there is a lesson for every singer in the way she uses her voice. Among the soloists are Harry Edison, Gene Quill, Al Cohn, Jimmy Cleveland, and Hank Jones.

Bill Potts: The Jazz Soul Of Porgy And Bess
United Artists UAS 5032

The sheer quantity of albums triggered by the movie of this folk opera often leaves little room for quality, but here is one that deserves high marks on all counts. First because it introduces a young arranger from Washington, D. C., who finds something new at this late date to disclose in the Gershwin themes. In making his recorded debut, Bill Potts also proves himself to be an orchestrator of taste and substance, writing for a star-studded studio group of nineteen men. He adds immeasurably to the tonal textures of the ensembles, while respecting the need for a feeling of spontanity and swing, resulting in a full, charging sound on his settings of *Summertime, My Man's Gone Now,* and *Oh Lawd, I'm On My Way.* They deserve a place in the book of any band capable of playing them.

Some might present difficulties and it can be readily seen why three sessions at Webster Hall were needed to complete the set. The

* *732 The Parkway, Mamaroneck, N. Y.*

jazzed classic numbers that used to send us back before the war.

We've come a long way since then. "Contemporary" here means jazz on the intimate side, for smallish groups of players, set up in the newer idiom of harmonies and effects that calls itself (well, some people call it, anyhow) modern. As always, my occasional jazz opinions are strictly personal and not guaranteed for general consumption. But be that as it may, I left this record at about the fourth number, feeling bored.

I felt that, first, the old-fashioned harmonies and tunes of "Carmen" are just plain unsuited to the contemporary sort of harmonic thinking —or to this group's thinking, anyhow. And I felt, beyond this, that the players themselves tend to fall into clichés of the new "modern" idiom, effects that, Carmen or no Carmen, already sound tired and unoriginal.

You get the feeling that if only the boys would put "Carmen" away and forget all about it, they could really start playing, maybe. "Carmen" is just a drag on the proceedings, for my ear.

Each number, by the way, is identified by the original title in the opera, complete with the Act and the Scene in which it occurs. Doesn't help the music but it's a good idea just the same. Scholarly.

Finlandia—Music of Grieg and Sibelius. London Proms Symphony, Charles Mackerras. **RCA Victor LSC 2336 stereo**

This has a grab-bag title, like many discs today, but the record itself turns out to be a really first class "pops" disc, a solid, easy-listening program that is well played, neatly turned out and always entertaining, cleanly styled for high-type casual listening.

"Finlandia" itself, the famous old war horse, is a lot more palatable here than in most of the heavyweight, over-pompous playiug it gets. Here, it is tough, efficient, lightfooted for all its ominousness, and it never drags. Even the gloomy "Valse Triste" comes off with considerable style and éclat, though that piece is pretty hard to make much out of under the best of circumstances.

As for Grieg—he gets better and better as we delve into his large output of shorter, lesser pieces, like several featured on this record, the "Elegiac Melodies" for instance. In these short items he is a more effective composer than Sibelius—indeed, he runs rings around him. Good man, Grieg, more modern in his day than Sibelius ever was in his.

This is a good record, the kind you put on as background music and end up listening to in the foreground.

Song of India. Boston Pops, Fiedler. **RCA Victor LSC 2320 stereo**

RCA is getting desperate in its search for new and beguiling titles to spark the never-ending Boston Pops series. This record isn't Indian at all, neither East nor West. Its biggest feature is an excursion into blown-up dance music that has me shivering with distaste. Side 1 opens with a long pot-pourri arranged by Richard Hayman of every dance tune you ever heard of and the kitchen sink too, done up in a semi-big-band high-society style that seems to me grossly ugly in an orchestra of the size and scope of the Boston Pops—the Boston Symphony in disguise, after all.

If you want dance music, go get it from where it belongs, and don't even listen to the great big Boston orchestra trying to make like Mantovani. After this, the good old "Song of India" itself, next on the record, was a pleasure to hear—back to the genuine "Pops" tradition of well-played orchestral entertainment.

The rest is the expected and usual good "Pops" stuff, Strauss Polkas, Leroy Anderson, a Khachaturian Lullaby, etc. It's all in super-duper stereo.

Pops Caviar. Boston Pops Orch., Fiedler. **RCA Victor LSC 2202 stereo**

Tack this on too; I don't even have to play it. Prince Igor Overture, Polovetzian Dances, Russian Easter, Steppes of Central Asia—if you want zippy Pops playing of these Russian delights, here they are in big stereo. AE

NEW PRODUCTS

• **Pilot Speaker System.** This advanced, compact three-way "bookshelf" system is comprised of five individual speakers—two 3-in. tweeters, two 6-in. mid-range units, and a special 12-in. Air-Flex woofer capable of 1-in. cone excursion. It may be mounted either horizontally or vertically with equal effectiveness. Designated Model PSV-1, the system achieves a great degree of flexibility by having the tweeters and mid-range speakers mounted in such a manner that they can be rotated from outside the enclosure by means of Pilot's Acoustimatic Turret Control. The user

himself can thus place the mid-range and treble speakers in the best operating position for either vertical or horizontal mounting of the enclosure. Frequency range of the system is 40 to 16,000 cps, with crossovers at 800 and 8000 cps. Power handling capacity is 40 watts of program material. Means are provided for matching the system to its acoustical surroundings, or to the user's individual taste. Located on the back panel are a presence control for adjusting response of the mid-range speakers, and a brilliance control for adjusting the tweeters. Dimensions of the PSV-1 are 25¾" × 14¼" × 12" d. Pilot Radio Corporation, 37-04 36th St., Long Island City 1, N.Y. **K-1**

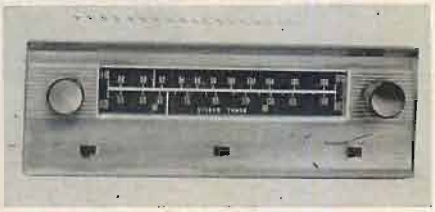
• **Marantz Stereo Amplifier.** Essentially, the new Marantz Model 8 consists of two of the well-known Marantz 30-watt amplifiers mounted on a single compact chassis. It incorporates simple metered adjustment instruments, making unnecessary the matching of output tubes. Three telephone-quality electrolytic capacitors are

included in the silicon power supply, assuring long life and high reliability. The amplifier realizes significant savings through the fact that the power supply section and metered adjustments are common to both channels. Complete specifications and price may be obtained by writing the Marantz Company, 25-14 Broadway, Long Island City, N.Y. **K-2**

• **Record Filing System.** The Quick-O-Matic record storing system stores and files records in a matter of seconds, at the same time protecting them from dust, scratching, warping, and breakage. The system consists of three elements—(1) The Add-A-File, (2) albums in which the Add-A-Files are stored, and (3) a record and file numbering system. The heart of the system is the Add-A-File, which consists of an envelope and an attached pocket which rotates in and out. The record is placed in the pocket and pushed into the envelope, which has walls of specially-finished manilla to overcome the scratching problem. To find a record, the number of the desired disc is first found in an index. Then the correspondingly numbered tab on the Add-A-File is pulled from the album. Each album holds 20 to 25 Add-A-Files and records, and is handsomely finished in two-tone leather and

gold. All file numbers are in full view and can be spotted at a glance. Manufactured by The Howard Company, 5726 N. Broadway, Chicago 40, Ill. **K-3**

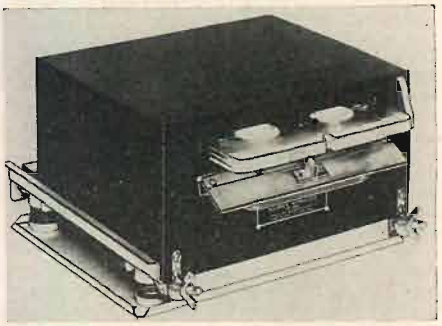
• **Matching Stereo Tuner and Amplifier.** The Model 2157 AM/FM stereo tuner and the matching Model 2460 "Dual 10" amplifier are highlights of a complete new line of hi-fi components recently introduced by Eric Engineering Company, 1823 Colorado Ave., Santa Monica, Calif. The 2157 features two separate sections—one for AM and one for FM—and may be used



equally well for monophonic or stereo operation. A tuned r.f. stage on FM and oscillator a.f.c. assure drift-free performance. FM sensitivity is 1.5 microvolts for 20 db quieting, and frequency response is 20 to 20,000 cps. AM sensitivity is better than 30 microvolts, and frequency range is 20 to 8000 cps. Flywheel tuning with slide-rule dial. The 2460 amplifier has two 8-watt output channels, each of which has total harmonic distortion of less than

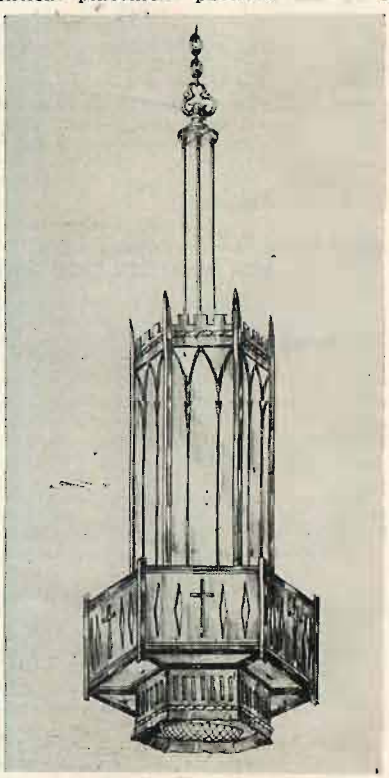
1.0 per cent. They may be combined for 16-watt monophonic operation. Frequency response is 20 to 20,000 cps ± 1.0 per cent and noise is 65 db below rated output. All conventional stereo controls are incorporated, including separate db-calibrated tone controls for each channel. Level is controlled by a ganged loudness control which adjusts both channels simultaneously. Decorator styling with attractive gray hammertone cabinet and handsome anodized front panel blends with any decor. Illustrated descriptive sheet will be mailed upon written request. **K-4**

• **Two-Hour Cartridge Tape Recorder.** The new Telectro Model TR-555 is a uniquely small, one-hand loading cartridge tape recorder which will store two hours of information. It is especially suited for aircraft, trucks, cars, boats, and other mobile units where vibration is a factor. It utilizes a 4-track quarter-inch tape cartridge. Transistorized and miniaturized, the recorder is only 11½"w × 10"d × 6½"h. It may be fitted into an airplane instrument panel or into the glove compartment of a taxicab or other vehicle. For power the new Telectro unit utilizes a 12- or 24-volt d.c. supply. Developed chiefly for permanent recording of radio communications, as between airplane and control tower or between fleet vehicle and dispatcher, it will withstand vibration of 0.03 in. peak-to-peak amplitude over a



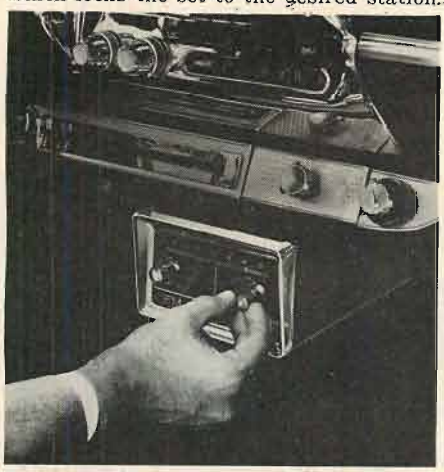
frequency range of 10 to 55 cps. It meets specifications while operating in an ambient temperature of −20° F. to 120° F., continuously. Frequency response is 200 to 10,000 cps ± 3.0 db. Power consumption is less than 60 watts at 24–29 volts d.c. Weight is 15 lbs. A remote-control unit, available as an accessory, permits push-button start, stop, selection, and playback of any one of the four tracks. Telectro Industries Corporation, Long Island City, N.Y. **K-5**

• **Speaker Baffle/Light Fixture.** The Audio-Lite, a unique inovation combining both illumination and sound coverage in a single ornamental fixture, is intended especially for churches, cathedrals, temples, and other places of worship. It is designed on the premise that the placement of lighting fixtures and speaker baffles follows similar principles. Through careful design of the light and sound sources, identical placement patterns can be ob-



tained, affording the correct position for low-level sound reinforcement. In addition to providing a secluded spot for the baffle, the Audio-Lite, through its cubic volume, allows the use of acoustical devices not suitable for the average small commercial baffle. Manufactured in gothic, classic, and modern styles as standard models, or fabricated from original designs on special order. Soundolier, Inc., P.O. Box 3848, St. Louis 22, Mo. Catalog will be mailed without charge. **K-6**

• **Auto FM Tuner.** Engineered for use in automobiles, the new Gonset Model 3311 FM tuner affords interference-free reception in spite of steel bridges, power lines, neon signs, trolley lines, and medium-length tunnels. The unit represents distinct improvement over the earlier model. It covers the standard 88–108-mc range, and features automatic frequency control which locks the set to the desired station.



Comparing favorably with that of good home-type FM tuners, the 3311 has high sensitivity. No technical knowledge is required to install the unit easily under the dashboard. One tuner lead plugs into the car radio's antenna jack; the other lead attaches to any 12-volt accessory. Designed for 12-volt negative-grounded batteries, the tuner can be readily adapted to 12 volts positive (most foreign sports cars). Manufactured by Gonset Division of Young Spring and Wire Corp., 801 S. Main St., Burbank, Calif. **K-7**

• **Telephone Pickup Coil.** Intended primarily for use with a recorder in transcribing telephone conversations, or making conversations audible to a group when used in conjuction with an amplifier, the HP-61 may also be used as a probe in locating sources of hum. Suitable for use with all types af telephones, the unit is

equipped for suction-cup mounting on the receiver. It is fitted with cord and standard phone plug for connection to the high-impedance input of any amplifier. The HP-61 weighs only 1½ ounces and measures ⅝"d x 2⅜"l. Microtran Company, Inc., 145 E. Mineola Ave., Valley Stream, N. Y. **K-8**

• **"Staticmaster" Record Brush.** In just a few seconds, while the record is rotating on the turntable, the Staticmaster eliminates static and removes dust which clings to records because of static charges. Polonium is employed as a static neutralizer. The brush of the Staticmaster is

made of genuine jaguar hair which is luxuriously soft, free from breaking, and with the correct degree of resiliency for cleaning microgroove records. Nuclear Products Co., 10173 E. Rush St., El Monte, Calif. **K-9**

(Continued on page 110)

COMMERCIAL ELIMINATOR

(*from page 22*)

Connect this oscillator to the input of the amplifier, remove the output pilot bulb from its socket, and connect a VTVM across points A-A (*Fig.* 2). Adjust the inductance of the coils for maximum output, starting with the third coil, and proceeding down the line. When output appears maximum, run through the sequence again for resonance. When the amplifier appears aligned, replace the output pilot bulb, and note performance as the oscillator frequency is varied from somewhat below 20 kc to somewhat above it. Output should appear as in *Fig.* 6.

The input to this amplifier is normally connected to the FM detector output, ahead of the de-emphasis network. The bias output of the amplifier can be connected to the grid circuit of the first a. f. tube of the receiver as at (A) in *Fig.* 7. This connection is made by lifting the grounded end of the first a. f. grid resistor, and inserting a 470 k resistor between the free end of the grid resistor and ground. The junction of the two resistors is connected to the "hot" "A" terminal in *Fig.* 2, and ground of the receiver is connected to ground of the amplifier. The resistor is inserted here so that the receiver will work whether or not the commercial suppressor is connected.

If relay control of the speaker is desired, in place of bias control of the first a. f. stage, the ungrounded speaker line is opened, and connected to points B-B in *Fig.* 2. With this connection, the speaker functions normally as long as no "beep" tone is present, but is open-circuited whenever the 20-kc signal is received. Connections are shown at (B) in *Fig.* 7.

Alternate Connection

If, for psychiatric or other reasons, you want to listen to the commercials, but do not desire the musical programs, terminals B-B of *Fig.* 2 may be connected across the speaker, as in *Fig.* 7, C. With this connection, the speaker is shorted at all times when the 20-kc tone is absent, but operates normally when the "beep" signal is present.

Performance of this selective amplifier commercial killer is highly satisfactory, and it will function with any FM station that can produce intelligible

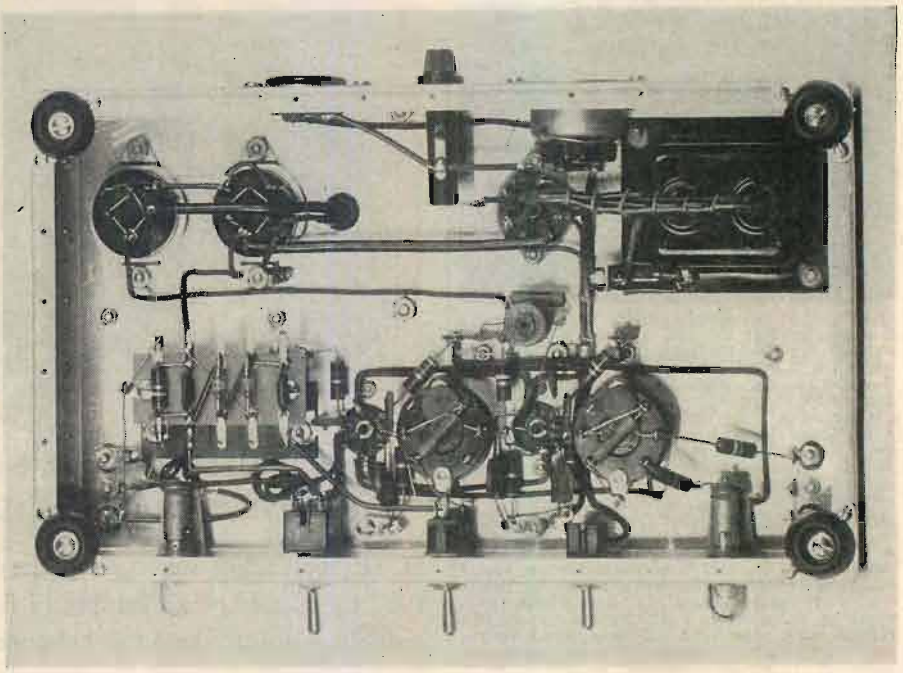


Fig. 5. Underchassis view of selective amplifier.

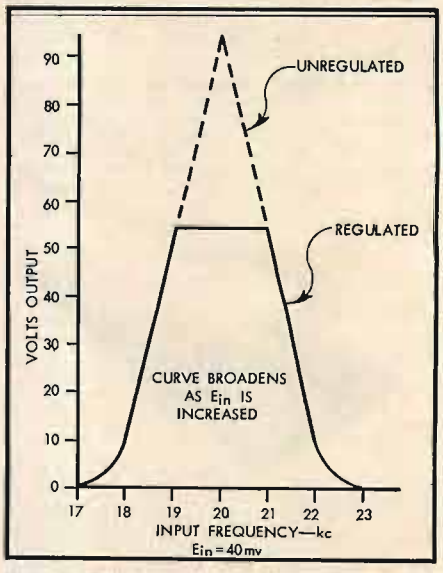


Fig. 6. Output characteristic of selective amplifier.

speech, provided it also puts out a "beep" signal (most stations do not). Tube life should exceed 5000 hours of actual use, some in similar service having lasted beyond 10,000 hours. Tuning adjustments apparently last indefinitely, if they are not tampered with. Those shown have withstood three months of use including several thousand miles of travel in a suitcase.

With this type of "beep" commercial killer, you can enjoy FM musical programs, from stations which emit a silencing signal, even in fringe areas, with periods of silence replacing the long-winded importunate tirades commanding you to "run, do not walk" to the nearest supermarket, where you *must* buy a "large economy size 55 gallon drum" of Joe Blow Yogurt ("contains *activated* Milorganite, a potent source of vitamin B-29"). This type of suppressor is also effective in squelching the hourly dissertations on the difference between background music and *functional* background music. Æ

PARTS LIST

C_1, C_5, C_9	.001 µf, tubular ceramic
C_2, C_3, C_6, C_7, C_{10}, C_{11}, C_{12}, C_{13}, C_{14}, C_{15}	.02 µf, disc ceramic
C_4, C_8	.005 µf, disc ceramic
C_{16}, C_{17}, C_{19}	80 µf, 450 volts, electrolytic
C_{18}	4 µf, 250 volts, paper
C_{20}, C_{21}	40 µf, 250 volts, electrolytic
D_1, D_2	1N34A crystal diodes
E_1	NE51 neon lamp
E_2	#44 pilot lamp
J_1	input connector, to suit personal preference
J_2	female a.c. connector, Amphenol 61-F
L_1, L_3	50–100 mH, North Hills #700F

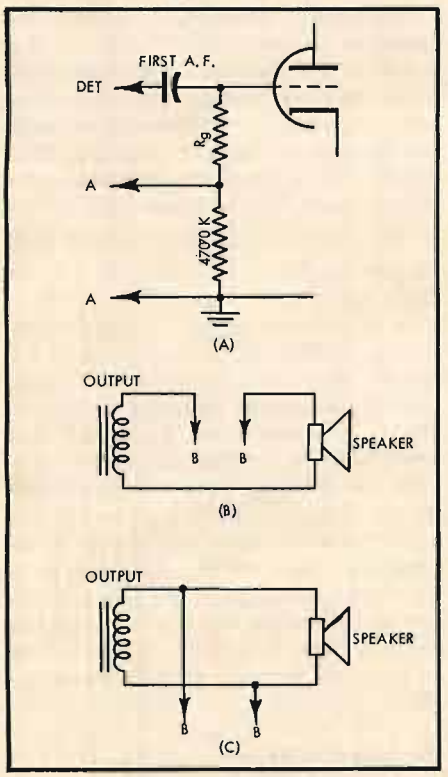


Fig. 7. Receiver connections to amplifier output.

L_2	15–60 mH, Miller #6319
L_4	filter choke, 12 H, 80 ma.
P_1	male a.c. connector, Amphenol 61M61
R_1	220 k ohms, 1 watt, (all resistors 10%)
R_2, R_5, R_8, R_{11}	1 megohm, 1 watt
R_3, R_6	100 k ohms, 1 watt
R_4, R_7, R_{12}	1000 ohms, 1 watt
R_9	47,000 ohms, 1 watt
R_{10}	470 ohms, 1 watt
R_{13}, R_{15}, R_{16}	100 ohms, 10 watts, wirewound
R_{14}	10 ohms, 2 watts
SR_1, SR_2, SR_3, SR_4	60 ma, 125-volt selenium rectifiers
T_1	power transformer, 240–0–240 v. at 10 ma; 6.3 v. at 3a. (Stancor P8419 or equivalent)
T_2, T_3	alternate power transformer, 125 volts at 50 ma, 6.3 volts at 2 a. (Stancor PA-8421 or equivalent)
V_1	12AX7 tube
V_2	12AU7 tube
V_3	6X5 or 6AX5 tube
	Chassis—Seezak 7 × 12 × 2 in. or 5 × 9 × 2 in. (See text)

WHAT IS HI FI

(*from page 45*)

Direct radiators are either electrostatics or cones, although neither type will warm a room as efficiently as will a 50-watt amplifier.

Electrostatics utilize the same force that causes shocks when shuffling across carpets in dry winters, but listeners who prefer to sit while listening will find it convenient to use a power supply with their electrostatic tweeters.

There are three different kinds of loudspeaker: woofers, middle-range speakers, and tweeters. Woofers are preferred by people who do not like treble tones, such as women, although many knowledgeable hi-fi enthusiasts prefer to use woofers and tweeters together. Middle-range loudspeakers reproduce the middle range, which is not high fidelity at all because everybody knows high fidelity means reproduction of all the highs and all the lows.

In a two-way system the tweeter carries the middle range, except when the middle range is carried by the woofer. This is termed the crossover frequency, and it is exceedingly important that phase shift be avoided in order to prevent low fidelity. Four-way loudspeakers are notable mainly for having one more speaker than three-way loudspeakers. Most of the speakers in a four-way system are middle-range speakers, and although woofers and tweeters are still important, they are not nearly as much so as you might be led to believe.

The Listening Room

The final link in the high-fidelity sausage is the listening room. The room

itself does not listen, but is called a listening room because it contains a listener.

The listener is the heart of the high-fidelity system, and is noted for having high distortion, poor frequency response, marginal stability, and arbitrarily variable performance characteristics. Listener instability is the most common form of defect in a high-fidelity system, which is why manufacturers recommend that the ears be checked periodically by a qualified service agency to ensure that they are meeting their specifications. Defective ears may be cleaned with anti-static spray or a mild washday detergent containing a wetting agent, or may be replaced by a microphone and an oscilloscope or, in cases where there is a little interest in music, by a camera and a well-equipped darkroom.

Recessional

An educated guess as to the future of high fidelity and steerio can lead to practically anything, including tremendous strides, many of them forward. It is anticipated that the multi-million-dollar high fidelity industry will increase in economic status with increasing national inflation, and may conceivably survive a devaluation of the Yankee dollar and a general broadening of the world's economic barriers *Æ*

TAPE GUIDE

(from page 42)

dioid. The bidirectional microphone lends itself to arrangements of musicians or others in front of and behind it. Thus one can divide a performing group into two sections instead of trying to crowd them all before the microphone. It should also be mentioned that the Figure-8 microphone plays a special role in the stereo technique known as mid-side recording. The bidirectional microphone, coupled with one having a cardioid pattern, both in a single housing (see *Fig.* 11), is designed so that when the signals of the two microphones are properly matrixed (combined in phase and out of

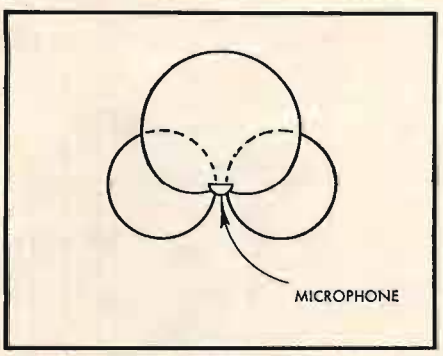


Fig. 17. Pick-up pattern of the mid-side microphone.

phase) they produce one signal corresponding to the left side of the sound source and a second signal corresponding to the right side. *Figure* 17 shows the pick-up pattern of the mid-side microphone.

Microphone Placement

Placement of the microphone depends upon the type of microphone used, as previously suggested, upon room characteristics, upon the nature of the sound source, and upon the amount of reverberated sound that is desired. The closer it is to the subject, the greater will be the ratio of direct to reverberated sound, and therefore the less the sense of spaciousness. On the other hand, clarity and definition will be heightened.

Close up recording will tend to reduce the exaggeration of bass, because it gives less prominence to reverberated sound, which consists primarily of the lower frequencies. On the other hand, one should avoid bringing the microphone too close to the source, because what is known as the proximity effect will then exaggerate the bass notes. The degree of bass emphasis depends upon the particular microphone. As a general rule, one should be at least one foot away from the microphone to avoid undue proximity effect. "Hugging" the microphone will produce those unnatural barrel tones we so often encounter. A little experimentation will indicate the closest that one may get to the microphone without sacrificing realism. A crooner may prefer singing within inches of the microphone, but this can well be a special case where his "microphone voice" is preferable to his natural voice.

Sometimes it is desirable to use more than one microphone. If one is dealing with a large group but does not want to get too far back because of undue pick-up of noise and reverberation, it may be necessary to use two or more microphones for adequate coverage. It may be necessary to use an additional microphone to give due prominence to a soloist. Or an additional microphone may be useful in picking up the desired amount of reverberated sound at a considerable distance from the source. In all these cases it is necessary to employ a mixer in order to combine the signals from the several microphones.

A mixer will have from two to as many as eight microphone inputs (or even more in professional studio equipment), each with its own gain control so that the various signals can be blended in desired proportion. Before attempting to make a recording, one should monitor the combined sound output through headphones or through an audio amplifier and speaker to ascertain that the gain controls are set for proper mixing. Or one can make a brief tape recording and promptly play it back to check the mixing.

Mixers are of two types, passive and active. The passive, sometimes called dry, type has no tubes and introduces some drop in signal level. Also, there may be danger of high-frequency loss unless the cable length from the mixer to the tape recorder is minimized. The active type of mixer employs tubes, achieves better isolation between inputs (so that adjusting gain on one input does not affect the gain of the others), usually causes no drop in signal level or provides some amplification, and minimizes danger of treble attenuation. On the other hand, the passive mixer does not introduce distortion since there are no tubes in the circuit, whereas the active mixer, unless well designed, may do so.

Mixers may range from very simple and inexpensive affairs, such as the passive two-input unit shown in *Fig.* 18, to

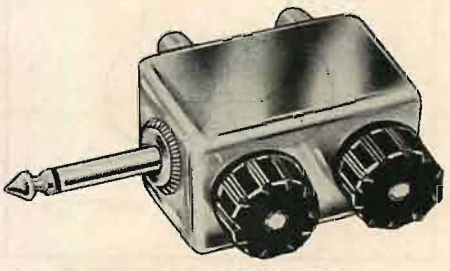


Fig. 18. Two-input passive microphone mixer, Lafayette PK-242.

tion of the intensity of an actual performance, for it is a rare singer indeed who will not surpass his "test" output by a few decibels when the take is slated and the tape machines are rolling. Consequently, a final adjustment is usually necessary at the last moment.

The position of a singer is also dictated by the nature and power of his vocal production as picked up by the microphones. There is no question that some voices are more phonogenic than others—that is, they are easier to place than most. It can be rather tiring for one such phonogenic artist to repeat his part in a scene over and over again while his partner is being sonically "fitted." Only after these basic positions have been discovered can the recording director concern himself with stage movement.

There are three main approaches to action in stereo opera. The first favors unlimited movement, not only in places in the score in which a specific change of position is indicated, but even in arias. According to this approach, the singer should behave at the session as he does on the stage during an actual theatre presentation; if he feels like moving his head from side to side, twisting his body in a lively dance, or even stepping forward or backward, nothing should restrain him from doing so for the sake of realism. The second approach involves a cast of characters spread out across the stage, but glued to their assigned positions; this might be described as stereo opera in white tie and tails. The third approach falls somewhere between the two extremes. Movement here is supplied when called for to underline the drama, and to indicate changes of position, exits, entrances, asides, and so on, but it is not employed at the expense of intelligibility and aural focus. Regardless of the degree or manner in which it is used, movement in stereo opera is here to stay and brings the theatre's visual and dramatic impact closer to the listener than ever before. *Æ*

AUDIO ETC

(from page 16)

This is what can be done with slow-speed quarter-track, and it's good. It ought to convince many who are doubtful.

Confusions

The Tandberg machine itself is interesting, if confusing. It *is* confusing, and to this day I have not yet figured out exactly what I'm getting onto my two tape channels in the way of recorded level. There are anomalies, ambiguities, inconsistencies, at least in my production model, that make recording quite a tricky business. It took me a long, long time before I managed to get things under control for respectable results under duress—that is, at public concerts, and so on. There would seem to be honest reasons for this, and interesting.

The Tandberg 5-2 is an adaptation of the well-established basic model, and some of the adapting had to be done pretty sketchily, on the outside; there wasn't any

inside room left. The second preamplifier, for recording the second channel, is an extra unit that sits alongside the main recorder, and plugs in via two cables. One goes to the back, for power; the other, for recording signal, reaches clumsily out over the left-hand tape reel and plugs down through the top of the head protector—it must be removed each time a reel is changed, and the second channel will not play back, either, unless it is pulled out. This extra preamp is, literally, a drag on the portable main recorder and in Canby fashion I ended up sticking it on via big pieces of sticky tape. (You may perch it on the bottom half of the carrying case, if you're careful.) Clumsy, and you will find that the overhead extra cable is a snare and a trap that is quite diabolical—either you forget to re-plug it after changing a reel (always done in a hurry at concerts) and thus get only one track, or you forget to pull it out for playback and spend ten minutes in futile searching for the cause of one mysteriously dead channel. I've done both a dozen times, if I did them once.

Moreover, in Tandberg's attempt to provide really flexible controls, there is trouble—though the intention is surely excellent.

Two volume controls for recording, one on the extra preamp and the other the lower half of a dual control on the main machine. (The upper half controls the second channel for playback only), and I quickly found that not only was the setting different on each, for an equal signal in the two "magic eye" level indicators, but, apparently, *the taper was different.* That was my conclusion, anyhow, after endless fussing, trying to get a balance for varying input levels. For one level, perhaps, the balance would be at 2½ on the main control and at 4 on the second channel preamp—but if I moved the first one up one point, the other went up *less* than a point to restore an equality! Each change in level threw the whole balance off. Worse—the two electric eyes had curiously different shapes, one a perfect V and the other with a space at the bottom between the sides, so that I was never quite sure when they were acting alike—or maybe it was a difference in *their* sensitivity . . . anyhow, I could never get this little complex of troubles untangled for sure, and have not done so yet.

The playback level, similarly, depended on one of the same controls, that on the main machine (but set higher usually) and the top half of the same control (instead of the control on the second preamp); there were reportedly also a pair of level sets for playback, somewhere inside, but they were too inaccessible for me to fuss with. And so in playback I also was all confusion, confounded by my putterings with level and balance during the recording. I kept telling myself that once set, I *must* not change the two recording levels—but what can you do if one suddenly is overloading? I would try to adjust both together, but they never stayed the same.

Channel Balance

Channel balance is, I can say right now, the biggest problem in all amateur two-track recording. There are only two proper approaches to the problem. One is to provide a joint control. The other is to provide separate controls for balancing, but of a sort that is unequivocally and immediately clear. This, it seems to me, demands a master level control, and could best be done as in our standard stereo preamplifier-control units nowadays, with a common level control for both channels supplemented by a balance control that, preferably, adjusts only a small distance either way. The intention, after all, is to equalize the channels, not to turn one down to near-nothing.

That sort of arrangement will be easy enough when Tandberg gets out a new basic design, but in the present model the recording controls had to be devised from those already present in the machine. Now if only the little things were right—if the taper were the same on my two controls, if the eyes looked exactly alike and a balanced input *looked* balanced, say with both controls set at 3, then Tandberg's present system would be acceptable enough as is, even without master gain. Very possibly all these details are adjustable via Tandberg's serviciug and I'll probably try, before I'm finished.

Joystick

The other controls, common to the basic and long-tested design, are generally excellent. The recorder uses the T-shaped

"joystick" single control, which moves sidewise for fast tape motions and towards you to lock into record-play position. It's much easier to use than pushbutton controls and you can't possibly make a mistake. There are two small prices to pay, though—at least on this machine—which are worth mentioning. First is the loud *clank* that occurs as the T-bar control is locked into record-play position. This involves moving the tape forward to contact the heads and is a precise and very positive mechanical action—but noisy, mechanically. The machiue itself is virtually noiseless as it records, which is fine. But that *clank*, each time I started the recorder (I turned it off during applause) was distinctly embarassing at public concerts. You can reduce or eliminate by partial movement of the control, but it isn't too easy.

The other tricky thing in recording is the two-hand operation. The recording switch is a spring-loaded lever on the left; you can pull it forward and read levels on the two eyes without tape motion, but it snaps back when you let go. The T control is interlocked and you cannot record without holding the record switch in position with the left hand, while your right hand locks the T. An excellent protective arrangement and you'll be unlikely to make an accidental erasure with it. But if you happen to have something in one hand, or are perhaps holding a mike or two mikes, or an ice cream soda, you're stuck. Short of an assistant, you can't start a recording without having both hands free. Maybe it's just as well—and I'm sure that's how Tandberg has it figured. It's only dopes like me who insist on carrying handfuls of live mikes around.

An excellent feature of this machine is the retracting tape, which is automatically pulled away from the heads except during play or recording, as part of the T control action. No unnecessary head wear, and head performance seems to remain precise over long periods, even with the ultra-delicate small-gap adjustment on the four-track staeked head. No trouble whatsoever in the alignment on my machine, after months and dozens of tapes, plus miles of assorted rough handling in the carrying. But one minor qualification here, too, as a price to pay—it isn't easy to locate specific parts of your recording because there is no sound except when the machine is at playing speed. No screetch and wail of high-speed playback; but though this is a pleasure in general, it does remove one major means of quick identification.

Nor can you "rock" your tape back and forth, slowly, to locate an exact spot for editing. Editing would seem to be a tough proposition on this type of machine, any way you look at it. (Who wants to edit a four-track tape? Well, for many purposes it is economical to use only two tracks, one direction, and thus make editing possible. Same as on conventional half-track machines.)

The Americans Wanted It

I'll only make one more small grouse, concerning this already-favorite machine of mine. (No amount of grousing can offset the splendid results I've had from it.)

This concerns the output connections for playback which, frankly, make no sense at all. I figured 'em out by trial and error.

I had a talk with one of Tandberg's Norwegian engineers, just arrived in this country, and it seems a good deal of the confusion in the present model is due to the insistent demands of the Americans, who wanted this and that and the other feature added until the Tandberg people were going crazy.

One result (which I could not fathom in the explanation) was the odd output connection board, an affair with a long row of small holes, color-coded, into which individual pins are inserted—four of them. Every other hole is a ground; the rest are for the two channels and an extra pair that I've never bothered to use—but what got me was that the color coding is false and doesn't match the color of the pins, as they must be inserted!

It took me an hour or so of fussy experimenting before I got them in right way around and with the grounds where they belonged; a pair of RCA plugs would have done it in seconds. Why all this? "Oh, those colors are for us in Norway," said the engineer cryptically, which left me more confused than ever, especially after he said that in Norway they used only one cable for both channels, but "the Americans" insisted on four separate connections and two cables. *What* Americans, I wonder?

The cathode follower outputs seemed fairly low in level but I found that, rather to my surprise, the two built-in power amplifiers could be used as preliminary boosters (the controls set low) for a better gain ratio, with no great loss in quality. They act like preamps. (At full volume they overloaded the main power system on the outside, but the range of gain at their lower volume positions was definitely useful.)

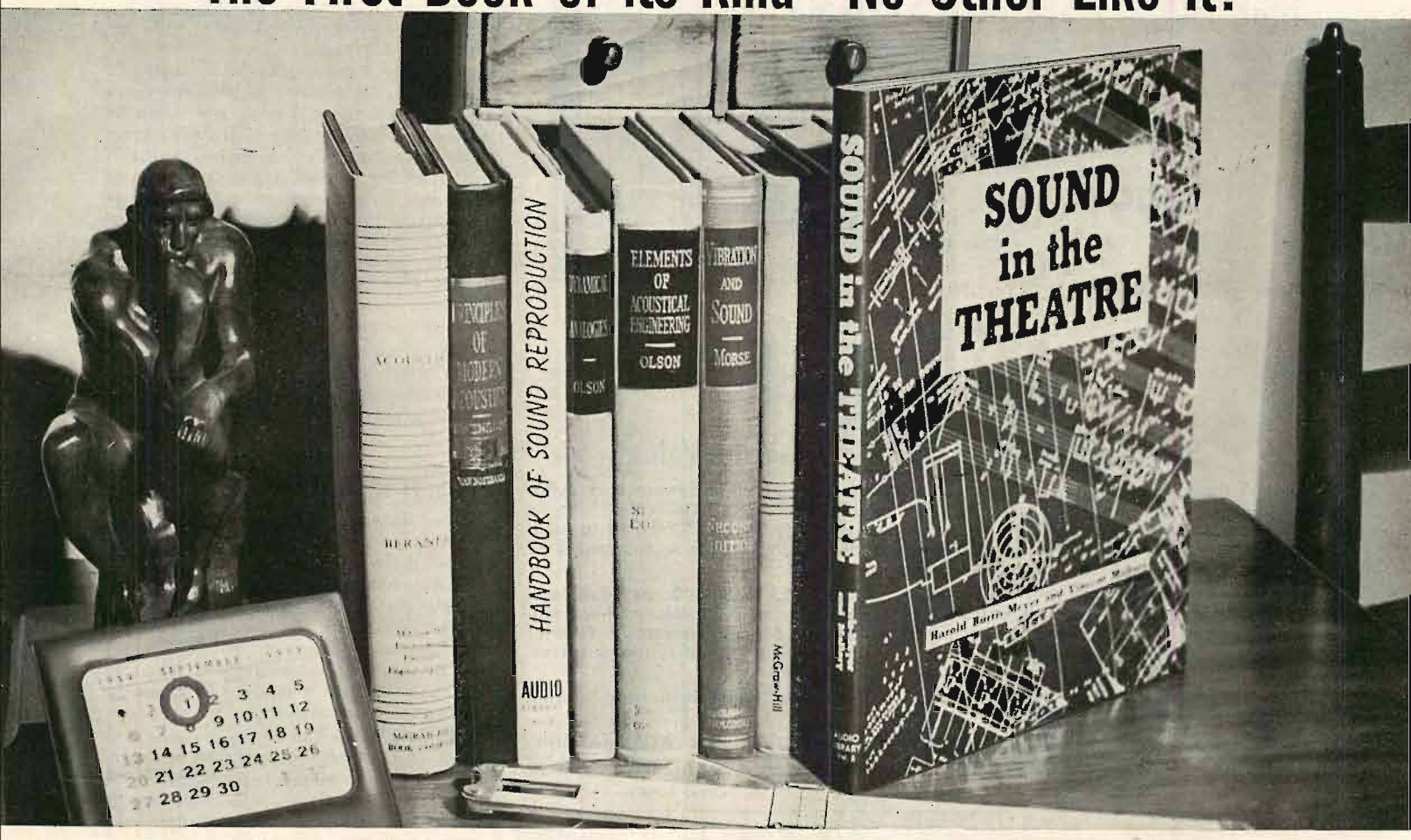
As I say, I never did get to figure out what levels I had on my tape, due to the complications. Even when the two eyes read the same, I got what seemed to be a lower level on the second channel in playback and had to compensate for this by channel adjustment. Only way I can find out what actually happened is to check the tapes on a professional four-track machine with meters on the output—I probably will, one of these days, out of sheer curiosity.

Instructions, Please

Oh yes—a final observation on international communications. I got a fine, big instruction book with my Tandberg, covering all the Tandberg line in detail. But, alas, not one of those in the book was the same as mine, specifically in the little matter of that overhead cable for the second channel. There wasn't any in the picture. No instructions either.

Boy, did *that* give me a couple of days of agony, 'way down in Tennessee where nobody could help me. I tried everything but I couldn't get even a trace of a signal out of the second channel, with the cable in, without it, or any other way. I discovered the trouble by sheer accident when I happened to pull the cable out while the tape was playing back and lo—the second

The First Book of its Kind—No Other Like It!



The publishers of AUDIO invite you to purchase—*at a prepublication saving*—the completely new

SOUND in the THEATRE

by Harold Burris-Meyer and Vincent Mallory

THE BOOK

Nothing like SOUND in the THEATRE has ever been published. It is the first book to set forth in authoritative detail what you can do with sound by electronic control, and how to do it whenever the source (singer, musician, speaker, etc.) and the audience are present together. The book develops the requirements for electronic sound control from the necessities of the performance, the characteristics of the audience (hearing and psychoacoustics), and the way sound is modified by environment, hall, and scenery. Sound sources are considered for their susceptibility of control and need for it, and the many techniques for applying electronic sound control are described and illustrated in thirty-two specific problems. From these problems are derived systems and equipment specifications. Complete procedures are given for: Planning, assembling, and testing sound control installations—Articulating sound control with other elements of production—Rehearsals and performances—Operation and maintenance of sound control equipment.

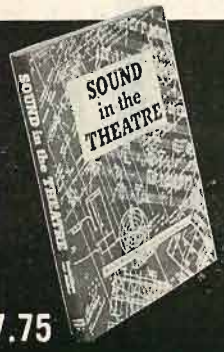
THE AUTHORS

During the past thirty years, the authors have developed the techniques of sound control in opera, open-air amphitheatres, theatres on Broadway, theatres on-the-road and off-Broadway, in concert halls and night clubs, in Hollywood and in the laboratory. Some of their techniques are used in broadcast and recording as well as in performances where an audience is present. From their laboratory have come notably successful applications of sound control to psychological warfare and psychological screening.

HAROLD BURRIS-MEYER has written **Scenery for the Theatre,** the standard text on the subject, and **Theatres and Auditoriums,** both done with Edward C. Cole. He also wrote **Acoustics for the Architect** with Lewis S. Goodfriend. Presently an acoustical consultant to the Department of Defense, he is a fellow and past counsellor of the Acoustical Society of America; fellow of the Audio Engineering Society, Senior Member of the IRE, and member of the American Physical Society, The American Institute of Physics and the American Educational Theater Association.

VINCENT MALLORY is presently chief of the General Equipment Branch of the Missile Guidance Division in the Naval Ordnance. His background in acoustics dates back to his days as an engineering student at the University of Pittsburgh. He first employed sound control in the legitimate theatre in GRAND STREET FOLLIES of 1928 at the Booth Theatre. He has served as consultant in open-air sound control for the New York City Department of Parks. He has extensive experience in manufacturing having served as chief engineer with many fine companies. He is a fellow of the Acoustical Society of America and a member of the American Institute of Physics.

An invaluable reference—an indispensable guide for anyone working in the theatre—a complete technological thesaurus for the engineer, architect, designer, technician, student, and teacher concerned with the reinforcement of sound and speech.



TO BE PUBLISHED AT $10.00

Prepublication price $7.75

This prepublication saving certificate is worth $2.25

RADIO Magazines, Inc., Dept. S99
Post Office Box 629 Mineola, New York

I am enclosing my remittance for $7.75, special prepublication price.
Send my copy of SOUND in the THEATRE postpaid.
(No C.O.D., all books sent postpaid in U.S.A. and possessions, Canada, and Mexico. Add 50c for Foreign orders.)

Name_____ Address_____

City_____ Zone____ State_____

This offer expires October 15, 1959.

channel came alive. It had been recording all along but would not play until the cable was unpluged.

When my Tandberg began to develop a flutter (I didn't notice it until the tapes were spoiled for a day or so's worth of recording) I went again to the voluminous instruction book for aid. Under "Mechanical Operation" I found a reassuring note that said all mechanical functions were identical with other models and were covered in detail in Booklet So-and-so. Was Booklet So-an-so included with my machine? It was not. I waited three weeks before I got that flutter ironed out—in moments—by the Tandberg engineer.

The moral of this is surely clear. GET YOUR INSTRUCTION BOOKLETS STRAIGHT! It's a first consideration in all audio, but al too often it comes as an afterthought, or not at all.

THE H-K MADRIGAL

The Harman Kardon "Madrigal"—one of the continuing series of musically-named models out of that company—is an FM-AM tuner typical of this somewhat interim period in radio hi-fi, when stereo is firmly entrenched in records, tapes and most home equipment yet is still hanging fire in the broadcast department, pending F.C.C. action. (It was still hanging, anyhow, when I wrote this.)

What to do, in tuners, when stereo is so much in the air, when AM-FM stereo broadcasting continues, when FM multiplex still seems likely to be the ultimate system—but remains experimental and unsettled in detail?

This "Madrigal" is the sort of practical answer that has come up this year, providing as far as possible for all anticipated alternatives but omitting an actual multiplex section though allowing built-in space and connections for a multiplex adapter. (Most multiplex adapters today are on an outside chassis, however.)

The adapter is already officially listed, as the Model MA350, a Crosby-type unit, and you may presumably have it at once, though I didn't ask for it since I prefer to wait a bit for the F.C.C. to get around to action. The good thing here is that, clearly, the Harman-Kardon people will at once produce a new insert multiplex model to match the F.C.C. specification, if it is in any way different from the present Crosby system. This should reassure those who are wondering what to do for broadcast stereo. If important alterations in the Crosby multiplex unit are in order when the long awaited decision arrives, I have a strong suspicion that Harman-Kardon will offer a reasonable replacement deal for those who buy the present Model MA350 Crosby insert for the "Madrigal."

In use at my home the "Madrigal" has gone to work well enough and has left me with very little to say, which is perhaps as it should be. It's a good tuner; it receives what I want and generally keeps doing it (for a good many months, anyhow—and it's guaranteed for a full year, by the way) and that is that. The main operation is via a row of pushbuttons which, I've found, are a good solution to a complex problem, minus only one defect: you'll find it not too easy to read the labels.

Nothing unusual in *that*—it's my commonest beef with much home hi-fi these days.

Why is it necessary, here as elsewhere, to squat on your haunches and bring your eyes down somewhere near waist level in order to find out what button or knob does what? How many hi-fi units do *you* know that are mounted high, at *eye-level?* Yet practically every unit I've used lately, including this one, is an "eye-level" model.

I soon memorized the buttons and, anyhow, I had already disfigured the "Madrigal" with red marking crayon and the like, to make operations ultra-clear! I usually do; it looks ugly but it works. A good feature here is an OFF button, at the right end, which cancels everything and turns the whole thing off. There are two FM buttons, with and without AFC, a button for plain AM and a handy noise filter button next to it, plus, in the center, the "extra" functions, one pushbutton for AM-FM stereo, both tuners simultaneously, and another for FM multiplex, when the multiplex unit is present. The now-familiar ferrite-stick antenna for AM is in back and a 48-inch piece of wire is included for FM—instead of the 300-ohm "T" antenna furnished with many FM tuners in the past. As usual, I got mostly loud noise and hiss on AM, the familiar experience of the country resident away from big-city AM stations; but the FM section brought in my regular collection of stations, near and far, about as I had anticipated. If reception was less reliable than on my last tuner, this might be easily explained by the simple fact that I used the "Madrigal" in summer, the previous one in winter. We have a pretty tough climate, electrically speaking, in the summer months in Connecticut.

Only a couple of further observations come to mind in connection with my uneventful use of this tuner. The AFC is fixed and to some extent I missed the variable AFC I've had on other models—but I also admit that few users ever learn how to take advantage of this. There seems to be some "AFC effect" on the plain FM position (AFC defeated); or at least the stations still seem to "pop" a bit from one to the next. I also noted, as in other sets I've used, that the center of the FM-AFC tuning position is slightly off from the center without AFC; I usually must move the pointer a bit to the right to get the best of AFC on weakish stations.

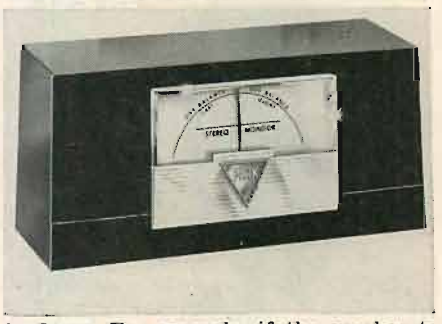
Finally, I sort of like an AM-FM panel design where the two bands appear one above the other. On the "Madrigal" they are spread out on a single level, all the way across. This results in a relatively small dial length for each band, and the mid-point between the two is not sharply set off. Matter of opinion, I guess. The two tuning knobs, in any case, are at opposite ends of the panel, matching the button positions, and there's no confusion at all in that respect.

There isn't anything more to say, short of a laboratory measurement and test, which is none of my business. No breakdowns with the "Madrigal," no bugs, no early-model boners, no collapses. If the thing had been a mess, I could write a much more interesting article—but it wasn't, so more power to H-K, and pardon my yawn. AE

NEW PRODUCTS

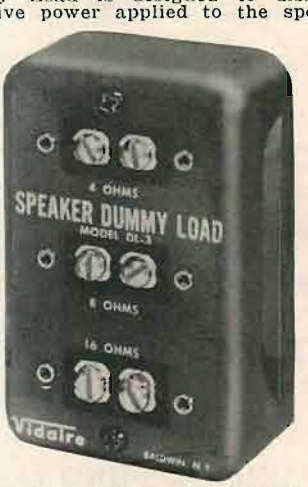
(from page 95)

• **Stereo Monitor.** This instrument was developed to meet the need for some means of visually indicating proper balance between speakers or series of speakers in stereo music systems. It is intended for both professional and home use. In construction it is a specially-designed center-point differential meter which, in conjunction with a network, tells the user if both channels of a stereo system have equal



loudness. For example, if the speaker to the right of the listener is louder than the speaker to the left, the needle moves to the right. By adjusting the balance control the needle is returned to center and equal loudness is achieved. The needle does not wave or bounce to any great extent, as in VU meters. Available for either rack or panel mounting, the Park Stereo Monitor may be installed in a matter of minutes. No insertion loss occurs and frequency response is not affected. Park Products Company, Inc., 4901 Perkins Ave., Cleveland 3, Ohio. **K-10**

• **Speaker Saver.** With the growing use of high-power amplifiers in home music systems, many expensive speakers are in danger of damage by the accidental application of more power than they are designed to handle. The Model DL-3 Dummy Load is designed to dissipate excessive power applied to the speaker,



without mismatching the impedance of the speaker system. Terminals are available for connection of 4-, 8-, or 16-ohm speakers or systems. The DL-3 will also find usefulness in service shops or labs for trouble shooting audio amplifiers. Manufactured by Vidaire Electronics Mfg. Corp., Baldwin, N. Y. **K-11**

• **Belden Hi-Fi Cable.** Ideal for connecting high-fidelity components where a shielded low-loss cable is indicated, the Belden Type 8421 incorporates three strands of tinned copper and four strands of tinned copperweld for increased tensile and mechanical strength. Jacketed in chrome-finish vinyl, the cable has a foam Polyethylene insulation for lower capacitance and a spiral tinned copper shield for reduction in interference and easy and neat connections. Available on 15-, 25-, 50-, 100-, and 500-ft. spools. Belden Manufacturing Company, Chicago 80, Ill. **K-12**

• **8-mm Sound Projector.** The Elite 8, a professional projector of Norwegian manufacture, combines a high-quality optical system and, in effect, a tape recorder. A magnetic sound strip added to the film after it has been processed is all that is

necessary to transform 8-mm silent movies into "talkies." The projector operates at two speeds, 16 and 24 frames per second. The recorder has a built-in amplifier, 6-in. loudspeaker, and high quality magnetic sound head. Erasure of material recorded on the film is automatic when re-recording. Accessories, such as a three-channel mixer for combining music with narration, and a panoramic lens for wide-

screen projection, are available. The Elite 8 is distributed in the United States by Tandberg of America, Inc., 8 Third Ave., Pelham, N. Y. **K-13**

● **Roberts Tape Cartridge Adapter.** An adapter mechanism, easily attached to any Roberts tape recorder for playback of RCA-type cartridge tapes, has been announced by Roberts Electronics, Inc., 1045 N. Sycamore Ave., Los Angeles 38, Calif. The adapter is mounted directly

over the feed reel and take-up reel spindles, and is driven by a belt connection from the recorder capstan to a flywheel beneath the adapter. Owners of Roberts recorders may thus enjoy the advantages of two- and four-track reel-to-reel tapes as well as avail themselves of the numerous selections soon to be available from cartridge tape manufacturers. Delivery of the adapter is scheduled for late fall. **K-14**

SUPERIMPOSED TAPE

(*from page 62*)

setting. The effect is very much like tuning a station on a radio. As the angular position of the head gap approaches one of the settings used for recording, sound will begin to be heard. As the position gets closer, the sound becomes clearer and clearer.

How is the fidelity? Surprisingly good in view of the mad things we have done to the magnetic oxide on the tape. But, the results are definitely *not* high fidelity. However, the results are good enough that it's reasonable to believe that technique and equipment could be improved

NEW!

No. 120
THE 4th AUDIO ANTHOLOGY
$2.95 Postpaid

This is the biggest Audio Anthology ever! Contains a wealth of essential high fidelity know-how in 144 pages of complete articles by world-famous authors.

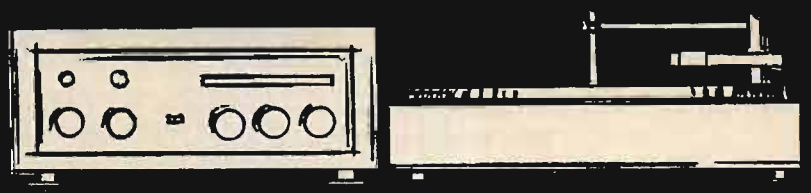
"the best of AUDIO" No. 124

A new compendium of AUDIO knowledge.

Here is a collection of the best of AUDIO—The AUDIOclinic by Joseph Giovanelli...noted audio engineer and the *original* high fidelity *answer-man*—EQUIPMENT PROFILES edited by C. G. McProud...Editor of AUDIO. Here is a wealth of hi-fi and audio information. Answers to the most important issues in high fidelity and a valuable reference on the performance of leading makes of high fidelity components. Volume I $2.00

the AUDIO bookshelf

A convenient service to AUDIO *readers. Order your books leisurely by mail—save time and travel, we pay the postage.*



NEW! Greatest Reference Work on Audio & Hi Fi No. 123

"The AUDIO Cyclopedia" by Howard M. Tremaine

Up to the minute, including stereo!

- **1280 pages**
- **3400 topics**
- **1600 illustrations**

Here is one single volume with the most comprehensive coverage of every phase of audio. Concise, accurate explanations of all audio and hi fi subjects. More than 7 years in preparation—the most authoritative encyclopedic work with a unique quick reference system for instant answers to any question. A vital complete reference book for every audio engineer, technician, and serious audiophile. $19.95

No. 115
McPROUD HIGH FIDELITY OMNIBOOK

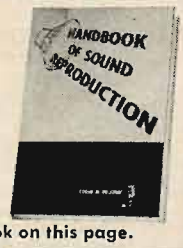
Prepared and edited by C. G. McProud, publisher of Audio and noted authority and pioneer in the field of high fidelity. Contains a wealth of ideas, how to's, what to's and when to's, written so plainly that *both* engineer and layman can appreciate its valuable context. Covers planning, problems with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

No. 112
TAPE RECORDERS AND TAPE RECORDING
by Harold D. Weiler

A complete book on home recording by the author of *High Fidelity Simplified*. Easy to read and learn the techniques required for professional results with home recorders. Covers room acoustics, microphone techniques, sound effects, editing and splicing, etc. Invaluable to recording enthusiasts. *Hard Cover $3.95. Paper Cover $2.95 Postpaid.*

HANDBOOK OF SOUND REPRODUCTION No. 110
by Edgar M. Villchur

Right up to date, a complete course on sound reproduction. Covers everything from the basic elements to individual chapters of each of the important components of a high fidelity system. Regularly $6.50...offered for a limited time at only $3.75.



SPECIAL! You pay only $2.75 for this book when you order it with any other book on this page.

OCTOBER SPECIAL! SAVE $6.95!

You save almost 60% with this combination of valuable audio and high fidelity books. The Fourth Anthology ($2.95); The Third AUDIO Anthology ($2.50); Handbook of Sound Reproduction $6.50).

TOTAL VALUE OF ALL THREE $11.95.
Your Cost ONLY $5.00 POSTPAID

This offer expires October 31, 1959
Good only on direct sale from the publisher.
ORDER #OS9

AUDIO Bookshelf
RADIO MAGAZINES, INC., Dept. J
P.O. Box 629, Mineola, New York

Please send me the books I have circled below. I am enclosing the full remittance of $.....(No. C.O.D.)

All U.S.A. and CANADIAN orders shipped postpaid. Add 50¢ for Foreign orders (sent at buyer's risk).

BOOKS: 110 112 115 120 123 124 OS9

NAME_____ ADDRESS_____

CITY_____ ZONE____ STATE_____

to a point of satisfying high-fidelity standards. If that could be done, then very interesting possibilities exist.

A seven-inch reel of long-play tape runs for a full hour at 3¾ ips. With ten recordings on the tape, it would play for a full ten hours! This is not only competitive with LP records—it is superior on a straight dollar-and-cents basis. The cost of reproduction should not increase, since multiple heads could be placed "in-line" and all recordings made in a single pass of the tape.

Intriguing? Æ

AUDIO PHILOSOPHY

(*from page 60*)

identical effect with that present in the first half. (*Fig.* 11). In this way the asymmetrical effect of the long-term time-constant changes in the supply circuit are neutralized out so that no component of this appears beyond the phase inverter. This results in an amplifier that does not get shock excited into bounce effect when sudden transients hit it.

There is one more variation of the unity-coupled circuit that this company has produced, using triodes in class-B instead of pentodes. In this case two transmitting type triodes, 8005's, are utilized for the output. The boot-strap method is used for the drive stage in just the same way as for the pentode circuit. But in this case tetrodes are used for the drive function. (*Fig.* 12). This is because the whole proportions of the output circuit are changed.

With pentode operation the cathode degeneration is responsible for reducing the effective plate-circuit resistance or source resistance for the output stage from its original very high value to a fraction of the load resistance. Hence a relatively low-resistance triode is necessary for the drive stage, in conjunction with the regeneration of the boot-strap circuit, to prevent complete loss of this improved output impedance and linearization. Using triode output tubes, the picture is practically reversed.

The plate resistance of the tubes is not larger than the load resistance to begin with. In a class-B circuit it is approximately of the same order. The cathode degeneration due to unity coupling reduces this to a lower figure and the regeneration of the boot-strap circuit can be permitted to bring it back approximately to its original region. What is more necessary with a triode output circuit is a bigger swing for the output-tube grids, because of the longer grid base of these tubes as compared with corresponding pentodes. For this reason a pentode, operated with a low-value plate resistor and using regeneration to multiply the effective value of the re-

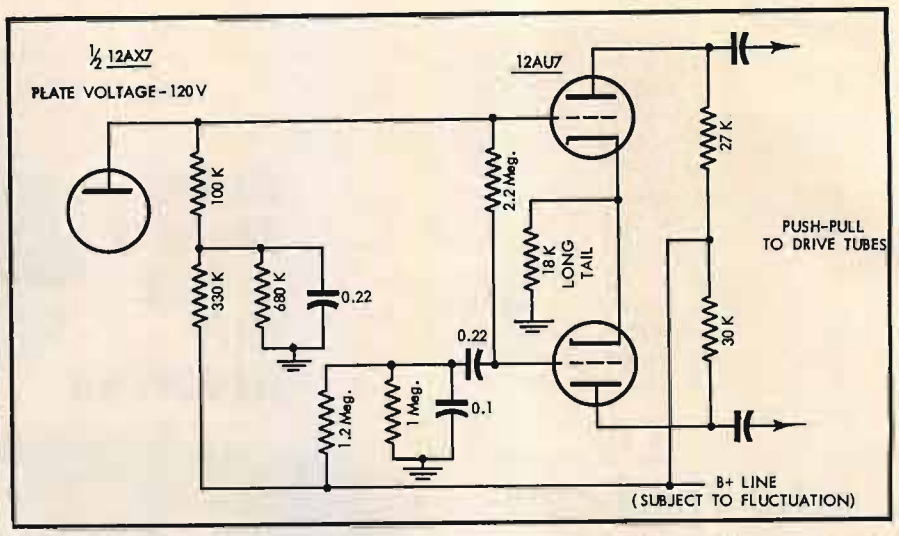


Fig. 11. The modified "long-tailed pair" phase-split inverter, designed to compensate for B+ line fluctuations (due to transient changes in signal level) that otherwise can cause erratic amplifier behavior.

sistor, enables the much bigger needed swing to be obtained.

Again, cathode followers are used to drive the triode grid directly and avoid the effects previously mentioned and also to enable the tubes to be driven into the positive grid region to get power drive.

Apart from these slight differences, the circuitry of the 200-watt unity coupled amplifier, using two 8005 triodes for the output, is very similar to the other circuits we have already discussed.

It will be noticed that the circuitry we have discussed in this article is different from that employed by many amplifiers in that it has been engineered to serve the purpose intended, not just taken from current practice and reduced to a minimum for economic purposes. Having engineered a working circuit the McIntosh people have then worked on their production technique to obtain a satisfactory price. Æ

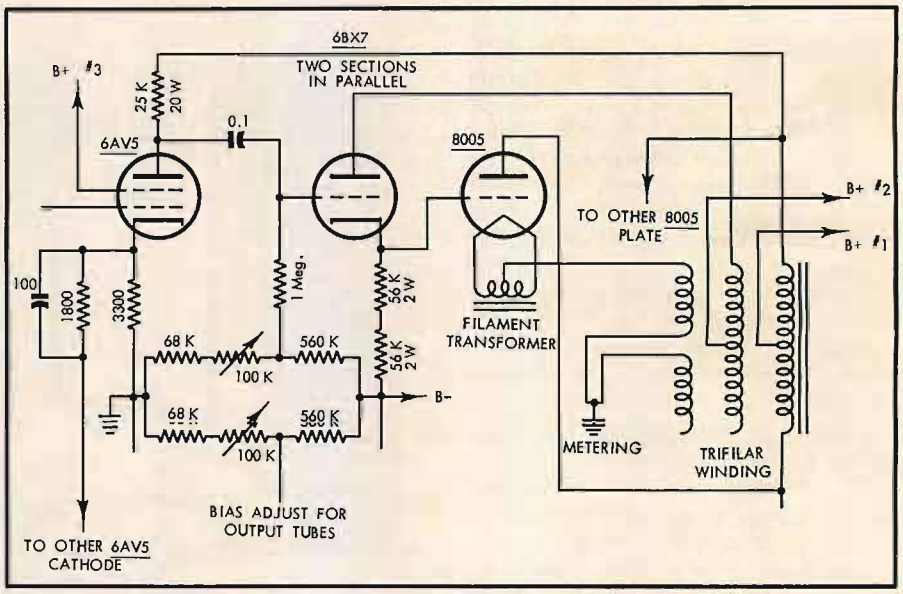


Fig. 12. An "inversion" of the unity-coupled circuit uses a transmitting triode in the output, with a pentode bootstrap drive. With power drive of the 8005's, this circuit delivers 200 watts.

"STEREO-PLUS" SYSTEM

(*from page 23*)

channel as shown in *Fig.* 4. Such a transformer must be able to handle the full power output of one channel, and must be of high efficiency to conserve valuable audio power. The transformer should also be bifilar wound to introduce the least possible degradation of the high-frequency power response. Since commercially available units meeting these requirements could not be located, special transformers were constructed. The size and cost of each proved to be substantially equal to the output transformers used in the amplifier.

Another satisfactory method, but requiring a special amplifier or modifica-

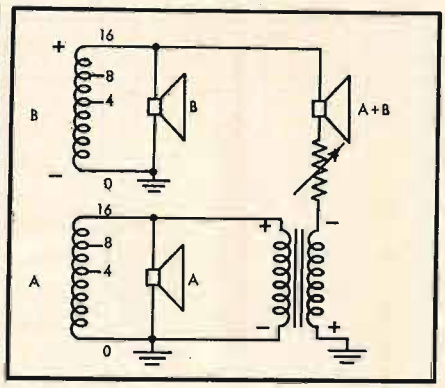


Fig. 4. Method of using a phase-reversing transformer on one channel to furnish a center-channel sum signal.

tion of an existing amplifier, uses an electronic phase inverter in one channel only, to reverse the output phase as shown in *Fig.* 5. The output of one channel is then in opposite phase to the other, over the entire audio spectrum. A speaker connected, between channels, to taps of the same impedance receives a signal which is proportional to the *sum* of Channel A *plus* Channel B.

A Simpler Solution

The "Stereo-Plus" System is an ideal solution to the problem of providing *sum* signal drive to the center-channel speaker system. It fulfills all of the required conditions and has none of the disadvantages inherent in the other systems described. Only a simple modification of the output circuits of a conventional stereo amplifier is required to obtain the advantages of the "Stereo-Plus" System. This system and its underlying principles are the subject of a U.S. patent application.

Basically, the modification involves grounding an existing tap of the output winding on one channel of a stereo amplifier, instead of one end as in usual practice. This makes voltages of opposite phase available from that winding. The other channel of the stereo amplifier is not changed.

The other channel of the stereo amplifier is not changed.

The series-aiding connection of two equal voltages, one from Channel A and the other from Channel B, required for

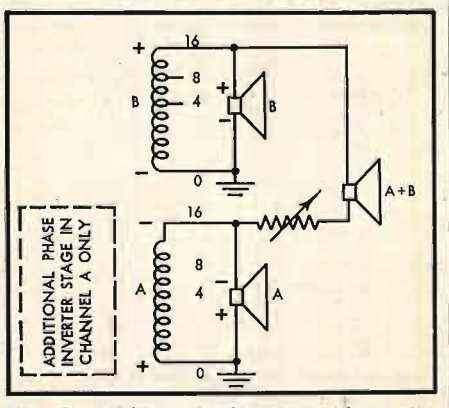


Fig. 5. Additional electronic phase inversion will supply center-channel signal, but requires amplifier complication.

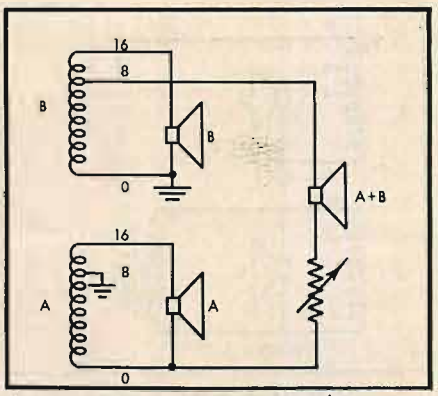


Fig. 6. Method of obtaining the center-channel sum signal by modifying output circuitry of one amplifier.

the *sum* signal, can be traced in *Fig.* 6 as follows. The path is from the end of the winding which was originally grounded in the converted channel, through the common ground connection, to the same impedance tap on the unconverted channel. A center-channel speaker connected as shown in *Fig.* 6 will respond to the *sum* of Channel A *plus* Channel B and therefore will reproduce center-stage sounds and monophonic signals.

In amplifiers with 4-ohm taps, advantage can be taken of the fact that the 4-ohm taps are the electrical center taps of 16-ohm windings. With the 4-ohm tap of *both* channels as the grounded point, equal voltages of either polarity are available from both channels. The modification in both channels is made by grounding the 4-ohm tap on each. In this arrangement both channels remain identical. *Figure* 7 shows how these voltages can be arranged to feed a *sum* signal to the center-channel speaker.

Moving the ground from one end of the secondary to a tap reduces the amount of feedback voltage. The feedback network values must be adjusted to restore the feedback to its original value. In any amplifier, changing the point from which the feedback is taken, may adversely affect the stability of the amplifier. After making the feedback change, the amplifier should be tested for stability and corrections made if needed. Æ

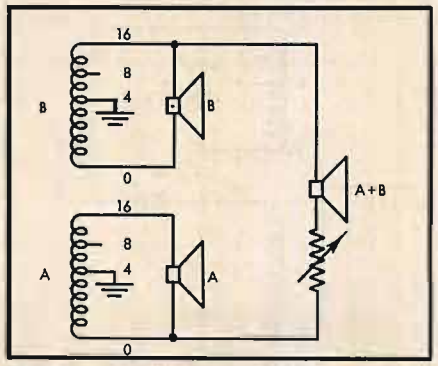


Fig. 7. Grounding the 4-ohm taps of both amplifiers provides a center-channel sum signal and makes both amplifiers identical.

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.

Industry Notes . . .

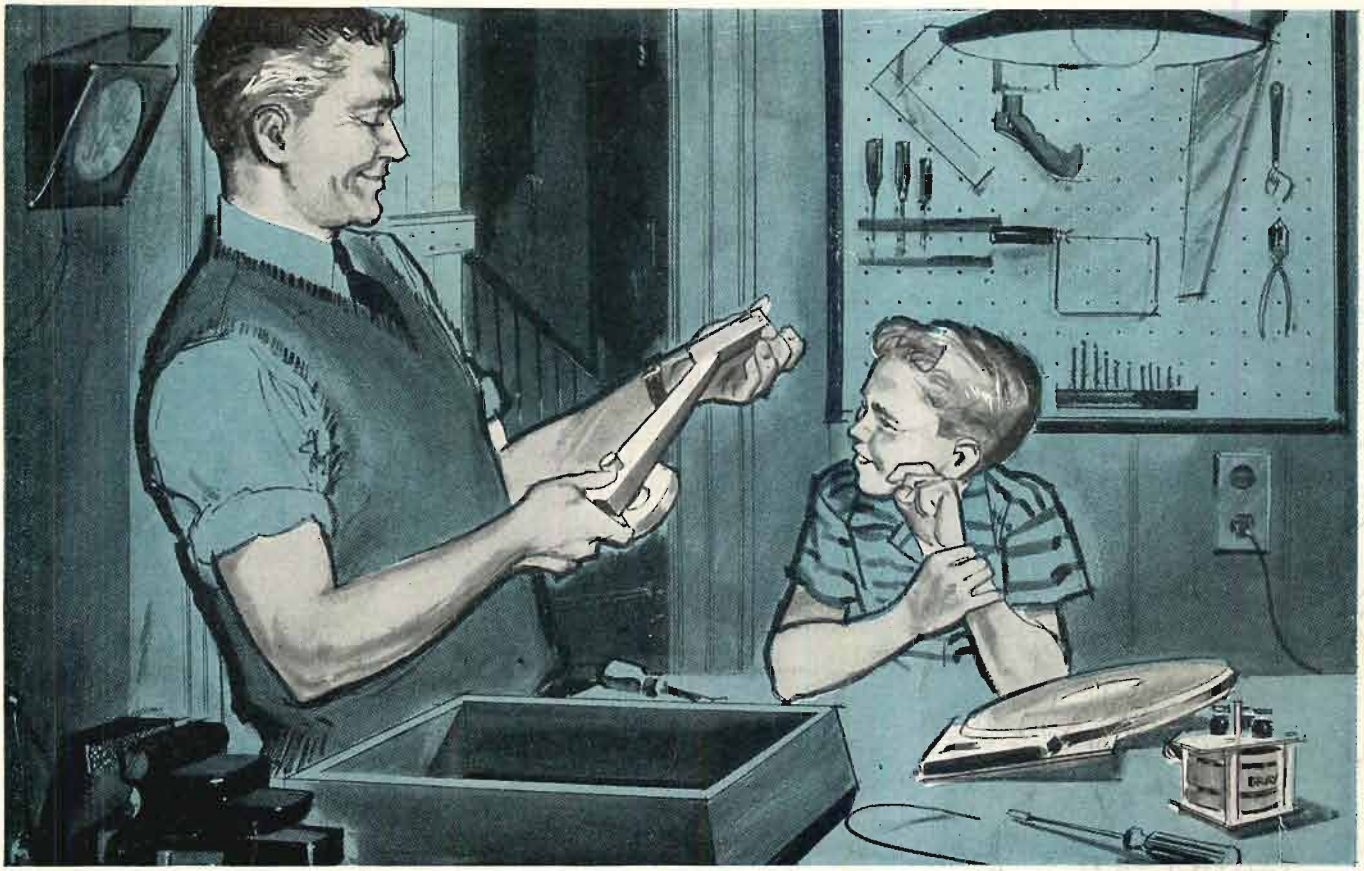
NEW MRIA CAMPAIGN. An industry-wide program to tell the country about the "versatility of tape" was endorsed by the board of directors of the **Magnetic Recording Industry Association** at a recent meeting in New York. Herbert L. Brown, MRIA president, said that the board chose the theme of versatility because it embraces a fundamental position basic to the interests of all industry members. "It is obvious that tape has experienced a remarkable comeback in the past few months and that it has a great future," Mr. Brown said. "There is room enough in the market for the special qualities of each type of tape operation—whether it be reel-to-reel, cartridge, fast or slow speed, two or four track."

AUDIO FIDELITY EXPANDS TO BRAZIL. Sidney Frey, president of **Audio Fidelity, Inc.,** New York manufacturer of high-fidelity recordings, has announced the formation of a Brazilian branch of the company. With offices in Sao Paulo and Rio de Janeiro, the firm will be known as **Audio Fidelity do Brasil, S.A.** Mr. Frey will be president of the new operation, and Sebastiao R. Bastos, formerly sales manager for RCA Distributors in Sao Paulo, will be vice-president. The Brazilian firm will operate directly with dealers in Brazil, and export to all South American countries.

KLH-JANSZEN COMBINE. Announcement has been made that **Janszen Laboratory,** a research and development company of Cambridge, Mass., has combined with **KLH Research and Development Corporation.** Arthur A. Janszen, president and general manager of the company bearing his name, will join Henry E. Kloss, and Malcolm S. Low, and J. Anton Hoffman, as an officer and director of KLH.

AMPEX PROMOTES OFFICIALS. Five new vice-presidents were appointed by the board of directors of **Ampex Corporation** at its recent quarterly meeting, according to announcement by George I. Long, Jr., president. John Jipp, Neal K. McNaughten, Herbert L. Brown, John M. Leslie, Jr., and Walter T. Selsted were named by the board following the corporation's annual stockholders meeting held on August 25 in Redwood City, Calif. Stockholders at the meeting voted approval on the proposal to merge with **Orr Industries, Inc.,** manufacturers of magnetic tape. Mr. Long indicate that such action would be consummated with a short time. Orr stockholders have already approved the action. First quarter net earnings of Ampex more than tripled those of the like period last year, while sales were almost double, stockholders learned.

ADVERTISING INDEX



START YOUR HIGH FIDELITY SYSTEM WITH A GRAY COMPONENT

KIT OR ASSEMBLED

...GRAY COMPONENTS for expert workmanship at low cost to you

GRAY Hysteresis-Synchronous Turntable Kit

Precision engineered parts. Balanced for both stereo and monophonic use. 33⅓ and monophonic use. 33⅓ RPM belt drive.

HSK-33 turntable . . $49.50
SAK-12 tone arm . . 23.95
TBA base 17.95

GRAY Tone Arm Kit

Outstanding features such as linear fluid damping, quick-change cartridge slide, adjustable static balance, and versatile wiring for all cartridges makes SAK-12 tone arm your best buy.

SAK-12 12" arm kit $23.95

GRAY Custom DeLuxe turntable, arm and base

Factory assembled components that give you all the extras you need for the most complex system.

33 H (Hysteresis-Synchronous)
Turntable $79.95
212 SX 12" arm 34.00
33 C Wood Base 23.95

GRAY Micro-Balanced Pressure Gauge

Indicates pressure on record surface so that adjustments can be made for proper tracking. A true balance without springs.

PG 200 gauge $2.50

Visit your friendly quality Gray dealer for a full demonstration. Write to us for complete literature.

GRAY

our 67th year in communications . . .

High Fidelity Division

DEPT. 6 • 16 ARBOR STREET, HARTFORD 1, CONN

critical listeners
RECORD LIKE "PROS"

WITH FINER Electro-Voice®

BROADCAST-TV MICROPHONES

The right microphone makes a world of difference in sound pick-up and recording quality. That is why critical audiophiles prefer E-V high-fidelity professional microphones like those used today by radio and television stations and recording studios. (You often see E-V microphones on TV.)

These *Electro-Voice* microphones are research-engineered to pick up and reproduce the full range of voice and music with utmost fidelity for maximum realism.

Choose from two basic types: the E-V *cardioid unidirectional* microphone gives greater definition to front sounds; rejects interference from unwanted rear-background noise and room reverberation; allows precise placement for more working distance from the microphone. The E-V *omnidirectional* type picks up sound from all directions; flat response assures remarkable fidelity for individual or group pick-up without critical placement. All have the exclusive E-V non-metallic Acoustalloy diaphragm. All are extra-rugged for long-life use.

FOR TRUE STEREO
Use two or more E-V microphones for most effective 3-dimensional high fidelity

Model 666 665 655C 649A 635

Model 666 665 655C 649A 635

Model 666 Super-Cardioid Dynamic. Variable D principle provides exceptional unidirectivity. Response 30-16,000 cps. Output —55 db. Changeable low impedance. For stand or boom use. List, $255

Model 665 Cardioid Dynamic. Similar in function to the Model 666. Response 50-14,000 cps. Output —55 db. 50-250 ohms impedance selector. For stand or hand use. List, $150

Model 655C Omnidirectional Dynamic. Extra-wide-range response 40-20,000 cps. Output —55 db. Changeable low impedance. Use on stand or in hand. List, $200

Model 654 Omnidirectional Dynamic. (Not illustrated.) Similar in function to Model 655C. Response 50-16,000 cps. Output —55 db. 50-250 ohms impedance selector. List, $100

Model 649A Miniature Lavalier Dynamic. For chest, desk or hand use. Easily concealed. Omnidirectional. Response 60-12,000 cps. Output —60 db. Matches all low impedances. List, $105

Model 646 Lavalier Dynamic. (Not illustrated.) Omnidirectional. Response 50-10,000 cps. Output —57 db. Matches all low impedances. List, $147.50

Model 635 Omnidirectional Dynamic. Very versatile. Response 60-13,000 cps. Output —55 db. 50-250 ohms impedance selector. For stand or hand use. List, $82

For high-impedance applications, add E-V Model 502 matching transformer.

Wide choice of other popular-priced E-V quality microphones, in low and high impedance, in the full E-V line.

Write for Catalog 136, and Names of distributors, to Dept. 109-A

ELECTRO-VOICE, INC., BUCHANAN, MICHIGAN, U.S.A.

Microphones • Speaker Systems • Phono-Cartridges • Sound Projectors