ICD APRIL 1958 • 35 CENTS

Stereo Discs Up-to-Date

audiocraft

for the HI-FI hobbyist

Build a smart music wall for your hi-fi rig

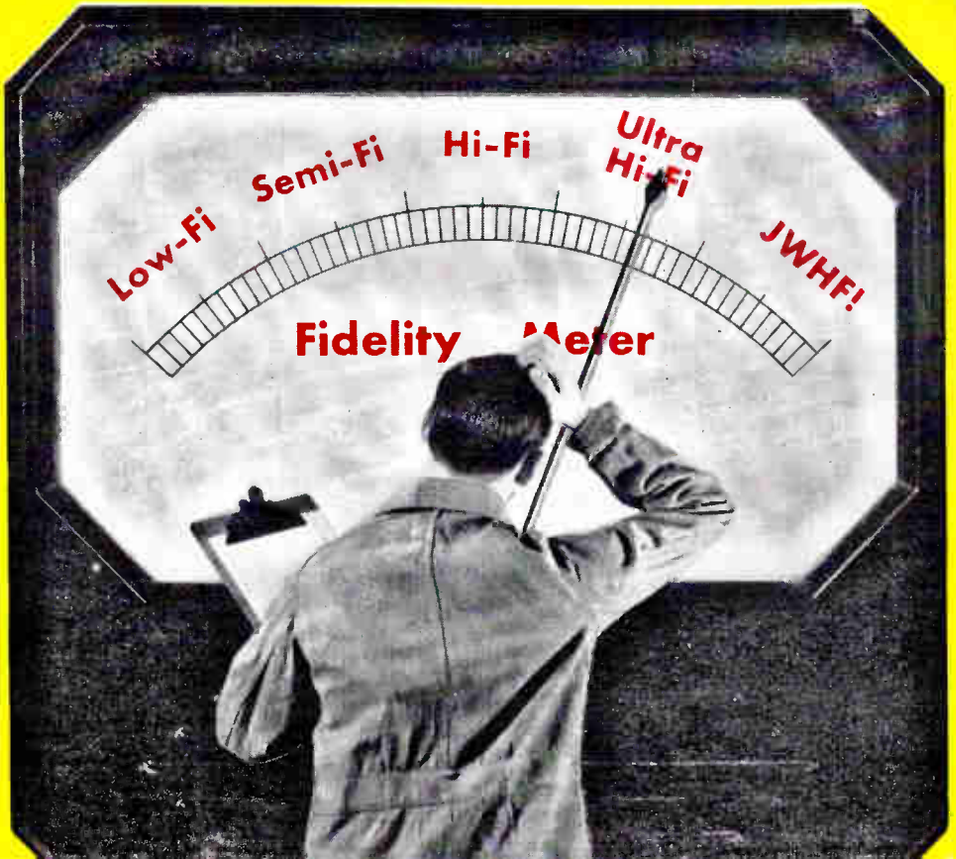
Beginning this issue . . .

AUDIOLAB TEST REPORTS

. . . objective laboratory test reports on high-fidelity components, prepared by former Audio League personnel

How to pick a stereo tape recorder that is just right for you

An $85 music system you can put together entirely from 3 kits

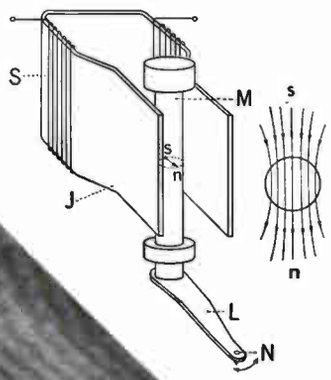


NORELCO® *presents*

the world's second finest* pickup cartridge

a new MAGNETO-DYNAMIC design by Philips of the Netherlands

*The world's **finest** pickup cartridge is carefully guarded at the great Philips audio research center in Eindhoven, the Netherlands. It is the laboratory prototype of the new NORELCO "Magneto-Dynamic" pickup cartridges—a special pilot model hand-built to zero tolerances by Europe's most renowned electro-acoustic research team. This reference standard must, of necessity, be a shade superior to the production models, which are constantly quality-controlled against it. It is an indispensable laboratory tool that obviously cannot be sold. But the world's **second** finest pickup cartridge—meaning any and every NORELCO production model—can be and **is** sold by leading hi-fi outlets everywhere, for the astonishingly low price of $29.95.



THE MAGNETO-DYNAMIC PRINCIPLE—The armature is a thin rod M, 1/32″ in diameter and approximately ½″ long, made of "Ferroxdure," a special high-coercivity ferrite material developed by Philips. This armature is magnetized perpendicularly to its axis (s — n) and is rotated about the axis by the transverse vibrations of the cantilever stylus bar L, which is driven by the 1-mil diamond stylus N. This rotation induces a varying flux in the core J, which results in the development of a corresponding AC voltage in the coil S. The inherent advantages of the system include very high compliance (more than 5 x 10^{-6} cm/dyne), very low dynamic mass (2.8 milligrams), high output (35 millivolts at 10 cm/sec), low stylus force (5 grams), and vanishingly low distortion. Frequency response is flat within 2 db from 10 to 20,000 cps.

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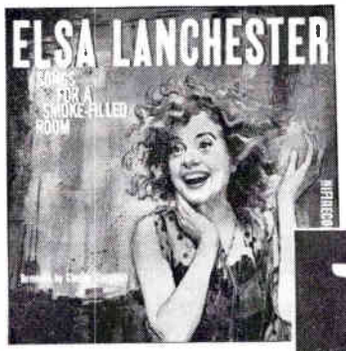
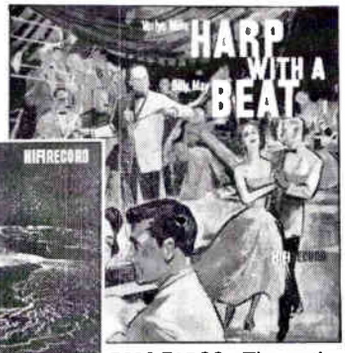
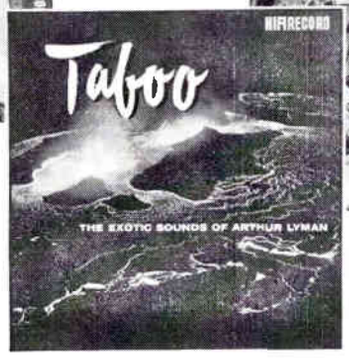


R405 ELSA LANCHESTER (remarks by Charles Laughton) Songs for a Smoke Filled Room. Gay, risque—they get by because they have culture!

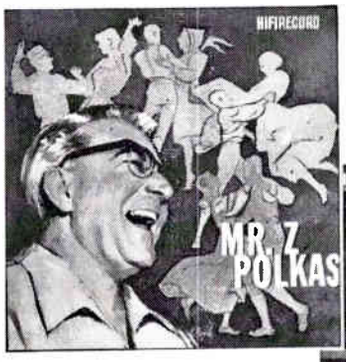


R606 VERLYE MILLS HARP WITH A BILLY MAY BEAT. Big band Billy May pile driver brass with Verlye Mills jazz harp.

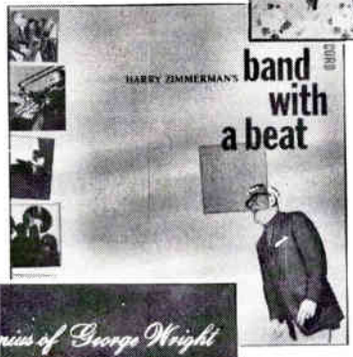


R806 TABOO—The exotic sounds of Arthur Lyman's Hawaiian Village Group recorded in Henry J. Kaiser's aluminum dome, Honolulu. Fabulous sound!

R715 GEORGE WRIGHT'S IMPRESSIONS OF MY FAIR LADY. Off-beat interpretations played on the mighty Wurlitzer 5 Manual Theater Pipe Organ as only Wright can do it.

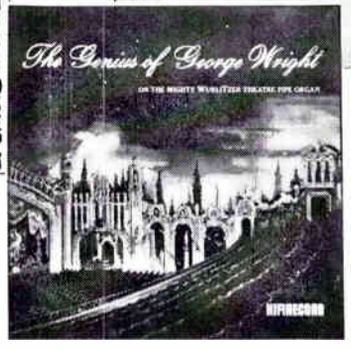


R605 MR. Z. POLKAS—Harry Zimmerman's big band. Polkas with sophistication. Welk won't like this.

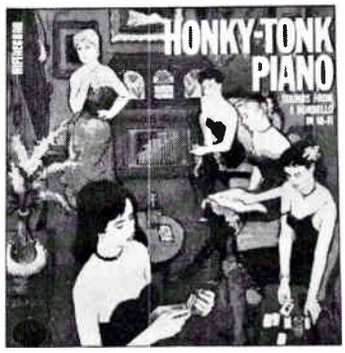


R602 HARRY ZIMMERMAN'S BAND WITH A BEAT. Unusual marching arrangements of pop standards. 25-piece big band recorded in wooden gymnasium, sensational sound!

R603 BRUCE PRINCE JOSEPH'S SWINGIN' HARPSICHORD. Played by prof. of music at Hunter College. Park Ave. lets down its hair! Will tax your tweeter.



R713 THE GENIUS OF GEORGE WRIGHT. The man who has made over 2,000,000 LP album buyers pipe-happy plays the mighty Wurlitzer 5 Manual Theater Pipe Organ.



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FM Stations Up-to-Date

Here, in convenient booklet form, is a complete geographical listing of FM stations in the United States and Canada. The list was compiled by Bruce G. Cramer directly from FCC records, and originally appeared in AUDIOCRAFT Magazine. With additional changes and corrections to bring it up-to-date, it has been reprinted as a booklet. The price is only 50¢. **264**

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The Third High Fidelity Annual

Edited by Joan Griffiths

Associate Editor, HIGH FIDELITY Magazine

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RECORDS IN REVIEW is published by The Wyeth Press, an affiliate of HIGH FIDELITY Magazine. The book is printed in clear type on fine quality paper, attractively bound and jacketed. $4.95 **257**

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Comments on the first two annuals:

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THE MAGAZINE FOR THE HI-FI HOBBYIST

APRIL 1958

Volume 3 *Number 4*

THIS MONTH'S COVER: The fidelity meters favored by Messrs. Hirsch and Houck for Audiolab Test Reports may not be as pretentious as the towering scale facing our perplexed audiophile, but they are every bit as revealing. See page 24 for the first of this long-awaited new series.

Cover by Phil Geraci.

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The Grounded Ear

What's new for your future in sound reproduction?

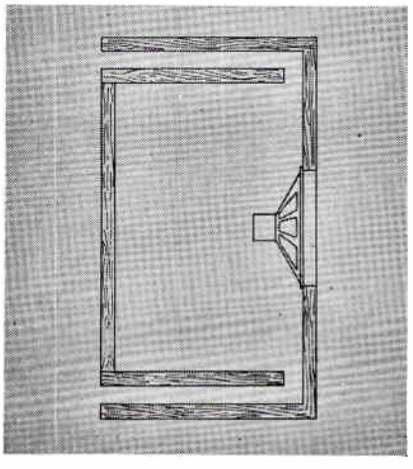
by Joseph Marshall

The Ducted-Port Enclosure

One of the most interesting of recent developments in speaker systems has been the refinement of the ducted-port enclosure, to produce compact speaker systems with excellent frequency range and fine over-all performance. Curiously enough, it is only recently that the principle of port ducting has been exploited fully in commercial enclosures, although it has been known for many years.

If you have worked much with bass-reflex enclosures, you know that a reflex cabinet can be altered by building a lip on the inside of the vent, or indeed building a box around the opening. This, of course, turns the opening into a duct with depth as well as area. The enclosure then resonates at a lower frequency than does a similar enclosure of the same volume with an unducted opening of the same area. This is obviously a way to make an enclosure of small volume behave as if it were larger. The first enclosure I ever saw that used ducted ports was the Pro-Plane Prismatic, on whose performance I reported in an early number of this magazine.

Fig. 1. Cross section of ducted port.



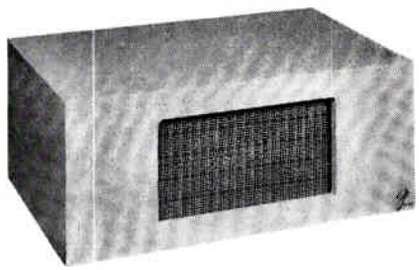
Now Jack Frazier of International Electronics is making several small systems with ducted-port enclosures, and I have had the opportunity to use three of them at home. Frazier's use of the duct is very simple in design; this is evident from Fig. 1, which is a cross-section diagram of one of the enclosures. It will be noted that the interior is partitioned into a sort of labyrinth which results in a very narrow duct at each end. In the Highlander and the Midget the ducts are vented to the back of the enclosure, and in the Black Box the vents are in front. 8-inch speakers are used for woofers, with separate paper-cone tweeters in the larger boxes; a single 5-inch speaker is used in the smallest system. The Highlander enclosure is 24 by 12 by 15 in. outside dimensions, which corresponds to an internal volume fairly close to 2 cu. ft. The Black Box is 24½ by 19 by 12 in. and has a slightly greater volume. The Midget is 16 by 9½ by 6 in. for a total volume of about ½ cu. ft.

The Highlander.

The impedance of these systems follows the bass-reflex pattern with two peaks about an octave apart. In the Highlander the peaks are at roughly 50 and 100 cps; in the case of the Black Box they are at about 55 and 110 cps; and in the midget they fall near 100 and 200 cps. The peaks are quite high — 14 to as much as 20 db — and high damping factors will be needed in the amplifiers which drive them to flatten the response.

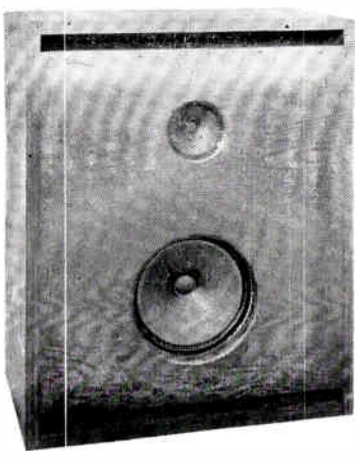
The Highlander has a smooth response to fundamentals down to about 45 cps. Below that the fundamental response cuts off and there is some doubling. The Black Box goes down to about 50 cps and the Midget to somewhere around 85 to 90 cps, doubling and tripling below that. All three are quite efficient, and balance between woofer and tweeter is good. The tweeter response of both the Highlander and Black Box is reasonably flat to around 13 or

Continued on page 41



The Midget.

The Black Box.



by RICHARD D. KELLER

book reviews

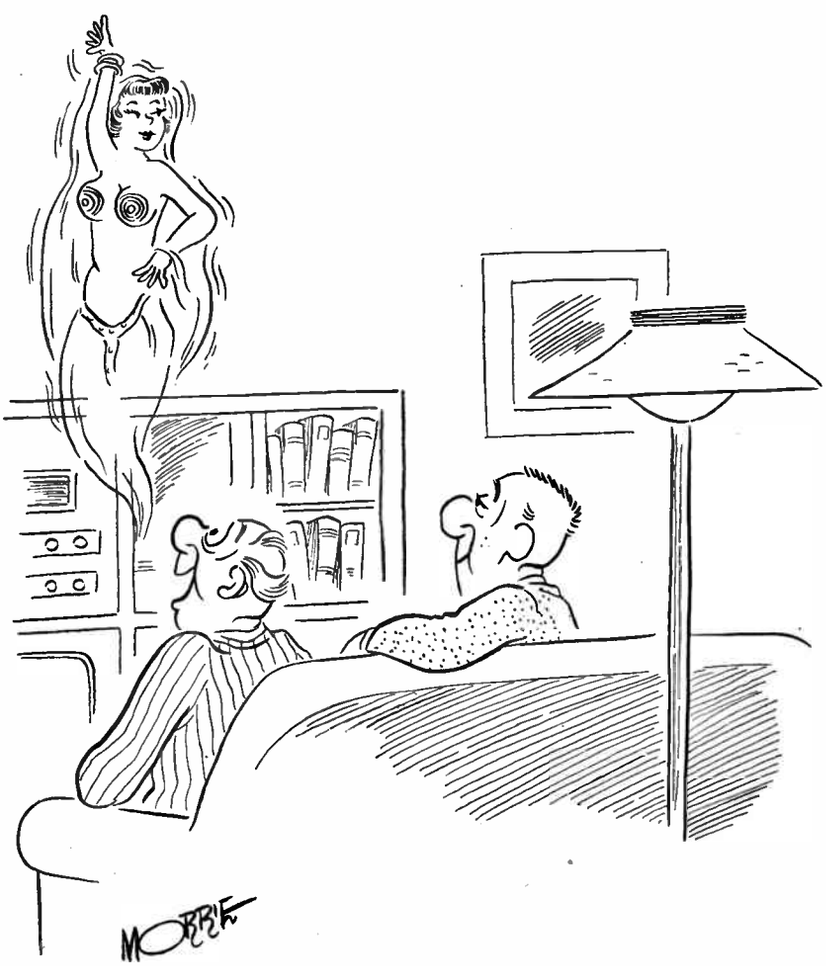
Techniques of Magnetic Recording

Joel Tall; pub. by the Macmillan Company, New York; 472 pages; $7.95.

An enormous amount of material is contained in this well-illustrated and well-paced book dedicated to improving the skills and the methods the recordist uses to preserve and sometimes effectively alter the sounds around him. There is no attempt to cover the technical electronic circuitry of tape recorders; rather, this book is for the professional looking for new ideas, and for the amateur who often has little concept of the many useful techniques of magnetic recording.

The book contains one of the most interesting and complete histories of magnetic recording yet published, including translations of Valdemar Poulsen's descriptions written at the turn of the century of his then-new invention. The Carlson-Carpenter patent of 1927 on AC bias is reproduced in its entirety, and translations of German descriptions of important Magnetophon developments in 1940 are given.

The inclusion of descriptions written by the originators of various techniques, such as the excellent chapter on "Recording Sound in Nature" by Professor Kellogg of Cornell University, add considerably to the stature of the book. Chapters on editing, re-recording and copying techniques, radio practices, an extensive section on motion-picture and television recording, and chapters on the uses of recordings in the business, computer, educational, and medical fields comprise the bulk of the book. Short sections on home uses, telephone recording, public entertainment, advertising, and the legal aspects of sound recordings (the author is a consultant in the detection of falsified recordings), along with an extensive glossary, bibliography, and index, round out this work.



"What's it like in stereo?"

1958 Test Equipment Annual

Pub. by Howard W. Sams & Co., Inc., Indianapolis, Ind.; 116 pages; $1.00, paper-bound.

This book contains a number of articles on test-equipment uses, particularly with respect to TV servicing. There is also some elementary material on wave-form analysis, field-strength meters, capacitor testers, and the servicing of VTVM's, sweep generators, and oscilloscopes. The plentiful advertisements are informative, and there is a 19-page condensed listing, with specifications, pictures, and prices, of the products advertised.

High Fidelity Simplified

Harold D. Weiler; pub. by John F. Rider Publishers, Inc., New York; 220 pages; $2.50, paper-bound.

This is the third edition of an extremely successful basic introduction to high fidelity.

It has been brought up-to-date with illustrations of new equipment and descriptions of the latest developments in good-quality home sound. Written in a friendly, lucid style, it explains the essential features of sound and acoustics and all the links in the high-fidelity chain from the sound source (tuner, record player, tape recorder, etc.) through the preamplifier, power amplifier, loudspeaker, and the loudspeaker enclosure. There are many pictures of fine custom installations, and enough diagrams and db curves to acquaint the newly initiated with the jargon of high-fidelity.

How to Make a Transistorized Portable Radio

Sylvania Electric Products Inc., New York; 34 pages; 25¢, paper-bound.

The RF transistor was placed on the market after publication of Sylvania's booklet, *28 Uses for Junction Transistors,* which dealt mainly with DC and low-

frequency applications. The current booklet, like its predecessor, is addressed primarily to experimenters and electronic hobbyists, and gives basic circuits and parts requirements for portable radios, oscillators, RF meters, and wireless phono and microphone oscillators. A handy pamphlet to have.

Elements of Tape Recorder Circuits

Herman Burstein and Henry C. Pollak; pub. by Gernsback Library, Inc., New York; 224 pages; $2.90, paper-bound.

This book fulfills its title very well and is a good buy for the serious home audiophile, who wants to know more about the electronic circuitry of his recorder, and for the technician and engineer, who wish to approach a tape recorder not only with instruments and a schematic but also with a secure understanding.

Basic design principles, with a minimum of arithmetic, are included so that the reader may modify his own equipment to suit his particular needs. Many circuits are analyzed to give the reader a better grasp of the fundamental principles of their designs. The book is well illustrated and is written so that anyone with a rudimentary understanding of electricity, magnetism, and audio terminology should be able to understand quite easily such important factors as tape and head characteristics, bias and erase oscillators, level indicators, and, perhaps most important and least thoroughly understood of all, equalization requirements in tape recorders. If fact, the largest portion of the book is concerned with an extremely thorough and complete discussion of equalization requirements and circuits for both recording and playback functions, and the interrelationships between equalization, supersonic bias, signal-to-noise ratio, and distortion.

How to Use Meters

John F. Rider; pub. by John F. Rider Publisher, Inc., New York; 156 pages; $2.40, paper-bound.

This is another practical book for the amateur do-it-yourselfer, technician, and experimenter.

It features hundreds of applications of AC and DC voltmeters, ohmmeters, ammeters, and wattmeters for general electrical tests and measurements, radio-TV applications, transmitters, oscillators, power supplies, and amplifiers.

The author explains how to adapt simple meter movements for voltage, current, resistance, and power measurements, and for operation at audio and power frequencies as well as radio frequencies. Typical examples of commercial multirange instruments and vacuum-tube voltmeters and volt-ohmmeters are given. This should be a very useful reference book for the lab.

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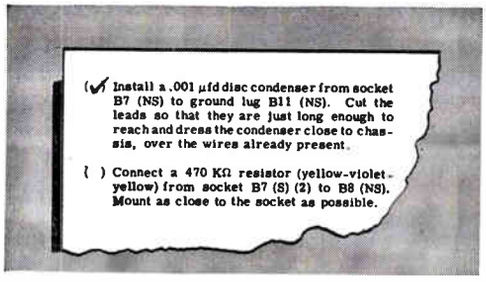

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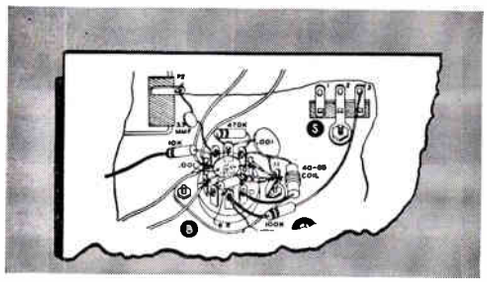

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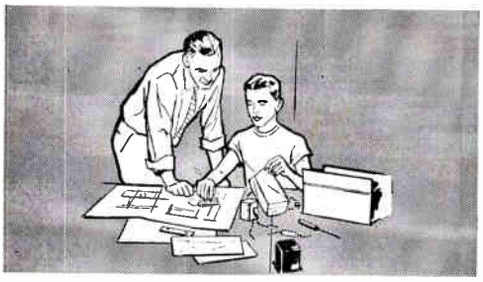
Detailed pictorial diagrams in your Heathkit construction manual show where each and every wire and part is to be placed.



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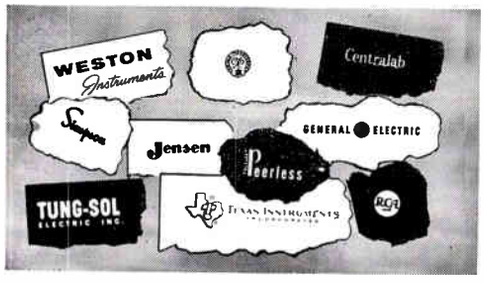
Kit construction is not only fun—but it is educational too! You learn about radio, electronic parts and circuits as you build your own equipment.



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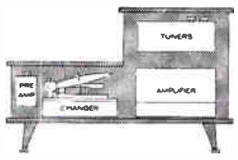
NEW This beautiful equipment enclosure will make your hi-fi system as attractive as any factory-built professionally-finished unit. Smartly designed for maximum flexibility and compactness consistent with attractive appearance, this enclosure is intended to house the AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier, along with the majority of record changers, which will fit in the space provided. Adequate space is also provided for any of the Heathkit amplifiers designed to operate with the WA-P2. During construction the tilt-out shelf and lift-top lid can be installed on either right or left side as desired. Cabinet is constructed of sturdy, veneer-surfaced furniture-grade plywood ½" and ¾" thick. All parts are precut and predrilled for easy assembly. Contemporary available in birch or mahogany, traditional in mahogany only. Beautiful hardware supplied to match each style. Dimensions are 18" W x 24" H x 35½" D. Shpg. Wt. 46 lbs.

CE-1C Mahogany
CE-1CB Birch
CONTEMPORARY



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Be sure to specify model you prefer

$43.95 each

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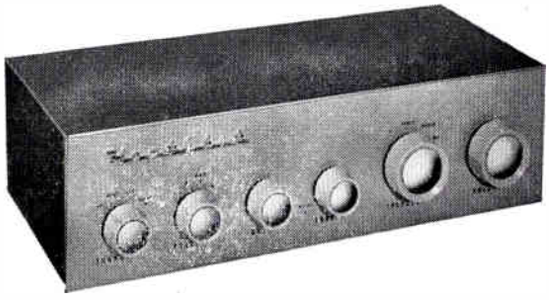
MODEL FM-3A $25.95 (with cabinet)

HEATHKIT

broadband AM tuner kit

This tuner differs from an ordinary AM radio in that it has been designed especially for high fidelity. 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. Incorporates automatic volume control, two outputs, and two antenna inputs. An edge-lighted glass slide rule dial allows easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

MODEL BC-1A $25.95 (with cabinet)



HEATHKIT

master control preamplifier kit

Designed as the "master control" for use with any of the Heathkit Williamson-type amplifiers, the WA-P2 provides the necessary compensation, tone, and volume controls to properly amplify and condition a signal before sending it to the amplifier. Extended frequency response of ± 1½ db from 15 to 35,000 CPS will do full justice to the finest program material. Features equalization for LP, RIAA, AES, and early 78 records. Five switch-selected inputs with separate level controls. Separate bass and treble controls, and volume control on front panel. Very attractively styled, and an exceptional dollar value. Shpg. Wt. 7 lbs.

MODEL WA-P2 $19.75 (with cabinet)

pioneer in "do-it-yourself" electronics

HEATH

a subsidiary of Daystrom, Inc.

COMPANY • **BENTON HARBOR 18, MICHIGAN**

HEATHKIT 25-WATT **HEATHKIT 70-WATT**

MODEL W-5M
$59.75

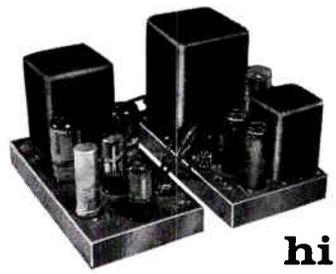
high fidelity amplifier kits

MODEL W-6M
$109.95

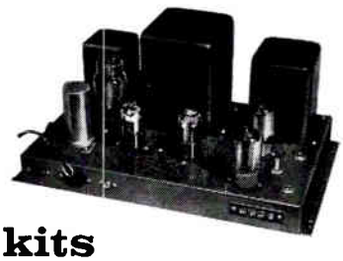
To provide you with an amplifier of top-flight performance, yet at the lowest possible cost, Heath has combined the latest design techniques with the highest quality materials to bring you the W-5M. As a critical listener you will thrill to the near-distortionless reproduction from one of the most outstanding high fidelity amplifiers available today. The high peak-power handling capabilities of the W-5M guarantee you faithful reproduction with any high fidelity system. The W-5M is a must if you desire quality plus economy! Note: Heathkit WA-P2 preamplifier recommended. Shpg. Wt. 31 lbs.

For an amplifier of increased power to keep pace with the growing capacities of your high fidelity system, Heath provides you with the Heathkit W-6M. Recognizing that as loud speaker systems improve and versatility in recordings approach a dynamic range close to the concert hall itself, Heath brings to you an amplifier capable of supplying plenty of reserve power without distortion. If you are looking for a high powered amplifier of outstanding quality, yet at a price well within your reach, the W-6M is for you! Note: Heathkit model WA-P2 preamplifier recommended. Shpg. Wt. 52 lbs.

HEATHKIT DUAL-CHASSIS
MODEL W3-AM
$49.75



HEATHKIT SINGLE-CHASSIS
MODEL W4-AM
$39.75



HEATHKIT

high fidelity amplifier kits

One of the greatest developments in modern hi-fi reproduction was the advent of the Williamson amplifier circuit. Now Heath offers you a 20-watt amplifier incorporating all of the advantages of Williamson circuit simplicity with a quality of performance considered by many to surpass the original Williamson. Affording you flexibility in custom installations, the W3-AM power supply and amplifier stages are on separate chassis allowing them to be mounted side by side or one above the other as you desire. Here is a low cost amplifier of ideal versatility. Shpg. Wt. 29 lbs.

In his search for the "perfect" amplifier, Williamson brought to the world a now-famous circuit which, after eight years, still accounts for by far the largest percentage of power amplifiers in use today. Heath brings to you in the W4-AM a 20-watt amplifier incorporating all the improvements resulting from this unequalled background. Thousands of satisfied users of the Heathkit Williamson-type amplifiers are amazed by its outstanding performance. For many pleasure-filled hours of listening enjoyment this Heathkit is hard to beat. Shpg. Wt. 28 lbs.

HEATHKIT

high fidelity amplifier kit

MODEL A-9C **$35.50**

For maximum performance and versatility at the lowest possible cost the Heathkit model A-9C 20-watt audio amplifier offers you a tremendous hi-fi value. Whether for your home installation or public address requirements this power-packed kit answers every need and contains many features unusual in instruments of this price range. The preamplifier, main amplifier and power supply are all on one chassis providing a very compact and economical package. A very inexpensive way to start you on the road to true hi-fi enjoyment. Shpg. Wt. 23 lbs.

HEATHKIT

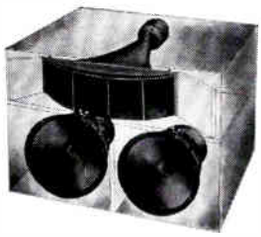
electronic crossover kit

MODEL XO-1 **$18.95**

One of the most exciting improvements you can make in your hi-fi system is the addition of this Heathkit Crossover model XO-1. This unique kit separates high and low frequencies and feeds them through two amplifiers into separate speakers. Because of its location ahead of the main amplifiers, IM distortion and matching problems are virtually eliminated. Crossover frequencies for each channel are 100, 200, 400, 700, 1200, 2000 and 3500 CPS. Amazing versatility at a moderate cost. Note: Not for use with Heathkit Legato Speaker System. Shpg. Wt. 6 lbs.

HEATHKIT "LEGATO"

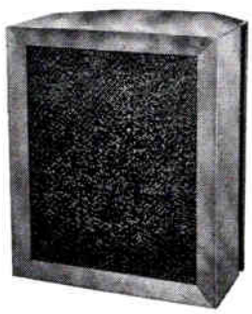
high fidelity speaker system kit



Wrap yourself in a blanket of high fidelity music in its true form. Thrill to sparkling treble tones, rich, resonant bass chords or the spine-tingling clash of percussion instruments in this masterpiece of sound reproduction. In the creation of the Legato no stone has been left unturned to bring you near-perfection in performance and sheer beauty of style. The secret of the Legato's phenomenal success is its unique balance of sound. The careful phasing of high and low frequency drivers takes you on a melodic toboggan ride from the heights of 20,000 CPS into the low 20's without the slightest bump or fade along the way. The elegant simplicity of style will complement your furnishings in any part of the home. No electronic know-how, no woodworking experience required for construction. Just follow clearly illustrated step-by-step instructions. We are proud to present the Legato—we know you will be proud to own it! Shpg. Wt. 195 lbs.

MODEL HH-1-C
(Imported white birch)
MODEL HH-1-CM
(African mahogany)
$325.00 each

HEATHKIT BASIC RANGE | **HEATHKIT RANGE EXTENDING**



high fidelity speaker system kits

MODEL SS-1 **$39.95**

A truly outstanding performer for its size, the Heathkit model SS-1 provides you with an excellent basic high fidelity speaker system. The use of an 8" mid-range woofer and a high frequency speaker with flared horn enclosed in an especially designed cabinet allows you to enjoy a quality instrument at a very low cost. Can be used with the Heathkit "range extending" (SS-1B) speaker system. Easily assembled cabinet is made of veneer-surfaced furniture-grade ½" plywood. Impedance 16 ohms. Shpg. Wt. 25 lbs.

MODEL SS-1B **$99.95**

Designed to supply very high and very low frequencies to fill out the response of the basic (SS-1) speaker, this speaker system extends the range of your listening pleasure to practically the entire range of the audio scale. Giving the appearance of a single piece of furniture the two speakers together provide a superbly integrated four speaker system. Impedance 16 ohms. Shpg. Wt. 80 lbs.

Free Catalog!

Don't deprive yourself of the thrill of high fidelity or the pleasure of building your own equipment any longer. Our free catalog lists our entire line of kits with complete schematics and specifications. Send for it today!

HEATH COMPANY • BENTON HARBOR 18, MICHIGAN

pioneer in "do-it-yourself" electronics

a subsidiary of Daystrom, Inc.

☐ Please send the Free HEATHKIT catalog.

☐ Enclosed is 25c for the New HI-FI book.

name _____

address _____

city & state _____

ALSO SEND THE FOLLOWING KITS:

QUANTITY	ITEM	MODEL NO.	PRICE

Enclosed find $..... Please enclose postage for parcel post—express orders are shipped delivery charges collect. All prices F.O.B. Benton Harbor, Mich. NOTE: Prices subject to change without notice.

Audionews

MAGNECORD RECORDER

Recently added to Magnecord's line of tape recorders is the *Courier*, which is available in two models: one for 7½- and 15-ips operation and the other for 3¾- and 7½-ips operation. Frequency response for the first is said to be from 20 to 15,000 cps, ±2 db at 15 ips, and from 40 to 12,000 cps, ±2 db at 7½ ips. For the second, it is stated as 30 to 15,000 cps, ±4 db at 7½ ips, and 40 to 7,500 cps, ±2 db at 3¾ ips. Otherwise, the two models are the same.

A hysteresis-synchronous motor drives the capstans and there are torque motors on the reels. Operational controls include REWIND, STOP, RECORD, PLAY, FAST FORWARD, and CUE. Should the tape break, the machine stops automatically. Inputs are provided for MIC 1, MIC 2, and AUXILIARY, with individual gain controls for mixing. The meter reads the record level, bias level, channel A playback level, or channel B playback level. Playback amplifier controls include MONAURAL-STEREO switch, BASS, TREBLE, LOUDNESS, and interchannel BALANCE. The manufacturer specifies that accuracy is ±3 seconds in 30 minutes; that signal-to-noise ratio is better than 50 db from the 3% third-harmonic distortion point; and that crosstalk is at least 50 db below the 3% third-harmonic distortion point.

FM TUNER BY MILLER

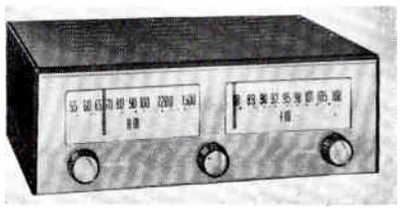
A new FM tuner from the J. W. Miller Company is the *Model 560* featuring self-powering, complete shielding, flywheel tuning, a built-in antenna for local reception, an edge-lighted dial, and a tuning indicator. The circuit has a grounded-grid RF amplifier, two IF stages, one limiter stage, and a Foster-Seeley discriminator. There are two output connections, one whose level is controlled by the VOLUME control on the front panel, and one without any level control. According to the manufacturer, sensitivity of the tuner is 3 μv for 20 db quieting, and the frequency response is ±0.5 db from 20 to 20,000 cps. AFC is said to make drift negligible. The 560 is 10 by 4 1/2 by 7 1/2 in., and its shipping weight is 9 lbs.; it sells for $59.95.

Miller FM tuner is moderately priced.

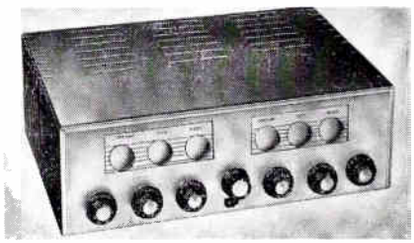
STEREO TUNER AND AMPLIFIER

Telematic Industries has introduced a stereo FM-AM tuner and a stereo amplifier. Both are available either as do-it-yourself kits or completely wired models.

The FM and AM sections of the tuner can be used individually for ordinary reception, or simultaneously for stereo broadcasts. The FM section is said to have a sensitivity of 0.9 μv for 20 db quieting and 1.8 μv for 30 db quieting, with a frequency response of 20 to 20,000 cps within 1 db. According to the manufacturer, sensitivity for the AM section is 15 μv per meter (loop sensitivity), and 3 μv per meter absolute sensitivity with direct antenna connection. Controls include AM TUNING, FM TUNING, selector switch for ON/OFF, FM, AM, and FM/AM. The tuner measures 4¼ by 13¼ by 10¼ in. It is available as the *KB-402* kit with prewired FM front end for $69.95, or as the *KB-402W*, completely wired, for $99.50.



The Telematic Industries stereo tuner.



Amplifier provides two 20-watt channels.

The amplifier contains a built-in preamp section and has two 20-watt channels. Controls for equalization, LOUDNESS, BASS and TREBLE, and VOLUME are provided on each channel. Inputs included are two high-level and one low-level; outputs are a tape-monitor output jack connected before all volume and compensation controls, and 4-, 8-, and 16-ohm speaker outputs. There is also a master VOLUME control and a selector switch for monaural preamp, monaural radio, monaural tape, and binaural preamp, radio, and tape. Frequency response claimed by the manufacturer is uniform within 0.5 db from 20 to 20,000 cps; hum and noise, down 55 db at full output in phono position and better than 75 db in high-level positions. The size of the amplifier is the same as that of the tuner. It is available as the *KB-403* kit for $82.50, or as the *KB-403W* factory-built model for $109.50.

Cages for both of these units may be obtained at a cost of $3.95 each.

PEERLESS CATALOGUE

A 12-page catalogue describing its full line of transformers may be obtained free of charge from Peerless Electrical Products. Specifications, performance curves, application data, and prices are included.

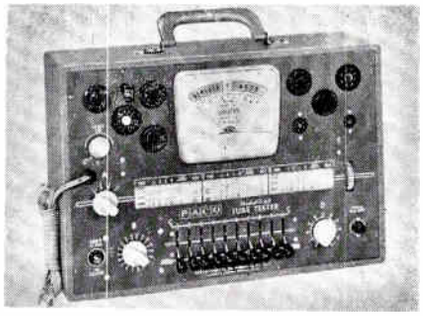
STEREO TAPE CATALOGUE

A complete listing of all available stereo tapes, including titles, artists, selections, catalogue numbers and prices is now being published in the *Complete Catalogue of Stereo Music* by Mooney-Rowan Publications. This listing represents the output of 47 companies. The catalogue will be issued quarterly and subscriptions will cost $2.00.

PACO TUBE-TESTER KIT

The *Model T-60*, a new tube-tester kit, has been introduced by Paco Electronics. The kit features a free-point lever-selector system, an extra-large 5-inch acrylic cased meter by PACE, an illuminated, high-speed, brass-geared, three-column roll chart, a ripple-finished steel cabinet, and a two-color panel with contrasting knobs. All new AM-FM-TV tubes including series-string types may be tested. Net price for the T-60 is $36.75. Accessories include a standard picture-tube test cable and a 110° picture-tube adapter. A removable hinged cover is priced at $3.95.

PACO build-it-yourself tube-tester kit.



VITAVOX COAXIAL

The *Model DU-120* Vitavox coaxial loudspeaker is now being offered by Ercona Corporation.

Nominal frequency response claimed for the unit is 30 to 15,000 cps; impedance at 400 cps is said to be 15 ohms. The crossover frequency is 2,000 cps and there is no need for an external dividing network. Recommended enclosure size to be used with the DU-120 is 6 cu. ft.

Vitavox Model DU-120 coaxial speaker.

FISHER AMPLIFIER

Just announced by Fisher Radio is the *Model 200* 60-watt amplifier.

Features of the amplifier are push pull amplification, multistage feedback loops, and variable damping. There is a choice of 4-, 8-, and 16-ohm speaker outputs, plus a 70.7-volt winding for multiple-speaker installations. Power and frequency response are said to be uniform throughout the hearing range; and distortion, hum, and noise are said to be inaudible.

The amplifier has a brushed-brass front panel and matching brass cage. Dimensions are 14¼ in. wide by 12½ deep by 8¾ high. It is priced at $179.50 (slightly higher in the far west).

HOLLAND SPEAKER SYSTEMS

The *Mark I* and *Mark II* loudspeaker systems manufactured by Holland Standards, Incorporated, employ an 8⅜-inch speaker which is said to respond well to high as well as low frequencies. Depending on room acoustics, frequency response has been conservatively rated from 30 to 13,000 cps and home-tested from 16 to 16,000 cps by the manufacturer; they are made to handle 20 watts of program material with 40 watts on peaks.

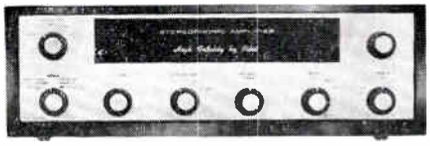
Both models are available with a Formica finish in mahogany, walnut, or high-gloss ebony. The Mark I functional model is 10 in. wide, 16 in. deep, and 22 in. high on brass-plated legs with self-leveling feet; it may be used without legs. Its shipping weight is 27 lbs. and the net price is $145. The Mark II corner model stands 36 in. wide by 17½ deep by 29 high. The shipping weight is 63 lbs. and the cost is $195.

PILOT STEREO MODELS

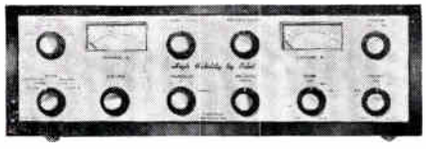
Pilot Radio has added a stereo preamp-control amplifier and a stereo preamp-audio control to its line of components.

The Model *SM-244* consists of two amplifiers rated at 14 watts each with 28 watts each on peaks and a self-contained bichannel preamp. Controls include BASS, TREBLE, POWER, BALANCE, LOUDNESS, VOLUME, MODE, (stereo, monaural, etc.), and SELECTOR for PHONO, TAPE, MIC, RADIO, and AUX inputs. The amplifier measures 4 13/16 in. high by 14 11/16 in. wide by 12 1/4 in. deep, and is housed in a brushed-brass and burgundy-metal enclosure. It retails for $189.50 with prices slightly higher in the eleven western states.

The *SP-215* bichannel preamp-audio control has inputs for stereo FM-AM broadcasts, stereo tapes, stereo discs, microphones, and other stereo signal sources. It has a separate output for recording stereo tapes, two VU meters, and controls for setting reference and peak recording levels. Other controls are for BASS, TREBLE, VOLUME, LOUDNESS, and BALANCE. Dimensions are 4 3/4 in. high by 14 9/16 wide by 10 5/32 deep; price and finish are the same as for the SM-244.



Pilot's dual-14-watt stereo amplifier.

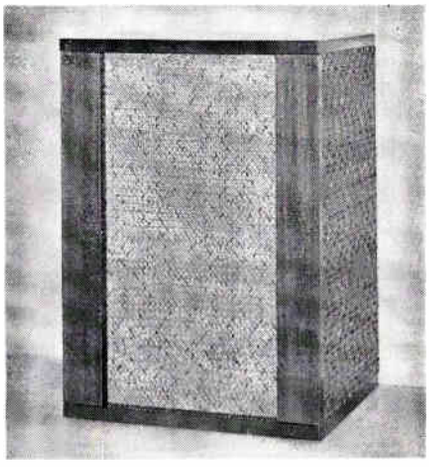


Stereo preamp features two VU meters.

For more information about any of the products mentioned in Audionews, we suggest that you make use of the Product Information Cards bound in at the back of the magazine. Simply fill out the card, giving the name of the product in which you're interested, the manufacturer's name, and the page reference. Be sure to put down your name and address too. Send the cards to us and we'll send them along to the manufacturers. Make use of this special service; save postage and the trouble of making individual inquiries to a number of different addresses.

KLIPSCH SPEAKER SYSTEM

Deriving its name from "Klipsch's Heresy," the Klipsch *Model H* is the only noncorner speaker system made by the company. The speaker is small and has been deliberately limited to about 100 cps on the bass end. It is applicable wherever a small speaker may be used, and is compatible with other Klipsch speakers. It is reported to be ideal for use as the second or third channel in a stereo system. Prices range from $165 to $202. Further information is available from the manufacturer.



A noncorner speaker system by Klipsch.

WHITE'S RADIO LOG

White's Radio Log, which has not been available for quite some time, has been bought and is being published by Science and Mechanics Publishing Company in *Radio-TV Experimenter.* It includes listings of United States and Canadian AM, FM, and TV stations, and world-wide short-wave stations. Price of the *Radio-TV Experimenter* is 75¢.

STEREO-PLAYBACK ADAPTER

Shure Brothers, Incorporated, has designed a kit for adapting all Revere and Wollensak tape recorders for stereo playback. It consists of a *TK-41* stacked stereophonic magnetic tape head with four leads which replaces the standard monaural head. One set of leads from the new head goes directly to the self-contained amplifier and speaker in the recorder; the other leads may be carried to the existing high-fidelity speaker and amplifier. The kit is inexpensive and simple to use. The old head is removed and the new head merely plugged into the tape deck.

UNIVERSITY BROCHURE

A brochure from University Loudspeakers describes their Progressive Speaker Expansion plan that satisfactorily expands a basic system by steps at minimum expense. Descriptions, illustrations, and prices of speakers, networks, and enclosures, as well as kits, are included.

Gentlemen:
As a radio and hi-fi enthusiast, I have been experimenting a little with sound. I have found that when recording from a radio with a tape recorder you can place your mike in a No. 1 or No. 2 wash tub and place the open side toward your speaker. It will give you better tonal quality and the vibrations from the tin will give you a hi-fi sound.

James B. Shrader
Helena, Ark.

No comment. — ED.

Gentlemen:
One of the several reasons I subscribed to AUDIOCRAFT was to obtain the plans for building an FM radio to be placed in a car.

To date I have not noticed this article in any of my monthly magazines.

Bruce E. Rogers
Aurora, Ill.

It is probable that no one has ever published an article on building an FM radio for automobile use. This would be a project requiring extreme design skill and precise parts layout — quite out of the range of home-type construction articles.

On the other hand, it is sometimes possible to alter a home-type FM radio for automobile use. We have published articles on this subject in the November 1955 and March 1957 issues. Both of these are available as back copies at 35¢ each; use the Readers' Service card bound in at the back of each magazine when ordering. — ED.

Gentlemen:
We are now prepared to receive contributions and favorable comment for our campaign to require by law that all music for recording and broadcasting be composed in, or transposed into, the key of D. Despite certain hasty minority opposition (traced to malcontents in the Electronics Maintenance Brotherhood and to the self-styled Anti-Friends of Monotony), an overwhelming opinion in favor of our cause is developing as the average listener hears compositions in the key of D played on the average player-receiver and finds such music in harmony with the 60-cycle hum. Our

liaison committee, designated Artists, Ltd., is getting the ball rolling with the offer of a $27.95 automatic 3-speed, 6-speaker, multichannel, hi-fi recorder-player (AM-PM-FM) for a theme song to be entitled *Magnificent Compromise* or *The Filter is Schottische.*

John Steiner
Infidelity Associates
Chicago, Ill.

You're doing it the hard way, John. Why not add variable speed controls to all turntables, so that listeners will be able to transcribe everything into D themselves? — ED.

Gentlemen:
Comparisons between locked-in frequency divider systems vs. independent tone generators for electronic organs appear quite regularly in the literature devoted to electronics, acoustics, etc. Recently the critics have fought out another round, this time in AUDIOCRAFT. It would appear that some clarification or simplification of thought is in order.

It is true that octavely related tones sound rather monotonous or mechanical when produced by a frequency divider chain, although the difference between a pedal tone and one ordinarily emanating from the swell manual is readily distinguishable. But many persons apparently lose sight of the fact that not all music is written in octaves. In addition to thirds, fourths, fifths, sixths, etc., etc., there are chords, all of which are pleasing in the right place at the right time. And surely no one will assert that the respective frequencies comprising these combinations are "locked" together. For example: there is just as much probability of random variation in the notes C, E, and G, comprising the basic C major chord, when produced by the respective oscillator chains of a frequency dividing system, as there is if the same tones are generated by wholly independent oscillators.

There are tens of thousands of people in this country (and elsewhere) who know not the difference between an octave and a Greek politician but who enjoy organ music whether originating from a full-blown Aeolian-Skinner or a

Continued on page 44

— EDITORIAL —

Kits and Components -- Competitors?

AS recently as three years ago you could count on the fingers of one hand all the suppliers of high-fidelity equipment in do-it-yourself kit form — and you'd have at least one digit left with which to point (with tolerant amusement) at the "hi-fi bugs" who bought it.

Suddenly, kits began to catch on. New companies, formed solely for the production of high-fidelity kits, entered the field in competition with the established kit vendors. Their success encouraged equipment manufacturers already in the business to make their ready-made products available as kits too, and soon it required fingers and toes as well to count everybody getting into the act. Now a wide choice of kits for amplifiers, preamplifiers, tuners, speaker driver systems, enclosures, complete speaker systems, equipment cabinets, and audio test instruments is available; there are even pickup-arm kits! About the only items missing are turntable and tape-recorder kits, and they will probably join the list. Moreover, the rush is still continuing: every week, it seems, another firm announces that it is getting into the kit business. And what are the reasons for this sudden boom in kits?

The *interest* in high-fidelity kits is, obviously, traceable primarily to two coexistent national trends. First, more and more people were becoming aware of hi-fi sound during recent years, and this interest is still spreading rapidly. Second, more leisure time and the constantly increasing cost of labor and services have, since well before 1950, predisposed consumers toward doing-it-themselves in all possible fields. Since good audio equipment is expensive, the saving possible in buying kits is irresistible to a great many with moderate incomes. Allied with this factor is the real sense of satisfaction gained from manual creativity; to some, this is the most important matter.

The *success* of hi-fi kit merchandising can be attributed not only to heavy consumer demand but, even more important, to the amazingly high average quality of the kits. Generally, the components supplied are complete and in excellent condition; the instructions for assembly are almost invariably accurate, clear, detailed, and well illustrated. There are a few exceptions, of course, but the novice constructor can avoid them if he buys from kit suppliers and manufacturers of good reputation. Our combined staff has built a great many kits, some quite complex, and those that didn't work perfectly upon completion have been few indeed. As a final protection to their customers, most kit manufacturers will put in working order (at moderate cost) the rare kit that the builder has trouble with.

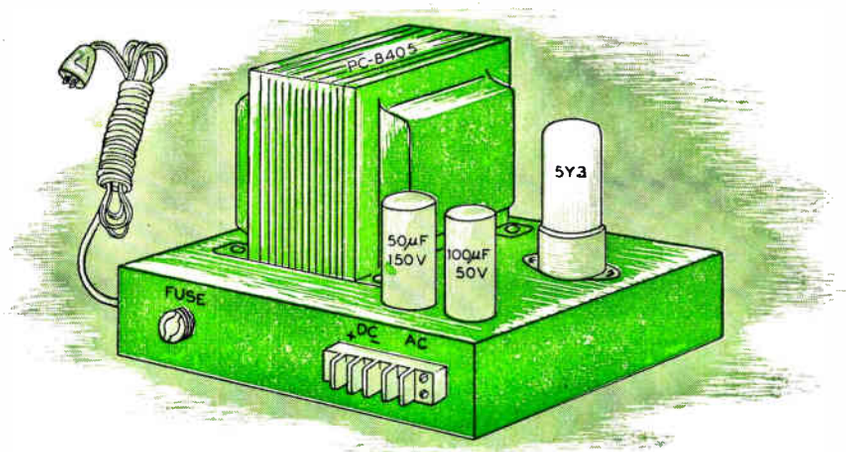
Is the kit boom altogether desirable? To our way of thinking, it is doing a lot of good and can hurt no one. The advantages to buyers are obvious enough not to require mention. Suppliers who sell equipment in kit form only can hardly be less than pleased by the present trend. And the sales picture is expanded considerably for makers of equipment that cannot be sold as kits, such as pickup cartridges and loudspeakers. After all, a kit-built amplifier and enclosure have little practical value until they are fed by a pickup and attached to a speaker.

The outlook is favorable even for the established equipment manufacturers with whom the kit suppliers are competing. They have carefully built up good reputations over the years for the quality of their products. By making those products available as kits too, they are in a fine position to capture a good share of the kit market, and make sales that might not otherwise be possible for their finished units. Further, kit builders are regarded by brand-new hi-fi prospects as neighborhood experts, and their advice is often requested on prospective purchases. If a man has had good luck with the Brand X amplifier kit, he won't hesitate to recommend the finished version of the Brand X amplifier to a friend who wants a high-fidelity system but doesn't want to bother with kit assembly. Finally, some of the finest or most elaborate equipment requires assembly techniques that cannot be duplicated by kit builders. There are many hi-fi hobbyists who, having started with kits, also buy top-quality factory-assembled equipment.

That's why we believe that the more kits there are, the better. — R.A.

a home-built DC Filament Supply

by Norman H. Crowhurst



One of the main sources of hum in a preamplifier is the filament circuit — particularly of the first tube, following which the gain is very high. A number of things can be done to tackle this problem. There are low-hum variations of the 12AX7 and similar tubes, that minimize filament hum radiation. Alternatively, one can carefully select regular tubes to get the hum down. Neither of these methods is altogether successful as an approach.

The so-called low-hum tubes sometimes don't produce any better results than the tubes they are made to replace, although they cost considerably more. While tube selection may be easy for the manufacturer, it is not easy for the man who has to go out and buy each tube and doesn't have the opportunity to try it out and see how much it hums before he pays for it.

Much of this trouble can be obviated by the use of a DC filament supply which makes the amplifier uncritical of the tubes (for hum, at any rate). If the tube suffers from other forms of noisiness or microphony this is another question. But, with the hum problem disposed of, at least one can concentrate on getting the best tube for the other purposes.

When a manufacturer incorporates DC operation of filaments into his preamplifier, he usually provides a special winding on the power transformer, uses a selenium or copper-oxide rectifier which gives just the right voltage for the purpose, and has a supply worked out (often with resistance-capacitance filtering), so that a satisfactory low-ripple content appears on the filament supply. Unfortunately, when you look around for materials needed to try building a similar supply at home, the particular type of rectifier needed is not a stock line — it has to be made to the manufacturer's requirements — and a power transformer with exactly the right secondary voltage to feed the rectifier doesn't seem to exist either.

If 12-volt tubes are used, such as the 12AX7, 12AT7, 12AU7, or 12AY7, and we connect them so that the filaments are in series, we need a 150-ma supply, whose voltage depends on how many tubes there are. We can, if we wish, run all the filaments in the preamplifier in series; then 36 volts DC will be needed, for example, if there are three double triodes. This seems to be the easiest kind of supply to rig up when we don't have the special components that are otherwise needed.

One good transformer for the purpose is the Stancor PC-8405, which has a secondary of 540 volts (center-tapped) at 120 ma. This 120 ma is based on use of the conventional-type high-volt-

Banish hum

caused by heater-cathode

leakage and use unselected tubes in your preamp

age supply, which uses a capacitor-input filter. If we use what is equivalent to a choke-input filter, the transformer will deliver 150 ma without overheating the winding, which is the important thing as far as safety of operation is concerned.

Working with a virtual choke input, a 5Y3 rectifier will pass 150 ma satisfactorily with such an AC input (270-0-270 v). By putting a large resistance between the rectifier and the first capacitor, we obtain virtually a constant-current arrangement and a circuit that behaves similarly to a choke-input power supply. This large resistance will have to break down the output voltage to well under 100 v at the first stage of filtering. The right voltage for the filaments is provided at the second stage of filtering.

Twist-lock-type capacitors of 100 μfd, 50 v for the second stage and 50 μfd, 150 v for the first stage provide good mechanical anchorage for the rest of the wiring. To figure out the wire-wound resistors: for the second filter stage, a 250-ohm, 10-watt resistor passing 150 ma will raise the voltage to 37.5 v more than the total required across the tubes. The circuit so far is shown in Fig. 1.

The first capacitor will charge up to a DC voltage 37.5 v higher than the required filament voltage. Assuming three 12-volt tubes are operated this way, the voltage will be 36 on the second capacitor and 73.5 v on the first. An RMS voltage of 270, given by the transformer, is equivalent to a peak voltage of $1.414 \times 270 = 382$ volts. So the peak voltage across the first resistor is $382 - 73.5 = 308.5$ v. This will correspond with an average or mean voltage of $0.637 \times 308.5 = 196.5$ v. So the resistance should be $196.5/150 \times 1{,}000 = 1{,}310$ ohms, with a dissipation of $196.5 \times 0.15 = 29.5$ w.

If only one 12-volt tube is fed, the DC voltage on the first capacitor will be $12 + 37.5 = 49.5$ v. In this case the peak voltage across the first resistor will be $382 - 49.5 = 332.5$ v, which is equivalent to an average of $0.637 \times 332.5 = 212$ v. Then a resistor of $212/0.15 = 1{,}410$ ohms, at $212 \times 0.15 = 31.8$ w, is required.

In each case, something less than 50 ohms of the total circuit resistance will be accounted for by the rectifier's internal impedance, and must be taken into account.

A suitable adjustable arrangement can be built up from two 2,400-ohm, 20-watt resistors in parallel, with a 250-ohm, 10-watt adjustable resistor in series, making the complete circuit as shown in Fig. 2. This provides adjustment so that the voltage can be trimmed correctly for one, two, or three 12-volt tubes in series. It should be noted that the adjustment is basically one for current, because the controlling component is series resistance; the current is adjusted to 150 ma so that each of the tubes gets the right voltage.

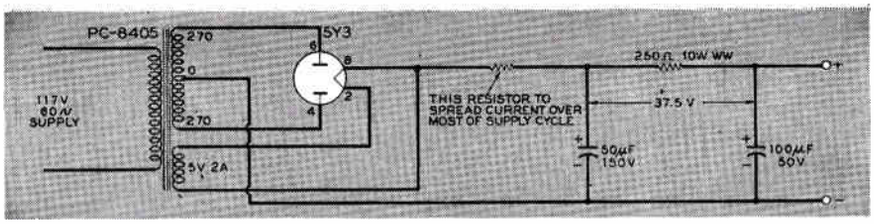


Fig. 1. Basic arrangement to simulate a choke-input power supply for DC heaters.

For this reason, the best method of making the adjustment is to apply a voltmeter across the one, two, or three tubes and adjust the potentiometer until the voltage reads 12, 24, or 36 v, as the case may be.

Page 16 shows suitable layout for this unit including a fuse and four-way terminal strip for the DC output and also a termination for the spare 6.3-volt winding on the same transformer. A switch has not been included because, normally, the circuit will be wired in with the rest of the equipment in such a way that the main equipment switch will turn the unit on when needed.

It is good practice to put the wire-wound resistors in such a position that they are fairly close to the chassis — about ¼ in. away. Then there will be no risk of them short-circuiting to the chassis, but their proximity will help the chassis to pick up the heat they radiate and keep the whole system well cooled.

An important point to observe in setting up this equipment is that the filament-supply unit should never be switched on without the filaments connected. The electrolytic capacitors are of a voltage rating that assumes filaments are connected. Absence of the filaments will cause the voltage to rise and an excessive leakage current to be driven through the capacitors. If you wish to check the circuit without connecting the filaments and do not have a suitable resistance, say 240 ohms, to simulate the three filaments in series to connect to it, then the best thing to do is to short-circuit the DC terminals.

It is possible to arrange the circuit with a bleeder resistance to safeguard the electrolytic capacitors. This involves reworking the circuit, however, to supply the larger current involved. Actually, the risk is smaller than may be thought, for two reasons: 1) using a series-feed arrangement like this heats the tubes more slowly than does a constant-voltage supply, so the heaters invariably outlast the tubes; 2) the series feed resistor between the 5Y3 and the first capacitor limits the leakage current, so the capacitor will not be destroyed immediately in the event of an open circuit in the filament change. But if the leakage current is allowed to remain it will overheat the electrolytics and cause permanent damage.

If you want to play it really safe, you can rework the circuit, basing the arrangement on a 200-ma current requirement. This will require a larger power-rating (as well as different value) resistors in the series feed; a bleed resistor is then connected across the output of the supply, whose value and wattage is figured to absorb the additional 50 ma.

Parts List

1 Aluminum chassis, 2 × 7 × 5 in.
1 Power transformer, PC-8405 Stancor or equiv.
1 Panel fuse mount, 342001 Littelfuse or equiv.
1 3AG fuse, 1 amp.
1 Octal tube socket.
1 5Y3 tube.
1 Adjustable wire-wound resistor, 250 ohms, 10 w.
1 Wire-wound resistor, 250 ohms, 10 w.
2 Wire-wound resistors, 2,400 ohms, 20 w.
1 Electrolytic capacitor, 50 μfd, 150 v, twist-prong.
1 Electrolytic capacitor, 100 μfd, 50 v, twist-prong.
1 Four-way barrier terminal strip, 4-141 Cinch-Jones.
1 Line cord.
1 ¼-inch grommet.
Small quantity of hookup wire, and solder.

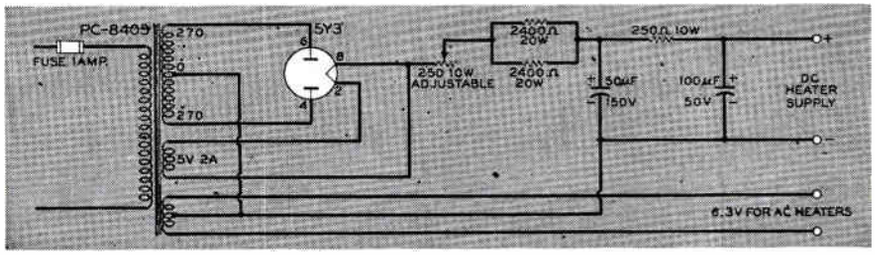


Fig. 2. This circuit permits current adjustment to supply one, two, or more tubes.

Stereo Discs

by Joel Ehrlich

SINCE the introduction of the Westrex stereo disc during the 1957 AES Convention, there have been many interesting developments on the same theme. Most important of these was the release of information concerning a number of other experimental systems that had, before that time, been kept pretty much under wraps.

Two of these were monogroove multiplex systems, while others involved a reversed data/signal method* (which results in a 45/45-cut record) or phase-connected V/L cutters which also produce a 45/45 groove. Of all the mechanical separation methods of cutting a disc with two channels, the 45/45 system seems to have borne out the inventors' contention that it was the most practical. All the newer mechanical systems utilize this 45° groove angle, and no matter which way it is obtained, it will be compatible on playback with 45/45 discs cut by other means. Further, all will be compatible with conventional discs by virtue of the mixed lateral information on the disc. Since all parts of the signal that produce lateral motion of the cutter are in phase, the resultant approximates the normal, single-channel monophonic recording. In this way, a 45/45 stereo disc can be played with a conventional cartridge having high vertical compliance and no vertical output. Needless to say, not all cartridges meet this requirement, but most high-quality conventional cartridges do.

Systems

Of the multiplex systems, probably the most interesting is the one developed by Jerry Minter, past president of the AES and now president of Components Corporation. This "MSD" system is a compatible one, and is quite unusual in a number of aspects. The two normal stereo channels (let us call them A and B) are mixed. All in-phase signals are combined to form a new channel (let us call this A′) while the out-of-phase components are used to form the other new channel (let us call this B′). Since the resultant channel A′ (as in the case of the 45/45 disc) approximates the signal of a normal single monophonic channel, it is cut on the disc in a normal manner. Channel B′ is first, however, used to frequency-modulate an oscillator operating at a mean frequency of 12.5 Kc. The new channel (let us now call it channel B″) is then mixed with channel A′ and the combination (channel A′ plus channel B″) is applied to the driving coil of a record cutting head.

The MSD cutting turntable and the tape recorder (from which the original channels A and B are obtained) are run at exactly half speed. Thus, the 12.5-Kc oscillator signal is actually a 25-Kc carrier in playback of the disc. With a conventional playback system, while a good cartridge will trace the normal (channel A′) signal and the carrier with modulation (channel B″), the system itself will produce only the normal (A′) signal — or, in any event, we will hear only the normal (A′) signal. For stereo playback, a decoder with an FM discriminator is connected to the output of the cartridge. In the decoding process the carrier is removed from channel B″, thus making it channel B′ again. Then the two channels (A′ and B′) are mixed both in and out of phase with each other, and the two original channels (A and B) are recovered. This is a fully compatible stereo system.

Unfortunately, the decoder is a six-tube affair and is an addition to the equipment currently forming part of a home music system. Taking another view, however, with a 45/45 system the new cartridge is an addition to the system now in use.

Another important system has been proposed by George Neumann of Berlin, Germany. Dr. Neumann is, among other things, the inventor of the famed Telefunken U-47M microphone, and has developed his own cutter and cutting turntable. Working with Teldec (a combination of Telefunken and European Decca), Dr. Neumann is responsible for the so-called London-Decca V/L system. Since the V/L system is evidently a lost cause, he has joined the 45/45 battle and has come up with some very interesting ideas. If the data/signal system described in my earlier article is reversed — that is, if the data is cut on the lateral channel and the signal on the vertical channel (by using a V/L cutter) — the resultant groove is identical with a 45/45 groove and, on playback, is virtually indistinguishable from it. Many advantages are claimed for this system; most notable (although I haven't yet had a chance to test it) is the claim for reduced intermodulation between channels. If true, this is a great step forward over the 45/45 system. The cutter designed by Westrex is, in reality, merely two of their standard vertical cutters joined at 45° from the vertical.

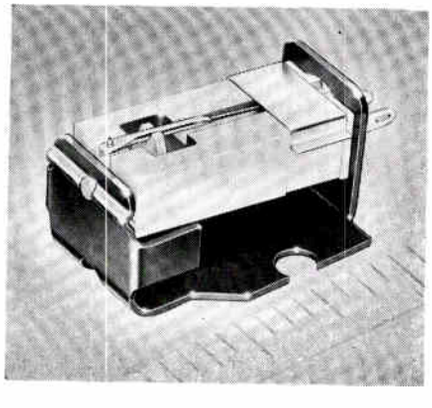
● ● ● ● ● ● ●

Dr. Neumann has also designed a 45/45 cutter head on which two identical coils are placed at 45° from each other.

Cartridges

On the reproducer side of the story, there have been a number of developments too. First to take a concrete step was Fairchild. Fairchild had a V/L reproducer ready at the time of the New York audio show. A short time afterward, the Fairchild 603 45/45 reproducer was ready. The 603 is an experimental unit, although in limited production; because it is not intended for consumer use, it carries a price tag of $250. R. G. Bach, Sales Manager of

The Electro-Voice stereo cartridge.



*Joel Ehrlich, "All About Stereo Discs", AUDIOCRAFT, III (Feb. 1958), p. 19.

Fairchild, says that he expects to have the new XP-4 stereo cartridge on the market by the end of March at the latest. This cartridge will still be rather high in price: about $75.

Far ahead as far as actual production is concerned is Electro-Voice, with a dual-ceramic cartridge now priced at $19.50 including a ½-mil diamond stylus. A major manufacturer has already ordered a large number of these cartridges for its 1958 stereo phonographs. Pickering has demonstrated its design for a 45/45 cartridge, named after the inventor (Walter Stanton) the "Stanton 45/45" cartridge. This cartridge, however, will not be in production until the RIAA and the EIA issue a standard for stereo discs (which may happen by the time this is published). Fen-Tone has also announced its B&O stereo cartridge. Of those so far announced, the Fen-Tone is the first *magnetic* cartridge to carry a low price — less than $35 including a diamond stylus. While neither the Fen-Tone nor the ESL has been demonstrated as this article is written (February), there have been a number of comments from the offices of these two firms. The ESL cartridge is ready in prototype, though not yet in production. Mr. McConnell of ESL notes that there is a disadvantage in using a stereo cartridge for conventional records because of the much reduced compliance and increased mass necessitated by the dual-unit type of construction. Mr. Madsen of B&O thinks that this can be overcome to a degree, in design, but that some rather unusual materials are needed for construction. In the B&O design, the stylus assembly is of extremely low mass but is of relatively increased fragility.

In all cases, the cartridges are of unusual appearance, necessitated by the larger innards. The Fairchild 603 will not fit into a conventional arm and must be used with a modified turret-head arm. The XP-4 cartridge, however, fits normal arms. The Electro-Voice cartridge is quite a bit larger than any E-V has made of late, although it will fit into a conventional arm with ½-inch mounting centers. The Fen-Tone will mount in a conventional arm, but it does project farther than a normal cartridge. All the cartridges in question are heavier than their conventional counterparts.

Records

Toward the end of January, the EIA (Electronic Industries Association) met in New York. A stereo-disc standard was not resolved, but a stylus-size standard was adopted: ½ to ¾ mil. All systems save the Westrex 45/45 system were, however, pretty much dismissed. By the time this article appears, it is a safe bet that there will be a standard and that there will be periodic releases of stereo discs. It is also pretty safe to assume it will be the Westrex system that is adopted.

In early January, Audio Fidelity Records released a test record (made by Westrex and pressed by B&C Recordings). Their plan is to have no fewer than four records on the market, for the public, by the end of February. There can be no doubt that the other manufacturers of records are equally busy. In a recent statement, RCA Victor announced that it is planning to release dual lines of records, conventional and stereo, with the stereo records priced one dollar higher than the monophonic line. In a talk I had with Sidney Frey of Audio Fidelity the other day, he noted that, while he too plans to release dual lines, he will do this only as long as he must. His StereoDiscs will be one dollar higher than his monophonic records, but only because he will put them in especially fancy packages. It seems to be the opinion of a great many people, both in and out of the record-making industry, that this dual-line idea would be very bad for stereo discs. As we see things now, we have a compatible disc — one which can be used to replace the monophonic disc as well as for stereo. If advantage is not taken of this, there will be fewer stereo discs made; therefore the price per disc must be higher and this can only be passed on to the consumer. This will, in turn, reduce still further the number of stereo discs available.

As with all new ideas, stereo on records will be accepted slowly. We can expect to see a gradual increase of stereo reproduction in the home, from records, with time. Still, this cannot happen if the stereo record is priced too highly. The record must be priced so that it can be bought. If this is done, not only will the record be sold in quantity (for it would then be practical to eliminate the monophonic record in favor of the compatible disc), but it would stimulate interest in stereo. And good stereo sound has something that even the best monophonic sound can't duplicate.

Predictions

Watch for more stereocasting as a result of the availability of stereo discs. It is a sad truth that the stations that broadcast good-quality FM, and which simulcast in stereo on their AM and FM transmitters, are usually too small to have very much live music. They make up for this with tapes. But, since their budgets preclude the purchase of many tapes and tape recorders, stereo records (and a changed public attitude toward stereo) will make it practical and necessary for them to press for FM multiplex standards, so that they can broadcast stereo on a single transmitter. Provided we are lucky enough to get some government action on standards, we may well have stereo on FM within the next two or three years.

In all probability, the major record companies will issue stereo discs immediately after the Audio Fidelity release. It takes only one break to loose the flood. If anyone is to make a mistake, it seems to be the opinion of the major firms, it should be the small experimenter. Look for stereo discs at your local record shop in a matter of weeks.

Fairchild is prepared to use their full production facilities for making XP-4's, should the demand occur. If this happens, the price may go down even more.

Compatibility?

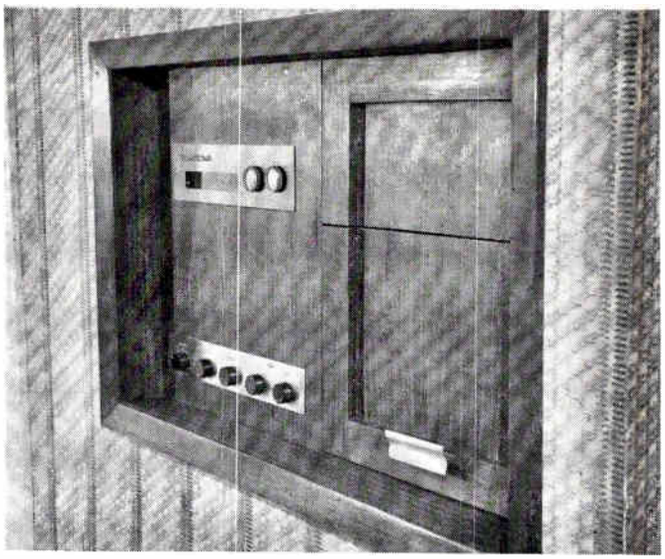
Playback cartridges?

up-to-date

New systems?

How soon?

BUILD it into a MUSIC WALL



1 Determine the space that your components will need, measure the wall selected for installation, and carefully saw away the wallboard along predrown lines.

Is space limited around your house? Then try this approach to built-in high fidelity. It needs no floor space at all.

by Scott J. Saunders

WRITING this article about building a music wall is proving not to be difficult at all — there are six fine background-music records on the changer. When the records are finished, the tuner will be turned on for the remainder of the evening.

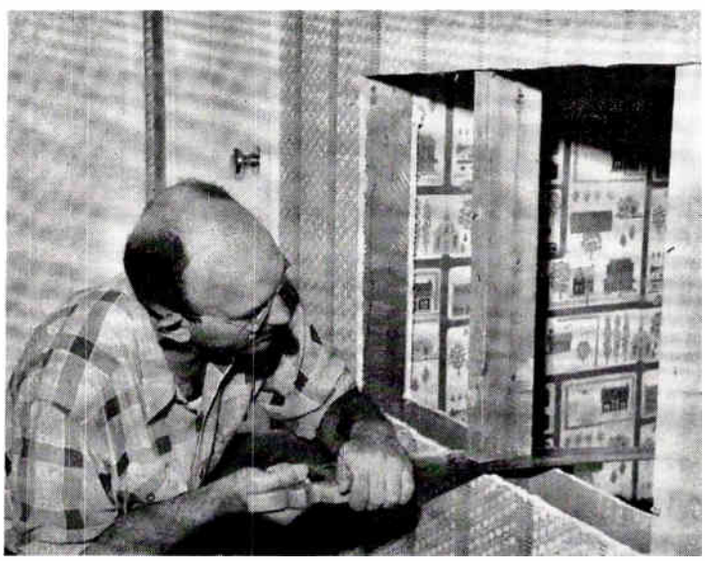
The amplifier and tuner were built from kits, and the changer was bought complete with mounting base. Everything fits neatly into the wall of an entrance hall where it is out of the way and easily accessible; this mounting dispenses with the need for an additional piece of furniture in the room.

Building this "built-in" requires no special tools nor any special skills — only patience and a desire to wind up with a professional-looking job. If you can handle a saw, a plane, and a drill, and can measure accurately between two points, this project should be a breeze.

All exterior wood for the job is furniture-grade walnut plywood, ¼ in. thick, plus one section of 1-inch solid walnut. You can choose any type of veneered plywood to match existing furniture, but the materials are not cheap. To prevent an excess from

Text continued on page 22

2 Cut away exposed two-by-fours flush with the top edges of the wallboard. Use a file to smooth the edges of the opening and square corners, to insure porallel edges on all four sides of the opening.

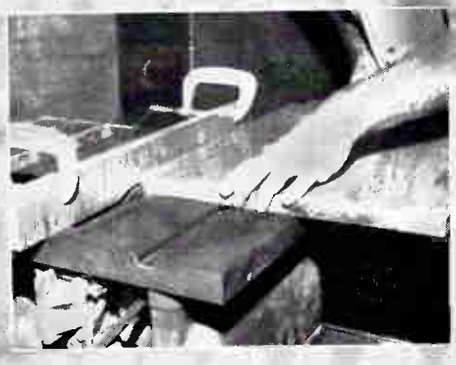


WALL

10 After solid center divider has been installed, nail ½-inch-square pine strips to top, bottom, and sides of enclosure. They form support for mounting panel which will be nailed and glued in place later.

9 Side panels are cut to fit flush with outside edge of opening, and attached to furring strips with glue and ½-inch brads.

8 A rabbet may be cut in the front edge of the solid hardwood divider to accept smaller plywood, to help conceal junction.



7 Exposed surfaces may be any desired wood material. Plywood ¼ in. thick of type desired may be cut to fit, and glued to top surface of over-all platform.

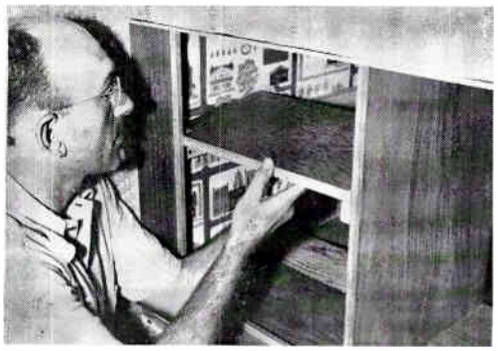
6 To provide an adjacent power source, a line can be drawn from nearby receptacle, and wired into junction box as shown here.

4 Add furring strips (or vertical two-by-fours) to make a "cage" whose edges are flush with the sides of the opening cut in wallboard.

3 Frame the supporting platform with two-by-fours nailed into wall studs. The top surfaces of cross members must fit flush with bottom edge of opening.

5 The over-all platform is a piece of ¾-inch plywood cut to set flush with the outside wall, and deep enough to support largest components.

11 A supporting platform for amplifier or tuner rests on furring strips nailed to sides of enclosure. Edges of platform are cut flush with sides and front.



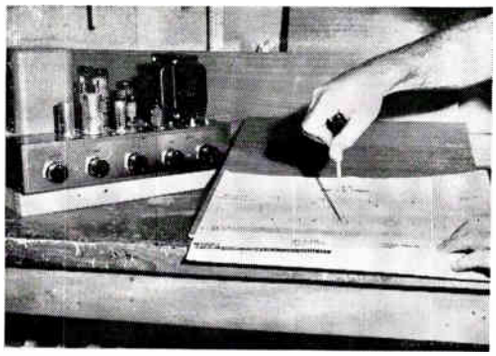
12 Components are placed in position to determine exact locations of knobs, plates, and tuning dials. Be sure to provide adequate clearance for ventilation.

winding up as scrap, follow that cabinet-maker's adage — measure twice and cut once.

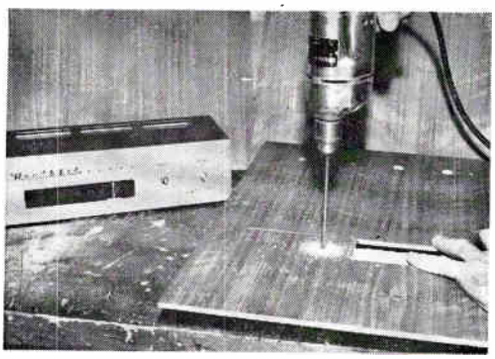
The basic idea in this project was to build a complete unit as economically as possible, yet wind up with a high-fidelity system housed in a fine wall cabinet. We chose a Heathkit FM-3A FM tuner, an EICO HF52 control amplifier, and a Garrard RC-98 changer.

Music-wall dimensions given here should be used only as guides for your own project. You can make yours larger or smaller, depending on what components you plan to install. The important thing is that, before you cut into a wall, you thoroughly investigate it first for plumbing and power lines — and the wall's possible function as a supporting member of the house. For example, if the wall you plan to use is a main structural support, don't touch it. Preferably try to use available interior space, such as a closet or a stair well. Our music wall was positioned above the headroom of a cellar stair well, and there were no complications. If in doubt about the location you've picked, call in a professional for advice.

Now, to construction.

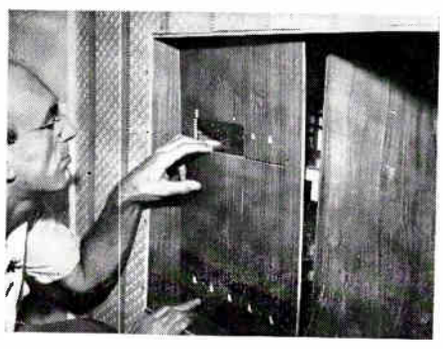


13 When component positions have been determined, place template in proper position on front panel, and mark drilling guides for all holes with a sharp instrument.



14 Drill out mounting holes with drill slightly larger than control shaft, but smaller than knobs which will be used. A mounting plate will hide holes.

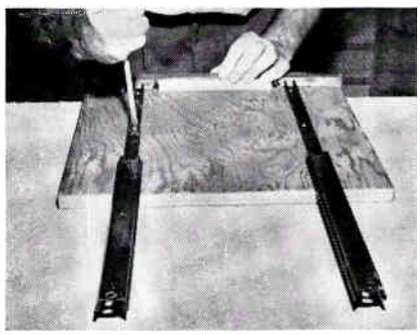
15 Mounting panel should fit snugly on all sides. Note rectangular hole for face plate of tuner. Panel is installed, and components inserted from rear.



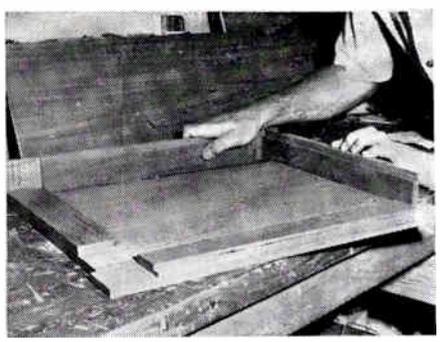
20 A final step is to frame the music wall with molding. Choose a type to blend well with other furnishings, miter the corners and nail the strips flush to the exterior plywood facing. Finish all exterior surfaces as desired.

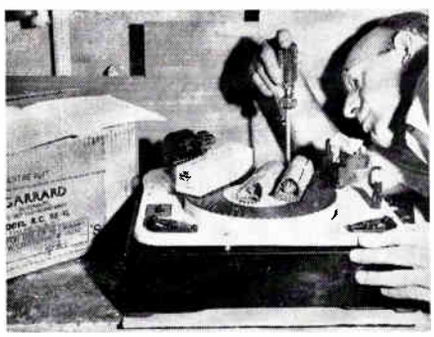
21 And here is the completed music wall, with components in position and ready to play.

Changer base sits on ¾-inch plywood platform on runners which must be perfectly parallel to avoid binding. **19**



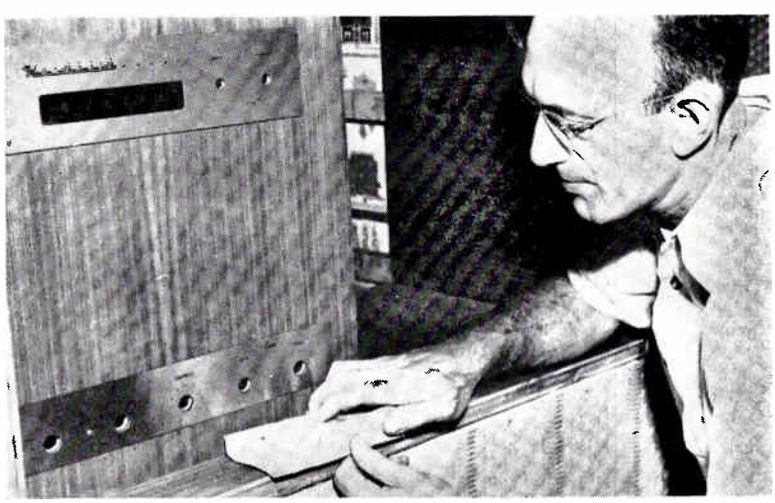
The framed panel for the changer is made from four pieces of solid hardwood. The pieces are half-lapped and glued together. A rabbet is cut along inside edges to take the covering panel. After the four pieces are joined, a section of plywood is cut to fit the inside dimensions and then glued in place. **18**





17 Changer is assembled on its own base with bolts and springs prior to being placed on sliding drawer.

After gluing the front panel in place, add face plates and then sand all exposed surfaces with No. 00 sandpaper. Sand lightly to avoid removing veneer. **16**



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MCINTOSH C-8 AUDIO COMPENSATOR

The adjective which best describes the McIntosh C-8 preamplifier is "flexible." It is hard to think of a feature which has been omitted from this very moderately priced unit.

Each of the five inputs has its individual level control. One of the two phono inputs has a variable load resistance to match any type of magnetic cartridge. In its extreme counterclockwise position this control provides correct termination for constant-amplitude cartridges such as ceramics or the Weathers pickup.

Both the main output and the TAPE output (for feeding the signal to a tape recorder) are from low-impedance cathode-follower circuits. They are insensitive to the effects of cable capacitance and there is no interaction between the two outputs. Three switched AC outlets are provided. In addition to standard phono jacks for the various inputs and outputs, a power and signal cable is supplied for plugging into the appropriate socket on a McIntosh MC-30 or MC-60 power amplifier. When this is connected, and the power cord of the power amplifier is plugged into one of the auxiliary AC outlets, the power switch of the C-8 controls the entire system.

The phono-equalization system of the C-8 is unique. Five slide switches are furnished for low-frequency turnover and five for high-frequency rolloff. The low-frequency turnover switches are marked 950, 750, 580, 400, and 280. This marking can be confusing to someone unfamiliar with the C-8, since it would be natural to assume that operating one of these switches would give a low-frequency turnover at the indicated frequency. This is not the case. The indicated turnover frequency is obtained when all the switches to the left of the indicated switch, and including it, are in the down position. By depressing various combinations of these switches, the turnover frequency can be varied in 10-cps increments from 280 cps to 620 cps, and in 20- or 50-cps increments to 950 cps. With all switches up, the turnover is at 1,200 cps.

McIntosh C-8 Audio Compensator.

A similar arrangement is used for high-frequency rolloff. The switches are labeled 5, 10, 20, and 25, referring to the attenuation in db at 10 Kc, when all switches to the left of the indicated switch, and including it, are in the down position. When all the high-frequency switches are up, there is no high-frequency rolloff.

The unequalized output of a tape playback head may be connected to one of the PHONO inputs. The instruction booklet lists the correct settings of the equalizer switches and tone controls for the standard NARTB playback-equalization characteristic.

Several sheets of adhesive labels are supplied with the preamplifier. They bear a sketch of the equalizer-switch layout, and are intended to be attached to record labels or jackets. After the correct equalization settings have been determined for a record, and the label has been properly filled in and attached to the record or jacket, it is a simple matter for anyone to properly adjust the equalization for that record.

A loudness control, called an AURAL COMPENSATOR, is provided. It is a five-position switch. Position 1 is OFF, and the others depress the middle-range response by successively greater amounts. This control must be used in conjunction with the uncompensated VOLUME control.

A second five-position switch controls the action of the RUMBLE FILTER (effective only on microphone and phono channels). Position 1 is OFF. Positions 2 and 3 provide a rather gradual rolloff of the low-frequency response below 100 cps. Positions 4 and 5 give a sharp null in the vicinity of 30 cps, which is the predominant rumble frequency of 4-pole turntable motors.

BASS and TREBLE tone controls complete the picture. The shape of the characteristics of these controls is not entirely coventional, however. Partial use of the BASS control provides significant amounts of boost or cut in the low bass region without a noticeable effect on the frquencies above 100 cps. Partial use of the high-frequency boost causes a gentle rise of all frequencies

Hum and Noise

Ref: 0 db = 1 v output

Input	*Tape*	*Tuner*	*Mic*	*Phono 1*	*Phono 2*
Sensitivity	0.25 v	0.22 v	2.4 mv	2.15 mv	2.15 mv
Crosstalk	–72 db	—	–62 db	Below Hum	
Hum and Noise					
Input open	–71 db	–71 db	–61 db	–50 db	–51 db
Input shorted	–72 db	–72 db	–64 db	–51 db	–51 db
Level-set control at minimum	–72 db	–72 db	–65 db	–51 db	–51 db
Volume control at minimum	–89 db	–89 db	–89 db	–89 db	–89 db

above a few hundred cps, having the shape of a plateau rather than an upward slope.

Test Results

The story of the frequency response, tone-control action, and loudness compensation is best told by the accompanying curves. The loudness compensation is different from the type usually encountered, since it provides a large amount of high-frequency boost. Most of such circuits provide little or no high-frequency boost. Used in moderation, we found it pleasant, but position 5 was too extreme for our taste.

The first three rumble-filter positions are too gradual in their action to be really effective against rumble, and cause too much loss of bass response. The last two positions are quite extreme though effective. We would not expect to use them with any but the poorest record changers, which are out of their class when used with a preamplifier of this caliber.

The RIAA phono equalization, using the recommended switch settings, was very smooth and accurate from 30 to 15,000 cps (within 1½ db). Possibly the ends could have been trimmed up a bit with the tone controls or other switch settings, but it could not have made an audible difference. The NARTB tape equalization was not so good. Here it might pay the user to experiment a little with control settings to try to improve the equalization.

The rated output of the preamplifier is 2.5 v, which is more than sufficient to drive any power amplifier to full output. The IM distortion of the preamplifier, measured through the TUNER input, was extremely low (0.36% at 3 v output and only 1.9% at 15 v output). Phono distortion was roughly the same at maximum gain setting, but rose appreciably when the VOLUME control was set for a phono gain of 40 db. This is a reasonably typical situation, in which a 10-mv signal gives 1 v output. The rise in distortion is due to overload of the phono preamplifier stage. This begins to become significant at about 30 mv of signal. When using any but the lowest-output cartridges, it is advisable to reduce the phono level control to prevent overload of the phono amplifier stage on signal peaks. This procedure is recommended in the instruction booklet.

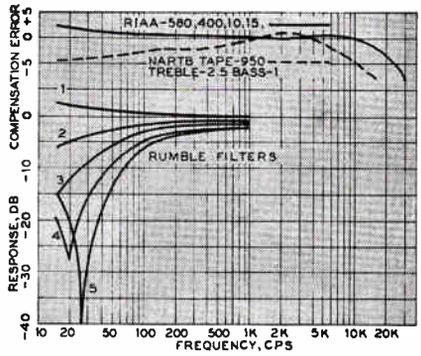
Hum levels are very low on TAPE, TUNER, and MIC inputs. They are appreciably higher on PHONO, due presumably to the low frequency boost in the equalization. However, phono hum should be disturbing only at maximum volume setting. At volume settings such as would normally be used, hum is completely inaudible. Crosstalk of signals from the TUNER input to the other inputs is low.

Summary

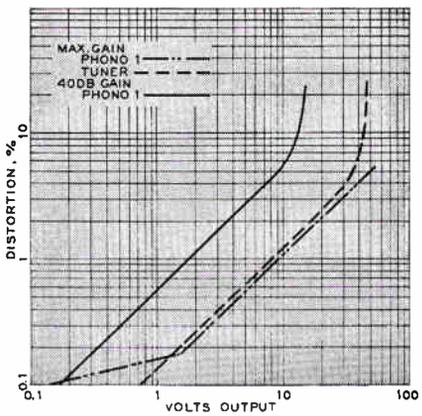
The McIntosh C-8 is a well-designed, unusually flexible preamplifier. It meets all its published specifications with the exception of hum — and even here it came very close to meeting them and has inaudible hum under ordinary operating conditions.

Our chief criticism of the C-8 is directed against the excessively flexible record-equalization system. There is no need for such a fine control over playback equalization, from either a practical or theoretical standpoint. A price is paid for it in the form of confusing control positions which would make it impossible for someone unfamiliar with the C-8 to use it effectively.

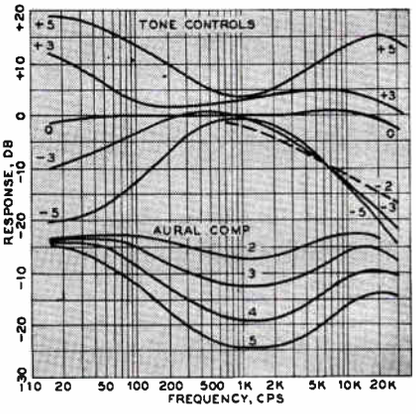
At its price, it is unquestionably a top value.



Equalization (shown as deviations from correct) and curves for rumble filter.



Intermodulation distortion.



Tone- and loudness-control contours.

EICO HF52 CONTROL AMPLIFIER

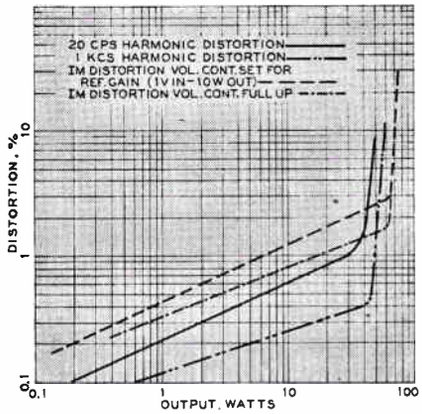
The HF52 is the most powerful integrated amplifier in the rather extensive EICO line, and one of the most powerful of any make that we have seen. Fortunately no attempt was made to squeeze this formidable package into a compact, "flat" configuration. It is a large unit of conventional chassis construction, weighing 30 lbs. and occupying an 8½-by-15-by-10-inch volume.

It is available in kit form or assembled and tested, at very reasonable prices. The unit we tested was assembled, but from previous experience with EICO kits we are familiar with their complete and detailed assembly instructions. The instruction book, as one would expect from a kit-type equipment, is very complete. Not only are the usual installation and operation instructions and performance specifications provided, but complete adjustment and trouble-shooting procedure as well.

Circuit-wise, we found a few desirable and occasionally unusual features. A tape output jack is driven from a low-impedance cathode follower ahead of the tone and volume controls. Separate volume and loudness controls are provided, allowing full flexibility in use. A pair of jacks is supplied which allows breaking the signal path between

the preamplifier and power-amplifier sections for driving an external electronic crossover network. The two outputs of such a network could then be fed to the power-amplifier portion of this unit and to a separate power amplifier for a bi-amplifier system with a minimum of interconnection complications.

The output stage consists of a pair of 6CA7/EL34 tubes in a tapped-screen type of circuit. Fixed bias is used, with the negative bias voltage also serving to bias the heater circuits for minimum hum. Bias and balance adjustments for the output tubes are easy to make, and jacks are provided so that any voltmeter can be used for adjusting bias and balancing circuits without breaking any of the amplifier wiring. The rectifier is a slow heating GZ34, which prevents excessive voltages from appearing on the



Distortion versus output.

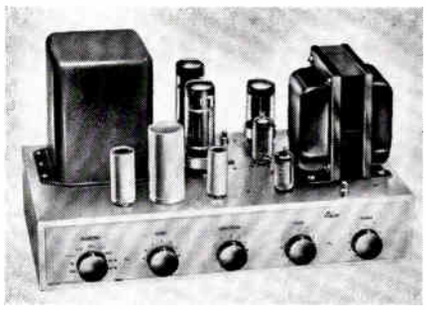
filter capacitors and other components during warm-up.

A very welcome feature is the use of a cathode follower input for all the high level inputs (AUX, TUNER, TV, TAPE). The input impedance of this stage is 2.2 megohms, which is suitable termination for a ceramic phono cartridge. This is one of the few amplifiers which can use a ceramic cartridge to full advantage.

Test Results

The EICO HF52 met its power specification handily, delivering 50 w from 30 to 10,000 cps and very near that power at the extremes of 20 and 20,000 cps. The evident size and weight of the output transformer are also reflected in the low-frequency power-handling ability of this amplifier, which could put out a clean 45 w at 20 cps. The harmonic distortion at 1,000 cps was less than 0.5% up to the "breaking point" at full output, and the 20-cps distortion was only twice the 1,000-cps distortion at all levels below full output.

At full output, the output tubes draw considerably more plate current than

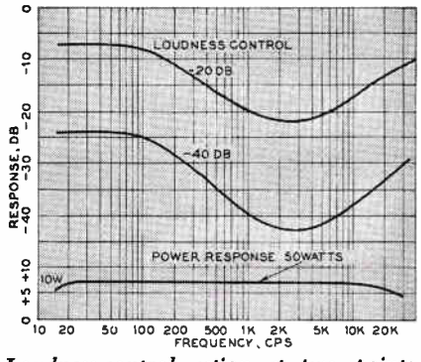


The EICO HF52 control amplifier.

when idling. This causes a drop in plate supply voltage which limits the continuous power output to approximately 50 w. In the IM-distortion test, full power is delivered only on brief peaks, with a resultant higher average plate voltage than during a conventional harmonic-distortion test. This shows up clearly in the distortion curves, where the IM-distortion break point is at 65 watts instead of 40 to 50 w. Because of the transient nature of music wave forms, this amplifier might be considered as a 65-watt unit when used in typical home music systems.

At any reasonable listening level, where the amplifier will rarely be called upon to deliver more than 10 watts, all distortions are quite low, and approach zero as the power output becomes very small. This is a perfectly reasonable and desirable way for a distortion characteristic to behave, but a surprisingly large number of amplifiers have high residual distortion levels at very low outputs. The HF52 is happily free from this difficulty, even when the signal is passed through the tone-control stages as in this test.

The tone controls are conventional in all respects and provide adequate range at both ends of the spectrum. The loud-



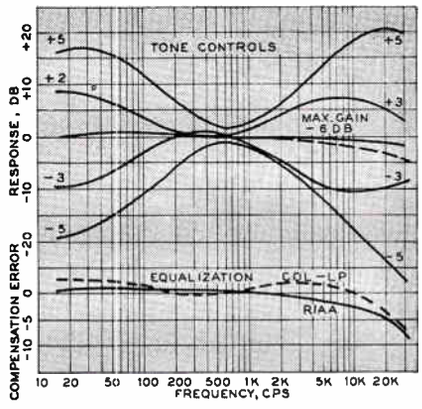
Loudness-control action at two points, and power-response curve (0 db = 10 w).

ness control is a Centralab Compentrol, which boosts the highs as well as the lows. Since it operates independently of the level control, it is easy to select the desired degree of compensation.

Record equalization is very smooth and free from "bumps." It is well within the usually accepted limits of plus or minus 2 db from 30 to 15,000 cps on both the Columbia LP and the RIAA characteristics.

The hum and noise levels are very low. On the phono input (low level) the hum was 59 db below 10 w output at full gain, and 67 db below 10 w at a standard gain setting which provided 10 w output with a 10-mv input signal at 1,000 cps. On the TUNER and AUX inputs, with the gain set for 10 w output at 1 v input, the hum was 83 db below 10 w. These figures not only equal or better the amplifier's specifications, but translated into listening terms mean that hum should be quite inaudible under any ordinary conditions of use.

The output tubes are run slightly below their maximum dissipation ratings

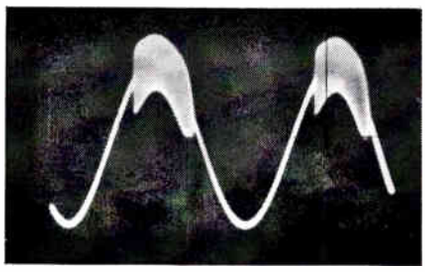


Equalization (shown as deviations from correct) and the tone-control curves.

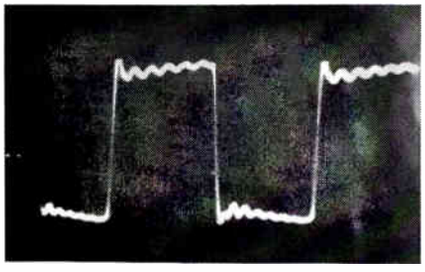
(94% of rated power) under quiescent conditions, which is the way they are operating most of the time, and only slightly over rated dissipation (104%) at a sustained 50-watt output. The filter-capacitor voltage is also on the safe side (94%) of maximum. Power-line leakage current is 1.1 ma; damping factor is 13 at 1,000 cps.

The only place where we found any performance characteristic inferior to the specifications for this amplifier was in the matter of stability. The manufacturer's literature stresses the "virtually absolute stability" of the HF52. In our tests, shunting the 8-ohm resistive load with from 0.25 μfd to 0.5 μfd of capacitance produced a high-frequency oscillation. In itself, this is not too serious, since no conceivable length of speaker cable would put such a capacitance across the output.

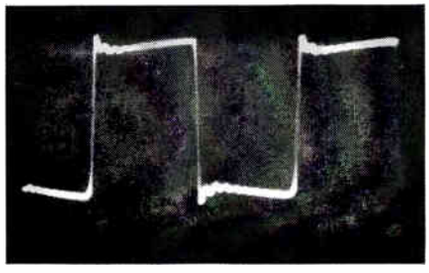
Other traces of instability were evident in the square-wave tests. At certain settings of the LOUDNESS control, bursts of oscillation appeared, both on 10-Kc and 50-cps square waves. A similar effect was



Fifty cps at 20 watts.



Ten Kc at 40 watts.



Ten Kc at 1 watt.

observed with a 50-cps sine-wave signal, at the same critical setting of the LOUDNESS control (number 7 to 8 on the calibrated chassis markings). In all these cases, the instability appeared at power outputs of 10 and 30 w, but never at more usual listening levels.

This transient instability did not produce any audible effect. For one thing, the oscillation took place at approximately 100 Kc. For another, it is unlikely that the amplifier would be operated at the critical power levels in normal use for any significant length of time — and if it were, the over-all sound level would be loud enough to mask these rather subtle effects. Nevertheless, we must conclude that the stability of this amplifier is something less than absolute.

Summary

The EICO HF52 integrated amplifier is a solidly constructed, conservatively operated amplifier capable of delivering from 40 to 50 w of clean, continuous power output from 20 to 20,000 cps, and with an effective maximum output of 65 w on music wave forms.

It is unusually flexible, with correct input termination for ceramic cartridges, provision for connection to an electronic crossover system, good phono equalization, and very low hum levels.

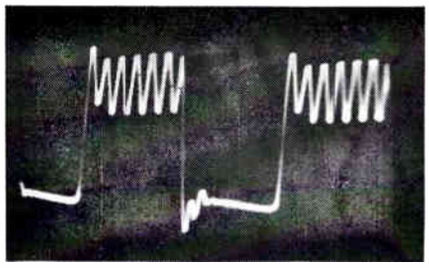
The sample tested showed evidence of a slight instability at critical high-power levels, and with heavy capacitive loading of the output. This did not affect the sound in listening tests under more normal conditions.

We believe the HF52 should prove highly satisfactory for home music systems requiring a 50-watt amplifier. At its price, either in kit form or assembled, it represents an excellent value.

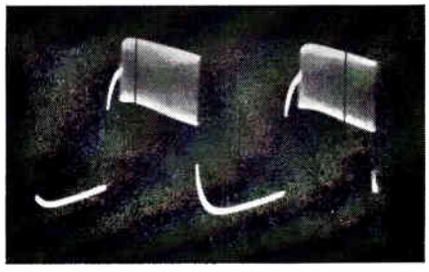
Stability Recheck

A stability check on a second HF52 showed no trace of the high-frequency oscillation found on the first unit. We have established that the original instability was due to excessive stripping of shielding from wires going to the electronic crossover jacks at the rear of the amplifier.

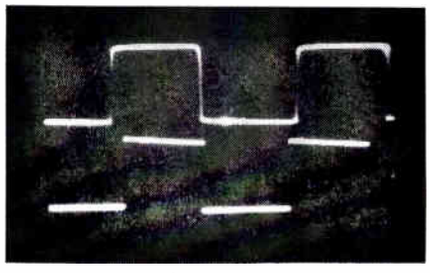
The instruction book includes wiring directions for use when the HF52 is bought as a kit. If these directions are followed, the wires are adequately shielded at this point. The fact that the first factory-wired unit deviated from the wiring instructions in this detail apparently was not picked up in the inspection process.



Ten Kc at 20 watts.



Fifty cps at 20 watts.



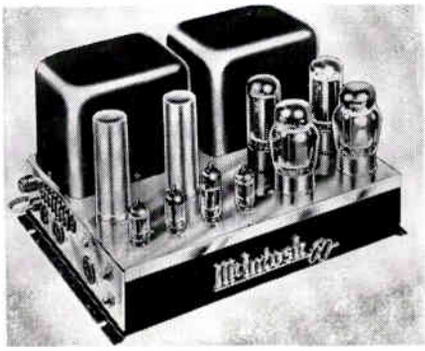
Ten-Kc and 50-cps input waves.

MCINTOSH MC-60 POWER AMPLIFIER

The McIntosh amplifier has been a familiar part of the hi-fi scene for nearly ten years. The MC-60 is the current version, essentially the same as the original in basic circuitry, but using more powerful tubes and packaged more suitably for home use.

The basic difference between the McIntosh amplifiers and others is the "unity-coupled" output circuit. A special output transformer provides very close coupling between all its windings. This feature enables the output tubes to be operated in Class B without objectionable distortion. In Class B, the tube operating voltages are set so that each tube of the push-pull output pair operates only 50% of the time. By contrast, the Class A operation which is employed in practically all other high-fidelity amplifiers keeps each tube operating 100% of the time.

Since the maximum power output obtainable from a given pair of tubes is ultimately determined by the amount of power which can be dissipated from the tube anodes in the form of heat, it can be seen that, all other things being equal, a Class-B output stage can deliver a much higher output than a Class-A stage employing the same tubes and plate voltage. For a given power output, the Class-B output tubes will dissipate much less power than the same tubes in Class A, and therefore will run cooler and in all probability last longer.



The McIntosh MC-60 power amplifier.

Obviously there must be some disadvantage to Class-B operation or it would have been adopted by all amplifier designers. The most serious drawback is the notch distortion which occurs each time one output tube cuts off and the load is transferred to the other tube. This is the result of imperfect coupling between the two halves of the output transformer primary winding, which is inevitable in conventional transformer designs. A second difficulty stems from the fact that the current drawn by the output tubes varies with signal level. A Class-A amplifier operates with

constant current, and the power-supply design is relatively simple. The power supply for a Class-B amplifier must have very good regulation — its output voltage must not vary widely as the load current is changed — or the maximum power output of the amplifier will be severely limited. Well-regulated supplies tend to be rather expensive compared to the run-of-the-mill variety.

McIntosh has overcome the first problem with spectacular success. Their output transformer, of patented design, virtually eliminates leakage flux and with it the distortion problems associated with Class-B amplifiers. As our test report will show, the power-supply-regulation problem is still present, though it is very doubtful it would ever lead to difficulty in a home music installation.

Test Results

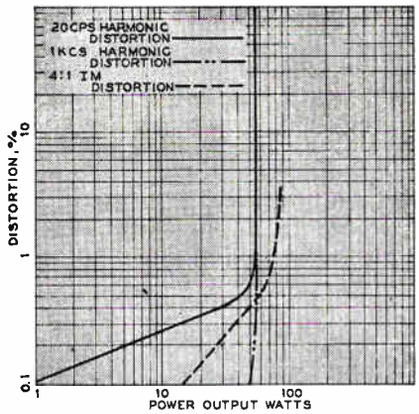
The low-level frequency response of the MC-60 is for all practical purposes flat from 20 to 20,000 cps, being down a fraction of a db at the latter frequency. This is no more than one has a right to expect from any reasonably good hi-fi amplifier.

In its power response the MC-60 shows its true mettle. It will deliver its full output from 15 cps to 10,000 cps without significant distortion, and 80% of full power at 20 Kc. This high order of performance is reflected in the distortion curves. It is noteworthy that the distortion at 20 cps is entirely negligible until practically maximum output is developed. In addition to good design, this indicates no skimping in the size of the output transformer (a common weakness of lesser amplifiers). Merely lifting the amplifier (which weighs 46 lbs.) should convince anyone of this fact.

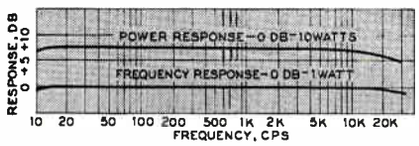
The 1,000-cps harmonic distortion of this amplifier is so low that our equipment cannot measure it at power levels below 15 w. The inherent distortion of our test oscillator and harmonic-distortion meter is approximately .06%, and we do not ordinarily attempt to measure distortion levels below 0.1%, since the instrument limitations would then affect the final results.

Sensitivity is 0.15 v input for 10 w output at maximum gain. With the input jack open, hum and noise level is 84 db below 10 w; with the input shorted, the corresponding figure is 90 db; and with the input level-set control turned all the way down, hum and noise level is 93 db below 10 w.

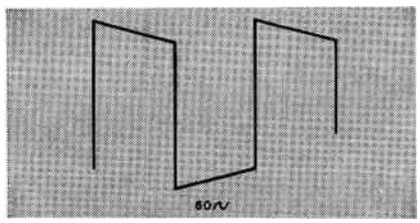
The IM distortion curve falls between the 20-cps and 1,000-cps harmonic-distortion curves, as one might expect, since it is largely an indication of the amplifier's distortion at 60 cps (the lower of the two test frequencies in the IM test). Notice, however, that the IM distortion remains quite low up to power outputs of 80 to 85 w, while the



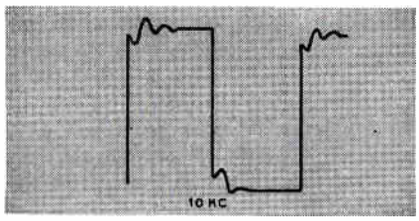
Distortion versus output.



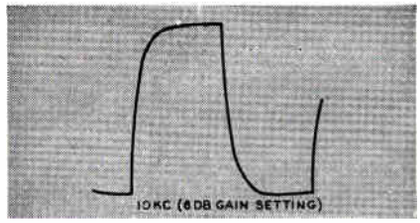
Power and frequency response.



Representative 60-cps square wave.



Representative 10-Kc square wave.



Ten-Kc wave at –6-db gain setting.

harmonic distortion rises sharply at 55 w. The explanation of this phenomenon lies in the matter of power-supply regulation. The voltage applied to the output tubes is 415 v at low signal levels, but falls to 350 v at full output because of the high current drawn by the tubes under this condition. The nature of the IM test is such that the peak power is supplied only for a fraction of the time, and the average power is approximately ⅔ of the maximum. From this we conclude that the MC-60 can deliver approximately 55 w continuously, but will handle short bursts (possibly up to ¼-second in duration) of up to 85 watts without significant distortion. Since the nature of music is such that large peaks are of brief duration, the MC-60 could fairly be called an 80 to 85-watt amplifier for home music systems.

The question may arise as to why this amplifier, rated at 60 w, delivers only 55 w continuously in our tests. There are three possible reasons, and we suspect that all three are involved to some extent. First, there is inevitably some error in measurement, which is most severe in power measurements. The probable error in our power measurements is 5 or 6%, which could account for a large part of the apparent discrepancy. Second, the condition of the particular output tubes may have a considerable effect on the maximum output. We have measured other MC-60's which delivered 65 w continuously. Third, the AC line voltage has a profound effect on the power capability of an amplifier. Our line voltage was 117 volts, accurate to 1%. The MC-60 specifications call for a range of line voltages from 117 to 125 v, and the amplifiers are shipped with the power-transformer primaries connected for 125 v. If ours had been connected for 117 v, there is no doubt that this amplifier would have delivered well over 60 w continuously.

The 60-cps square-wave response shows the excellent low-frequency response and low phase shift. The 10-Kc square-wave picture, with the maximum setting of the amplifier's gain control, shows a certain amount of ringing, apparently at 60 to 70 Kc. With the gain set to 6 db below maximum, the 10-Kc square wave shows considerable rounding, but no trace of ringing. Apparently the shunting effect of the input capacitance of the amplifier on the gain control reduces the gain above 20 Kc materially. There is no significant effect below 20 Kc, however.

The 6550 output tubes are literally loafing along at 63% of their rated dissipation at zero signal level (which is the way they would be operating practically all the time in a home music system), and reach only 85% of rated dissipation at full 55 w output. Although we cannot imagine deliberately operating the MC-60 under overload conditions, this must never be done. If it is overdriven it is possible to greatly exceed the rated dissipation of the tubes.

The MC-60 was stable under all conditions of capacitive loading, and would deliver 20 w at 10 Kc into a 3-μfd capacitive load. This simulates the load of a push-pull electrostatic speaker, which drastically reduces the high-frequency power capability of any amplifier.

In all other respects the MC-60

Continued on page 48

An $85 music system . . . from kits

This family found kits the solution to its music, budget, and high-fidelity problems

by ALAN THRASHER

TAKING things apart to see why they won't run has always been an easy and popular activity of Americans. Now the kit makers have made it just as easy to reverse the process, and put things together that will run.

I had my doubts when I first read advertisements promising that an unskilled person could buy a kit and build an FM tuner or an amplifier with the aid of only a few simple tools. Now I know it's true.

My wife and I had been wishing for months that we had a better music system for our home. We had the usual TV set, a couple of AM radios, and a weary 78-rpm record player; but we knew we were missing the fine musical programs that our friends were getting over FM radio.

We live in Pasadena, next door to Los Angeles, and there are a dozen or more FM stations in the area. These stations have large libraries of fine recorded music and a program to suit any mood is on the air at almost any hour.

We were in the process of remodeling the interior of our old house and wanted a music system that could be installed eventually in built-in cabinets. We also wanted it arranged so we could add units in the future.

I had misgivings about trying to build electronic instruments on my own; but Jeanne finally convinced me to order some kits and give it a try.

"After all," she argued, "if you do get in trouble, you can always get an expert to help you out."

We decided to get three Heathkits: an FM tuner, an amplifier, and a speaker system. We found these would come to $85, and that was well below the price tag on a comparable outfit in already assembled form. So we took the plunge.

When our kits arrived by express I had some momentary qualms, but the express driver gave me some reassurance when he remarked, "I've sure been delivering a lot of these things. Everybody must be going in for electronics. I'm about ready to get some myself."

We unpacked the carton containing the tuner parts first. While I was sorting them out Jeanne sat down to read the manual of instructions. When she finished it, I read it through and was surprised to see how detailed the explanation was and how much easier the project was made by the inclusion of pictorial diagrams showing each step.

The layout of parts and the wiring process was described, step by step, and a box was provided where each step could be checked off when finished.

Getting good smooth-soldered connections is an art quickly learned; and the manual indicated exactly when to solder so that it was never necessary to reheat a joint once it had been formed. This is important because soldered connections which have had to be reheated two or more times are most likely to give trouble.

We sorted the parts into piles — resistors in one, capacitors in another, and so on. This made it easier to find each part when it was time to wire it into the set. We went slowly, checking each part twice to be sure it was the right one and checking its position against the manual and the wall charts which were furnished.

I think the most important word of advice I could give to another person setting out to assemble a kit would be: *go slowly*. One hookup wire soldered to the wrong terminal, or a mix-up of resistors which all look pretty much alike, could prevent the completed set from operating. Such a mistake would be difficult to find after the whole job was finished.

When the tuner was completely wired we put it aside, since we could not test it until we had the amplifier and speaker system in operation.

The amplifier was much easier to assemble after our practice on the tuner. It was completed in about four hours one evening. The tuner had taken ten hours.

Putting together the speaker system was more a matter of joinery than electronics. The top, bottom, and sides of the cabinet were fastened together and glued, the grille cloth tacked in place, and the speakers mounted with screws. The only wiring on the speaker system was a small bit on the crossover control.

When all three units were completed we hooked them up and turned on the switches, keeping our fingers crossed.

"My gosh, it works," was about all I could say when the first musical notes came floating out of those speakers.

But along with the music there was a loud hum. No amount of fussing with the controls had any effect, and I supposed that the annoyance was caused by either a wrong connection in the amplifier or by an improperly shielded wire in either the tuner or the amplifier.

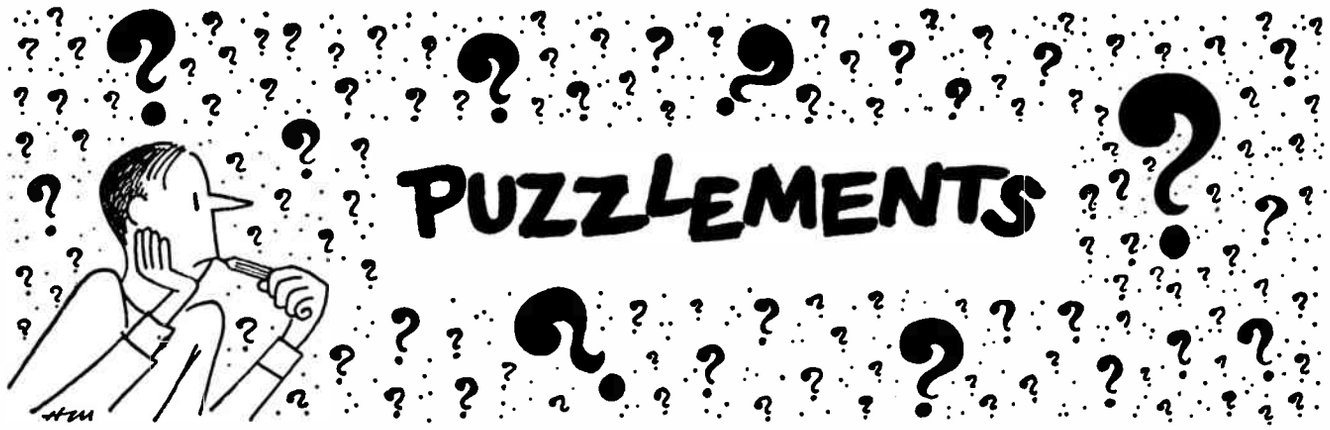
We rechecked all the wiring against the diagrams and all seemed to be in order. Then I tried moving the leads with a pencil to see if any change could be noted. No change.

An experienced radio hobbyist or serviceman would probably have guessed immediately what the trouble was. I finally found it after about an hour, and then more or less by accident. After trying everything I could think of without success I was sitting, chin in hand, staring at the amplifier when I suddenly noticed that the shield cups on the cable running from the tuner to the amplifier were not pushed down over the terminals. The outer shield of this cable

Continued on page 48

How do parallel and series connections affect loudspeaker performance?

by NORMAN H. CROWHURST



On Loudspeakers and Impedance

"If I connect two 8-ohm loudspeakers in parallel," the voice on the other end of the wire asked, "I should connect them to the 4-ohm tap on the amplifier, shouldn't I?" After confirming this point the next question was, "Why would one loudspeaker sound louder than the other, to the extent that the sound seems to come all from the first loudspeaker?"

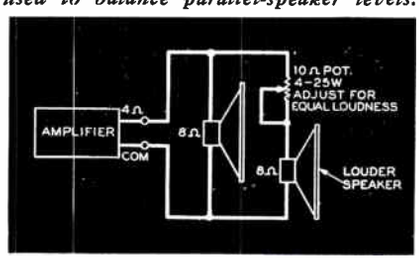
"Well, it could be that the first loudspeaker is more efficient than the other one," I suggested. "That's what I thought," the voice came back, "but now, if I connect the two in series, this should go to the 16-ohm tap of the amplifier, right?" "Right."

"But now I find that the loudspeaker that was the quieter when they were in parallel is the louder when they are connected in series. How do you explain that? If No. 1 loudspeaker is the more efficient of the two, wouldn't that one sound the louder whichever way I connect them?" "That's true," I conceded.

"How do you explain the fact that No. 2 loudspeaker is the louder when they are connected in series," the voice went on to inquire, "and how can I connect the two loudspeakers so they will sound about equally loud in the same room?"

This puzzlement really arises through assuming that a loudspeaker's impedance

Fig. 1. A 10 ohm potentiometer may be used to balance parallel-speaker levels.



is precisely what it says on the label. At best, the rated impedance of a loudspeaker is somewhat nominal. An 8-ohm loudspeaker, to take the example quoted, cannot possibly be 8 ohms at all frequencies.

The conventional dynamic-type loudspeaker has an impedance which begins, at very low frequencies, as just the voice-coil resistance. At the low-frequency dynamic resonance of the loudspeaker in its enclosure, the impedance rises to perhaps three or four times this value. Then, at some higher frequency again, usually in the region of 800 to 1,000 cps, the impedance dips to a little more than the voice-coil resistance. Finally, at higher frequencies, the inductance of the voice coil causes the impedance to rise again.

When a loudspeaker is stated to have a nominal impedance of 8 ohms, this could mean its impedance in the region of 800 to 1,000 cps, or its impedance at the low-frequency resonance, or at some point between these. Consequently, according to where the nominal value is taken, the impedance at other frequencies may deviate above or below the nominal value, or on both sides.

Another factor in loudspeaker impedance is the practical question of how any particular value is achieved. Only a certain number of things can be changed in winding a voice coil. For example, the voice coil may consist of one layer of a certain wire gauge, or two layers of another gauge of half the diameter, which will give four times as many turns, or three layers of one third the gauge of the original coil, yielding nine times as many turns. These three possibilities will have resistance in the ratio 1:16:81.

Length of layer, or small deviations in wire gauge, can affect the voice-coil resistance and its consequent impedance to some extent, but there are a limited number of choices for any given voice-coil dimensions. If a manufacturer wants a loudspeaker of 8 ohms nominal impedance, he may find that the choice of wire gauges gives him the alternative of 6 ohms or 10 ohms. Which would he choose?

Most amplifiers operate with a high damping factor; therefore, the voltage delivered by the amplifier is little affected by the resistance or impedance it has to feed. The 6-ohm speaker will draw 1⅔ times as much current as the 10-ohm speaker and, other things being equal, will produce this much more acoustic power and be a little more than 2 db louder. That gives the impression that the loudspeaker is a little more sensitive.

Possibly another loudspeaker manufacturer comparing his units with those

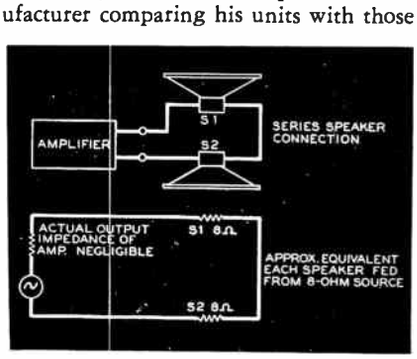


Fig. 2. Equivalent diagram showing impedance of series-connected speakers.

of competitors may find that his competitor has made the loudspeaker seem more sensitive by using a voice-coil resistance lower than his. So what does he do? He has to compete, and perhaps he lowers his voice-coil resistance too. The result may be a nominal 8-ohm loudspeaker that should truthfully be rated nearer to 4 ohms.

This seems to be the explanation in my friend's case. When the two loudspeakers were connected in parallel, the one that had the lower actual impedance

drew the most current and, consequently, seemed the loudest. But when the two were connected in series, they both passed the same current, and the one that had the higher impedance utilized the greater voltage. In series, then, the loudspeaker with the higher actual impedance seemed the louder.

In answer to the second part of his question, I suggested connecting the two speakers in parallel, with a 10-ohm wire-wound potentiometer as a variable resistance in series with the loudspeaker that seemed the louder (Fig. 1). The resistance is adjusted until both loudspeakers seem to give the same volume. This would probably result also in more nearly correct loading for the amplifier because in all probability the reason for one loudspeaker sounding the louder was a lower actual impedance than its nominal rating.

Had the same loudspeaker sounded louder, by about the same difference, whether the two units were connected in series or parallel, then the difference would have been due solely to the relative efficiency of the two units.

Solving this little problem, however, got us into a discussion of the relative merits of series or parallel connection of loudspeakers. "Why is it," my friend wanted to know, "that it is always recommended to connect loudspeakers in parallel, and never in series?"

Basically, the reason is that a dynamic type of loudspeaker is a voltage-driven device. This is why amplifiers with high degrees of damping (which means the output voltage is little affected by the impedance connected to it) have become important for driving dynamic loudspeakers.

If two speakers are connected in parallel, then each of them is fed from a low source resistance (or from a high-damping-factor source). On the other hand, if the same two loudspeakers are connected in series across an appropriate amplifier tap, then each loudspeaker is fed from the amplifier through the impedance of the other speaker.

Assuming for the moment that both loudspeakers are purely resistive at their nominal values (that is, each has an impedance of precisely 8 ohms) at all frequencies, then each loudspeaker will be operating as if the amplifier had a damping factor of 1: an output impedance equal to the load. Of course, this "output" impedance is that of the other loudspeaker (Fig. 2).

In practice, the impedance of a loudspeaker is not a constant resistance; therefore, the interference with damping can be more than this at some frequencies. The dynamic resonance of one loudspeaker will boost the actual impedance in series with the other one to quite a high value.

Interaction between the electrical res-

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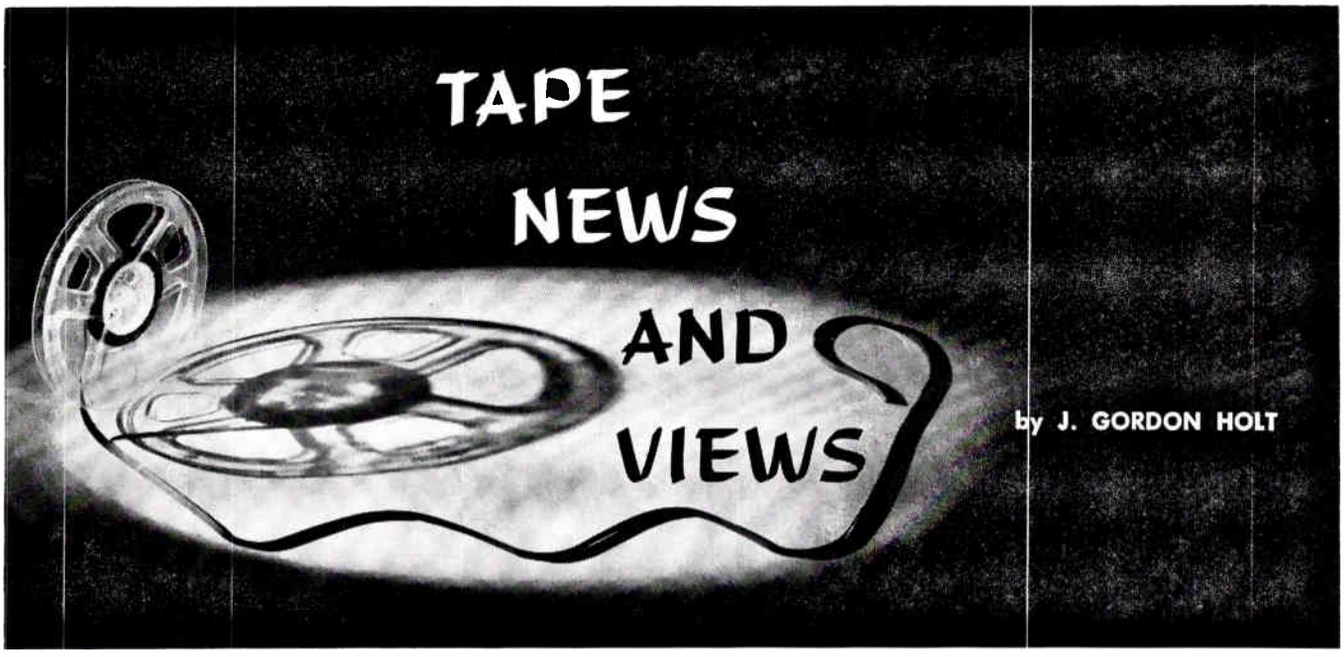


The Stereo Recorder

If advertisements and articles in the popular press are any indication of the status of stereophonic sound, it is the greatest advance in high fidelity since the "lifetime" osmium phono stylus, bringing to listeners the breadth, the spaciousness, the realism, and the oh-so-thrilling emotional impact of sound whose roundness and firmness is equalled only by the real thing.* "Old-fashioned high fidelity," we learn with breathless wonder, "is as shades of sonic gray compared to the incomparable tonal colors spread in a glorious soundscape by the magic touch of stereo, and available to you through the new Superphonic Stereorama tape player with single-knob control, twin speakers for all the highs and all the lows, and handsome styling by Anton Vechtenstein of Vienna, London, and the Riviera."

Somewhere amid all this foofaraw and ballyhoo surrounding the second-channel revolution are some grains of truth, which are worth taking note of. As a matter of fact, I had started out this month with the idea of plunging without ado into a discussion of the special requirements for stereo tape recorders, but the more I mull over the fringe factors the more I think I'd better preface that with a few observations about the nature of this beast that has suddenly come into the limelight.

Stereo *is* a revolutionary medium of home sound reproduction, but as a medium it is not new. Neither is it a revolutionary phenomenon which must, by definition, be high fidelity. There is good stereo and there is dreadful stereo, just as there is high fidelity and medium fidelity and practically no fidelity at all. Simply "going stereo" will not make a reproducing system significantly higher fi than it already is, unless the conversion involves adding a better speaker, amplifier, or what have you, in the second channel. Despite stereo, fidelity is still gauged by frequency range, smoothness, phase shift, transient response, stability, and lack of distortion, and while stereo can greatly improve subjective realism of any given system, it does not really increase its fidelity. So let's get the facts, Ma'am.

The so-called stereo effect is a purely subjective thing, and different observers will often describe it in different terms. To me, the most important difference between monaural and stereo is the feeling of spaciousness and power that stereo adds. I get an impression of the actual size of the hall in which the recording was made, and observe a general enhancement of musical dynamics that seems to add many db of dynamic range to the recording. In addition, of course, there is the sense of directionality which puts the performers in their respective places across the mentally conjured stage, and there is also a marked improvement in detail, which facilitates "spotting" in space and following by ear sonic intricacies which would normally be jumbled together when reproduced monaurally. Essentially, stereo is nothing more than two monaural systems side by side, but the slight differences between the sounds picked up by the microphones are heard by the listener as the stereo effect.

Thinking about buying a stereo tape recorder? Here are some tips to make selection easier.

The microphoning and the loudspeakers determine whether we hear a single, unified source spread between the speakers, or whether we get a two-point effect affectionately known as the hole-in-the-middle. There are other things which affect this center fill, too, and that's where we may start considering stereo tape recorders.

When we describe a basic stereophonic system as being made up of two separate, isolated channels, it is reasonable to assume that these channels are *totally* isolated. In actuality, they are never completely isolated, and this interchannel leakage can be a good thing under certain circumstances.

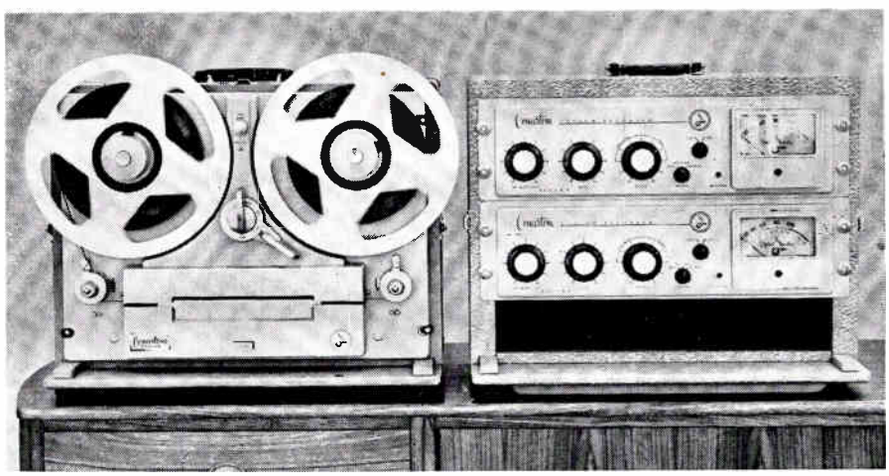
It is perfectly obvious that, were we to play one track of a monaural twin-track tape on a stacked stereo head that leaked, we would hear some of the reverse track in the background as interference. This is a case where interchannel leakage would be a bad thing. But if we were to play a *stereo* tape on the same head we would not hear the leakage, because both tape tracks would be carrying approximately the same material. On the other hand, though, if the leakage between channels were particularly bad, we might even get an improvement in the stereo reproduction. Shocking idea? Not at all.

Anyone who has played around with two speakers driven by a single amplifier has noticed that, when the speakers are balanced and connected in phase, the sound will seem to emanate from a spot midway between them — the exact antithesis of the typical stereo system with its sonic hole in the middle. It would seem that if a system could be

*Unless my memory fails me, phonograph advertisements were touting reproduction "just like the real thing" before the 20's, but let's just try to ignore that.

somewhere between isolated stereo and two-speaker monaural, the result could be an even distribution of sound from the left speaker to the right one, and this is precisely the case. Severe interchannel leakage, or purposeful interchannel mixing will, of course, sacrifice some of the directional qualities of stereo, but the resulting center fill — to my mind — is more than adequate compensation for this. So, point number one: if a stereo machine is to be used to play monaural half-track tapes as well as stereo tapes, make sure it has good interchannel isolation (at least 50 db). If it is going to be used only for stereo tapes, forget about the isolation altogether — any existing machine will be good enough.

A second requirement which is fundamental to and exclusive with stereo recorders is the special ultrasonic-bias-supply provision. Obviously, both channels are going to have a recording bias supply, and it would seem logical to purchase a tape deck with a stereo head, plus two record/playback preamplifiers.



The Concertone stereo recorder has its two record amplifiers housed in a single case.

Unfortunately it's not so simple as all that.

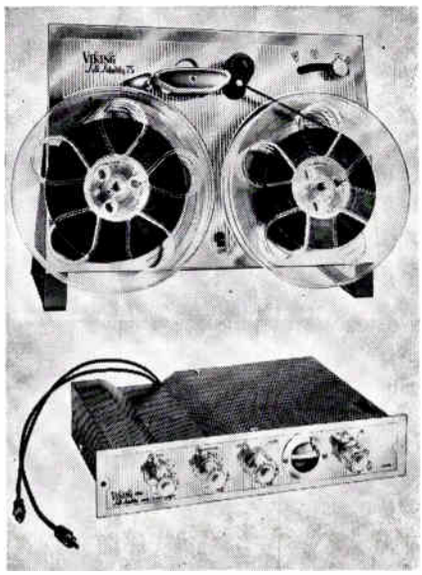
The ultrasonic bias used in tape recorders has a frequency of 40 Kc or higher; it will never become audible as a whistle in the background of the reproduced tape. However, a 60-Kc bias supply, for instance, is never likely to be exactly 60 Kc in frequency. If the manufacturer's quality control is extraordinarily good, the bias frequency may fall between 50,500 and 60,500 cps, but 60,050 is the closest it is ever likely to get. If two of these record/playback preamps are used together for stereo recording, their bias signals together will produce a very audible beat note within the audio range.

To avoid this possibility, a well-designed stereophonic tape recorder contains only one bias oscillator, which supplies both halves of the erase and record heads.

The Ampex 601-2 recorder, for instance, is a unitized combination of the basic 601 deck, a 601 record/playback preamplifier with bias oscillator, and a second "slave" amplifier section which consists of a 601 preamp *minus* its oscillator. The master preamp's oscillator serves both channels. A similar slave record/playback unit, designated the RP-61S, is sold by Viking of Minneapolis for stereo recording with the popular Viking deck and the RP-61 record/playback preamp. Some of the early Berlant stereo recorders, however, used a pair of standard record/playback preamps with their own individual oscillators. It was necessary with these to keep the oscillators trimmed right on their nominal operating frequencies to avoid whistles while recording — a ticklish job at best.

One question that is always good for a heated discussion among stereo recordists concerns the advisability of two recording-level indicators rather than one that can be switched from one channel to the other. There is no disagreement over the fact that the two channels on a stereo tape should be very well balanced, so that each tape will not require its own unique setting of the playback system's balancing control. Proponents of the separate record-level indicators claim that best balance can be obtained only in this way; single-meter adherents argue that there is so much difference between the programs picked up in the two channels that their different level indications on a pair of meters will simply be misleading, and will encourage unnecessary level-control manipulation.

Actually, the *only* way of obtaining accurate channel balance is by ear, while monitoring the entire output from the recorder through carefully prebalanced speakers or headphones. Perhaps an even better way is by means of a meter or indicator which shows the *difference* in levels between channels; however, since there isn't such a device at the present time, the stereo buyer's choice must be between two conventional record-level indicators (as on the machines mentioned above), or a single switchable meter like that used on the British Ferrograph 88 and the recorders made by Educational Laboratories, Incorporated.

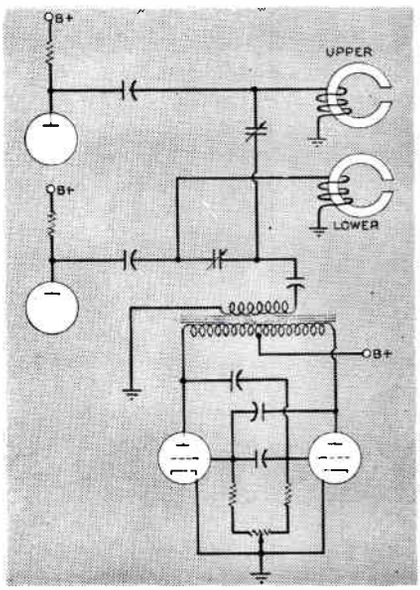


Viking recorder is adaptable to stereo by using two preamps and stereo heads.

Aside from the points that I've mentioned, the stereo recorder should be selected on the same basis as a monaural one — speed regulation, distortion, frequency response, and mechanical stability.

If your present recorder strikes you as being passably good but nothing to rave about, a stereo version of the same machine may impress you for a while, but won't satisfy you in the long run any more than did your present unit. Use your monaural standards of judgment when buying a stereo recorder, and then simply check to make sure it has (1) enough channel isolation to suit your specific needs, (2) a single bias oscillator supplying both recording amplifiers, and (3) the monitoring facilities that you feel you'll need.

One version of record circuit uses a single oscillator to power both heads.



TRANSISTORS

by PAUL PENFIELD, Jr.

in audio circuits

PART Xa: Transistor output stages

FOR low-level stages the transistor-circuit designer has his choice of three configurations to use: common-emitter, common-base, and common-collector. We have seen that except in unusual circumstances common-emitter is the only one to use because of its higher gain.

In building power transistor stages, however, the designer has more freedom. He is free to choose any of these three configurations. But he may also operate the stage Class A, Class B, or Class AB. Each class of operation has its own advantages and disadvantages. In addition, he may decide to use a single transistor, or a pair in any of three types of push-pull circuits — conventional push-pull, single-ended push-pull, or complementary push-pull. Certain combinations are not practical, but in all the designer has a choice of some thirty circuits.

Let's look at the advantages and disadvantages of each of these.

Configuration

Unlike the low-level case, there are some advantages in using common-base and common-collector configurations.

Common-Emitter. Advantage is large power gain, just as for low-level stages. Unfortunately, distortion is the highest of the three configurations.

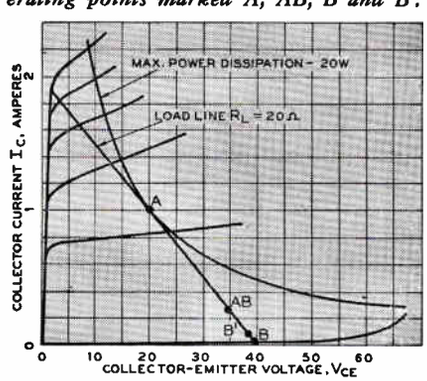
Common-Base. Intermediate power gain, and low distortion when driven by a high-impedance driver.

Common-Collector. Low power gain, but low distortion when driven by a low-impedance source.

The lower distortion in the common-collector and common-base configurations is a real advantage only if a driver is available which can deliver the necessary higher driving power without distortion.

The common-emitter configuration is the one most used for power stages as well as for low-level stages, so the analysis from now on will be for this configuration. Typical circuits and graphs shown will be for common-emitter stages.

Fig. 1. Characteristic curves with operating points marked A, AB, B and B'.



Class of Operation

Whether a transistor or a pair is operating Class A, Class B, or Class AB depends on the quiescent bias point chosen.

Class A. Low-level stages are invariably run Class A, and the biasing methods described in previous installments[1] of this series were for this class of operation.

Class-A operation occurs when the transistor or transistors are run in the so-called linear region entirely. The no-signal, or quiescent, bias places the transistor at a point like A in Figs. 1 and 2; each of these diagrams was explained in some detail in the preceding article of this series. The current can both increase and decrease from this point, as demanded by the signal.

For greatest power output with a given maximum power dissipation (set by the temperature rating of the transistor and the cooling methods), the AC load resistance seen by the transistor should be merely the voltage at A divided by the current at A. The entire load line should be on the safe side of the maximum dissipation. The dissipation is greatest without a signal — that is, at the point A, provided the load resistance is chosen as just specified. If A is picked so that dissipation is safe at that point, then the entire load line will be safe.

Either one transistor or a pair, push-pull, may be operated Class A.

Distortion is rather low in Class-A operation, and what distortion there is is of low-order — mainly second harmonic. This gives a "soft" distortion. The no-signal current is quite high, implying that this method of operation is wasteful of battery power.

The maximum collector efficiency[2] is 50% for a sine-wave signal. This figure holds also for plate efficiency of a vacuum-tube power stage. But because filament power is not included in this estimate, vacuum-tube amplifiers never approach this value in over-all efficiency.

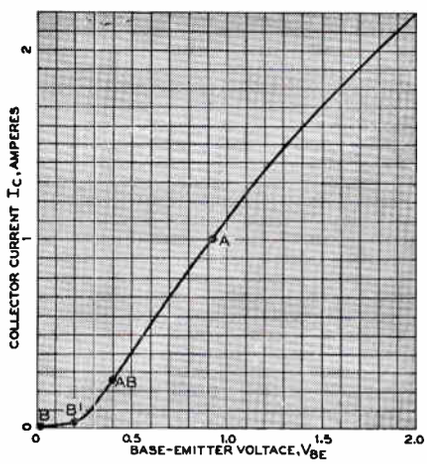


Fig. 2. Text explains how choice of operating point determines distortion.

Transistor stages, however, often do.

The output power from a Class-A single-transistor stage cannot exceed one-half the maximum power dissipation. Using a pair of transistors, the power output cannot exceed exactly the maximum allowable power dissipation.

In practice it is difficult to get close to these theoretical limits because of transistor nonlinearities, cutoff current, saturation resistance, and a desire for good bias-point stability.

Class B. Class-B operation occurs when the transistor is normally biased

[1] See "Transistors in Audio Circuits," Feb., Mar., Oct., and Dec. 1957 issues.

[2] Useful power output divided by final-stage power input, exclusive of the signal input power.

exactly at cutoff (at the points marked B in Figs. 1 and 2), and so conducts current only half the time. Clearly, one transistor operated Class B has an intolerable amount of distortion, and this method of operation requires two transistors used together. Whenever one is cut off, the other conducts. Thus, when the two outputs are combined, they add together to give a good replica of the original signal.

The difficulty is in combining the two signals properly, and in providing a smooth transition from one transistor to the other. The transfer curve has a sharp kink in it near the bias point, as we saw last month. Because of this sharp kink, the output current will be quite different from the signal point. The net result is that when the two signals are combined a sine-wave input voltage (Fig 3A) becomes distorted in the manner indicated in Fig. 3B. This "crossover distortion" is very obnoxious since it increases in percentage as the signal is decreased, unlike the more usual forms of distortion which decrease in percentage as the signal is turned down.

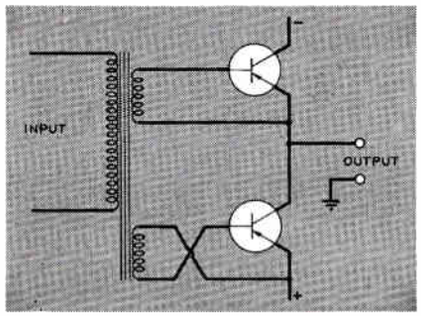
It is possible to eliminate crossover distortion by driving the stage with a high-impedance source, thus controlling the input current, not the input voltage. Unfortunately, this tends to make the bias point more unstable with temperature changes.

Crossover distortion can also be minimized by biasing the stage slightly away from cutoff, as shown at point B′ in Figs. 1 and 2.

Because of the fact that Class B amplifiers depend on transistor nonlinearities, we cannot use capacitor coupling to drive them. If we did, a normal-sized signal would drive each transistor alternately between cutoff and conducting conditions, making the average current through the coupling capacitor something other than zero. The capacitor would then charge up and alter the bias point of the stage so that we would have an extreme amount of crossover distortion. Transformer coupling or direct coupling is necessary.

The bias-point voltage should be less than one-half the maximum allowed voltage, since during the "off" half-cycle the collector voltage rises to twice its bias

Fig. 5. Single-ended push-pull circuit. Two identical transistors are required.



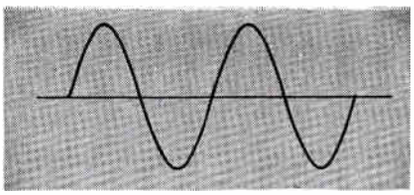


Fig. 3A. Pure sine wave has this shape.

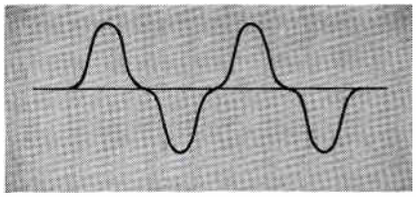


Fig. 3B. Effect of crossover distortion.

value. The load resistance seen by each transistor should be greater than $V^2/4P$, where V is the bias voltage and P is the maximum allowable power dissipation per transistor.

Class-B operation has the advantage of very low standby power, since the bias current is so small. Furthermore, the collector efficiency is high — theoretically, no higher than 78% for a sine-wave signal. With practical transistors, amplifiers can be built that are 60% to 70% efficient.

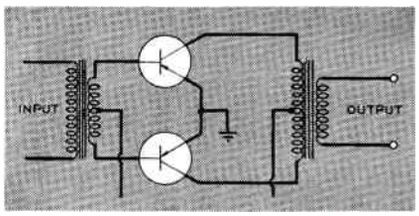


Fig. 4. Conventional push-pull output circuit, shown without the bias network.

The output power from a pair of transistors operated Class B is always less than twice the maximum allowable power dissipation per transistor, *P*. In practical cases it is difficult to obtain outputs close to this limit, however.

Class-B amplifiers are quite practical for portable radios, phonographs, and other equipment for which extremely low distortion is less important than low standby power and high efficiency.

Class AB. The bias for Class-AB operation is between that for Class A and Class B. Figs. 1 and 2 show one suitable point (marked AB). Most of the features are compromises between the features of Class-A and Class-B operation. Standby power is moderate but not as high as for Class A. Efficiency is limited by a number somewhere between 50% and 78%. Distortion is quite low for small signals but gets worse as one stage goes into cutoff.

Class-AB operation may be a suitable compromise for some purposes. Two transistors are necessary for low-distortion operation.

Just as with Class-B stages, capacitor coupling will not work for Class-AB operation. Transformer or direct coupling is used.

Types of Circuit

You can use one transistor for a power stage, or two in push-pull — either conventional push-pull, single-ended push-pull, or complementary push-pull.

Single Transistor. This type of circuit must be operated Class A. The circuit is very simple, certainly much simpler than any of the push-pull stages. It looks just the same as low-level stages, except that the currents (and possibly the voltages) are higher. It is easy to bias, using the same techniques as are useful for low-level stages. Coupling to and from the stage may be via a transformer, a capacitor, or any of the methods useful for low-level stages. Tandem coupling is quite practical, and, in fact, when using it the driver stage can be used to control the bias of the last stage.

A single-transistor power stage is certainly the easiest to design, easiest to drive, and easiest to bias properly. The input and output are both single-ended, which means it is easier to couple to.

Conventional Push-Pull. Suitable for operation in Class A, Class B, or Class AB, conventional push-pull circuits require two identical transistors — both *p-n-p*, or both *n-p-n*. As the basic circuit (Fig. 4, shown without the bias network) indicates, both the input and the output are double-ended. A phase splitter of some kind is required as a driver (a transformer is shown in Fig. 4), and an output transformer is necessary to mix the two outputs.

Capacitor coupling to the stage from any of the phase inverters shown in Part 7 of this series[3] is all right when the output stage is operated Class A. Otherwise, a transformer or directly coupled input is necessary.

Biasing this type of circuit is not

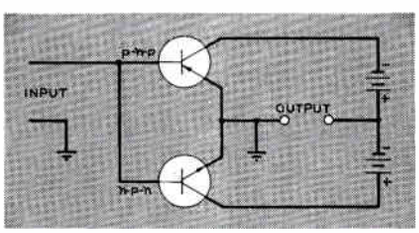


Fig. 6. Complementary push-pull circuit uses one p-n-p and one n-p-n transistor.

difficult. If a transformer input is used, the bias may be applied to the center tap of the secondary. Otherwise, each transistor can be biased by a separate network.

You may have read somewhere that push-pull operation eliminates second-harmonic distortion, as well as fourth, sixth, eighth, etc., order distortion. Theoretically this is so, provided the two transistors are exactly matched in all

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[3]See Dec. 1957 issue, p. 28.

Tape Identification

Individual tracks of double-track recorded tape can be identified by dots of white splicing tape near each of the threading ends. Use one dot for track one, two for track two.

R. L. Browning
Texas City, Tex.

Setting Fixed Bias

Users of amplifiers with fixed bias, that is, bias on the grids of the output tubes set with a potentiometer, will often have difficulties if there is a wide variation in line voltage. The instructions which come with such amplifiers indicate that the bias should be set at some fixed potential, usually between —35 and —47 volts DC. This is almost always the case with such tubes as the EL34/6CA7 and the 6550. Manufacturers of these amplifiers usually do not specifically point out that this bias setting must always be in relation to the line voltage. If the bias is set by the user at the arbitrary level recommended by the manufacturer without consideration of line voltage at the time of adjustment, then trouble is the result. If bias is set too low, the plates will heat up to a cherry red. If bias is set too high, distortion can result.

Consider the typical situation. If the bias is set at —35 volts with the line voltage at 110 volts, the bias will rise to —38½ volts if the line goes to 121 volts. What is even more serious in terms of the life of the tubes, setting the bias at —35 with the line voltage at 121 volts, the bias will drop to a dangerously low level when the line goes down to 110.

The answer to the problem is a careful setting of the bias level when the line voltage is 117 volts (the basis of all voltage potentials in transformers for home use). There is a margin of safety indicated in the specifications of most amplifier-operation manuals and within these limits satisfactory operation is possible, but in the case of fixed bias the setting must be in proper relationship to the other voltages in the amplifier.

When setting bias according to the manufacturer's instructions, measure not only the bias, but the line voltage as well. If a variac or some voltage control is available for controlling the line voltage during the setting of the bias — so much the better. I have found that periodic checks of bias and line voltages over a two-day period with a chart of variations makes optimum adjustment possible.

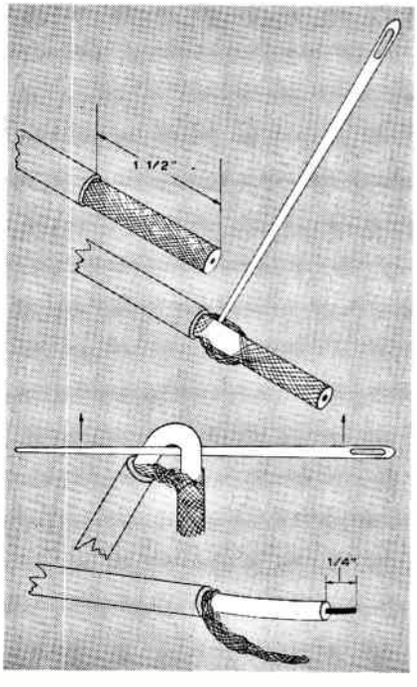
Edward T. Dell, Jr.
Millis, Mass.

Preparing Shielded Cable

Many do-it-yourself audiophiles have been confronted, at one time or another, with the task of preparing the ends of shielded cable. I have found that a 4-inch needle, such as might be used for sewing heavy material or mending sails, is very handy for this purpose.

The procedure is as follows: remove about 1½ in. of the outer cable jacket with a penknife to expose the shielded braid; use the needle to separate the strands of braid, and make a hole next to the outer jacket exposing the center conductor. Bend the cable sharply at this point, insert the needle under the center conductor, and pull it out through the hole. Finally, strip ¼ in. of insulation from the center conductor or tailor as required, and the ends are ready for connection.

The needle also makes a handy scribe and in a pinch can be converted to a



test probe to get into those tight spots by twisting a wire through the eye of the needle and then slipping on a piece of sleeving to cover all but ¼ in. of the sharp tip.

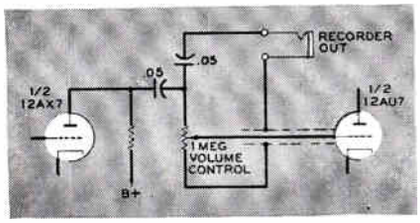
The needle is so handy and the cost so small that my workshop will never be without one again.

A. Hefflon
Jamaica, Vt.

Recorder Output

On most single-chassis amplifiers, a tape-recorder output jack can be added with very little time and trouble. On the Heath A-9C, for example, a standard phono jack connected through a .05-μfd, 600-volt molded capacitor to the input side of the volume control does the job.

This places the recorder output after the selector switch and before the volume and tone controls where it is unaffected by tone compensation and where recordings can be made with the speaker quiet.



Be careful to keep the shielded lead going to the recorder from such an improvised output jack as short as possible — not over 2 or 3 ft.

L. E. Johnston
Madison, Wis.

On Mounting Springs

Suitable springs for mounting turntables in custom cabinetry are a problem, as the requirements are not easily met by household varieties. Rubber or plastic foam does not hold up well near a hot motor, nor in a dry climate. My solution is illustrated in a recent picture story in this magazine. Four "compression springs" with ground ends, made by Dorman Products of Cincinnati, were obtained from a local garage. They are 1-inch-diameter, 2-inch-long coils with a compliance of about 0.1 in. per lb. These springs slip over some ¾-inch bolts and rest on nuts screwed on the bolts. Leveling is accomplished by turning the nuts.

The natural frequency of vibration for a weight supported by a linear spring is inversely proportional to the square root of the deflection of the spring so loaded. I designed my system for an average deflection of ⅜ in., which gives a frequency of about 5 cps; to get it down to 3 cps would require over an inch of deflection and make the system too shaky. The mounting shown in my

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Sound-Fanciers' Guide

by R. D. Darrell

Cook "BN" Redivivus

All the current hullaballoo about "new" stereo discs must amuse the handful of pioneering audiophiles who set up as far back as 1952-54 "outrigger" pickup systems to reproduce Emory Cook's twin-band binaural LP's, and who still claim that the eventual failure of this daring experiment was no fault of the dual-channel recordings themselves. Up to now, however, that claim has had to be taken on faith by the rest of us, who earlier had a chance to hear Cook's BN's only in his own audio-show demonstrations. The latter never impressed me too much, although I found many of the Cook discs exciting enough in single-channel reproduction, but perhaps the main fault was my own then considerable skepticism about stereo's powers. At any rate, it's a special pleasure to be given a new and better opportunity to learn for myself how effective the original recordings actually are (and how thoroughly, as well as how early, Emory mastered the basic problems of stereo techinques) through their belated release in taped form.

Eventually the whole Cook BN catalogue, augmented of course by more recent recordings, will be made available on stereo tapes, but just the first three releases I have heard provide ample proof of notable technical craftsmanship, especially in channel balance and fusion. Even the least striking of these, the 1954 Brahms First Symphony by the Boston Recording Festival Orchestra under Willis Page (Cook 1060 ST), exhibits beautifully blended if not particularly vital sonics, although the rather limp and unsteady performance itself gives the whole work an unduly subdued mood — or background-music character. But if the memorable *Speed the Parting Guest* or "Hi-Fi in a Chime Shop," the hit of the 1953 audio show, no longer sounds ultrasensational, its transient response now seems cleaner and more attractive than ever, and its amusing lightweight popularizations of Varèsian percussion materials are a real delight to the ear in the present 1071 ST taping — even to listeners who ordinarily would find much of the Jimmy Carroll ensemble's quasi-film-cartoon music making pretty childish for all its ingenuity.

More impressive still is *The King of Organs* (1150 ST), the first of the current Cook releases which has not appeared previously in BN-disc form (but which is being simultaneously issued in a conventional LP edition); for here the recording itself is much bolder, bigger, and more obviously up-to-date, yet it retains the same channel equilibrium and smooth "holeless" spread. Bill Floyd's program on the Paramount (New York) Wurlitzer is, incidentally, superior to most theatre-organ intermission entertainments in its avoidance of the usual Mighty Wurlitzer interpretative excesses and forced novelty sound effects, but the outstanding technical attraction is the authentic reproduction not only of Paramount Theatre acoustics, but also of exactly pinpointed pipe-choir locations, whose dispersal over a broad area in both depth and width is made astonishingly clear despite complete integration in the over-all reproduced-sound fabric. I still hope to hear Emory's fully developed stereo techniques devoted to more musically substantial works, but even here there is irrefutable evidence that all his present-day colleague-rivals must look to their laurels: the Old Master is a formidable challenger indeed!

Still-Unrivaled LP's

Many non-stereo-equipped listeners of today must suffer severely from a kind of inferiority complex as they find that their pleasure in many fine single-channel recordings is pooh-poohed by reviewers who seem to delight in stressing the superiority of stereo tapings of the same works. But perhaps they can take some comfort both from the obvious fact that innumerable attractive works are still available only in LP form and from the less obvious one that under certain conditions — perhaps most notably in solo instrumental and vocal performances — there is comparatively little that stereo, even at its best, can add. I have heard some fine stereo tapings of soloists, but except for their more expansive acoustical ambience, they seldom have struck me as markedly more satisfactory than first-rate conventional LP's. And in the case of several current disc releases, it never even occurs to me to wish for stereo versions.

Here are several I can commend wholeheartedly on their own sonic as well as musical merits: Frederick Marvin's beautifully played and recorded program of piano pieces by Padre Antonio Soler (Decca DL 9937), a batch of nine sonatas in no way inferior to, yet distinctively different from, those of Soler's master, Domenico Scarlatti, and a more ambitious, infectiously jaunty Fandango in D minor — a truly astonishing musical discovery. Louis Kentner's piano recital (Capitol P 8400) is most exciting for its virtuosic Gounod-Liszt *Faust* Waltz-Paraphrase, but even more treasurable for its restrained yet lyrically eloquent performances of three Liszt *Sonetti del Petrarca*. Kentner's two Chopin Impromptus and Nocturne, Op. 27, No. 2, are perhaps less unusual, but they too are played with fine delicacy and grace, and the unexaggerated singing piano tone with its exquisitely

blended high-register richness is an aural joy throughout. Another piano disc of a very different sort, which has its own nostalgic charms that I greatly doubt can be enhanced to any considerable degree in a promised stereo edition, is *Linda's Player Piano* (Audio Fidelity AFLP 1846), a program of mostly old-time, mildly ragged, sentimental favorites spiced by surprisingly vivacious, however mechanical, piano-roll versions of *Under the Double Eagle* and *National Emblem* marches — all of which sharpen the great regret of my youth (and one which I'm not ashamed to confess that I still feel) that I never owned a player piano of my own.

Perhaps the finest of all sonic documentations of the blues is *Big Bill Broonzy — His Story* (Folkways FG 3586), in which one of the greatest of blues singers not only illustrates his genuine artistry in a wide variety of musical examples, but also discourses in a deftly conducted interview with Studs Terkel on his own early career, the origins of his songs, and the essential nature of the blues idiom itself. Ordinarily I don't care overmuch for recorded talks, but here Broonzy actually has much to say which is well worth hearing, and the value of both his remarks and his performances is further enhanced by a model booklet distinguished both by Charles Edward Smith's illuminating notes and David Gahr's no-less-illuminating photographs.

Where Stereo Excels

In other musical domains, however, I can give but cold comfort to the LP-only listener. In stage works, for example, although the few operas we have had so far in stereo — principally the Concert Hall tapings of La Bohème (RX 9)

and *Die Entführung aus dem Serail* (RX 52) — are far from satisfactory, the incalculable stereo potentialities are at least made more clearly explicit in the Broadway hit, *West Side Story*. Where the original-cast recording in LP (Columbia OL 5230) leaves a good deal to be desired, especially in conveying the dramatic impact of the violent ballet scenes and big ensembles, the stereo taping (TOB 13, two reels) is infinitely more exhilarating as well as immeasurably more realistic in capturing the intricate details of Leonard Bernstein's brilliantly imaginative scoring. The "Gee, Officer Krupke!" chorus, in particular, simply has to be heard in stereo if one wants to relish its ribaldry with something closely approaching the full gusto of its live performance.

Again in baroque music, stereo's superiority, if less overwhelming, is still clear cut, hard as it may be for the single-channel listener to realize that there can be much more in Janigro's Solisti di Zagreb Vivaldi *Seasons* and *Eighteenth-Century Christmas Music* than he can hear in the LP's (Vanguard BG 564 and BG 569). Alertly precise, buoyant, and finespun as these performances are, they assume expansiveness too, as well as a more glowing warmth, in their twin-channel tapings (VRT 4002, Vivaldi; VRT 3017, with the Corelli, Torelli, and Bach items in the Christmas program; and VRD 2, with the latter's Haydn *Toy* Symphony only).

Another, more obvious example is the *Black Watch Pipe and Drum* Tunes (Phonotapes "Cameo" SC 410), but here the advantage is not so much increased hall (or armory) spaciousness over that in the earlier single-channel versions (PMC 1009 tape and Folkways FW 8810 LP), as it is the more vividly dramatic illusion of a marching band in actual motion which, of course, only stereo can capture persuasively.

No less impressive, even without the aid of moving sound sources, is the immediacy and infectious vitality with which stereo brings comparatively small ensembles almost literally alive right into one's living room. Jazz bands have profited most by such galvanization so far and do so currently in such sonically as well as rhythmically electrifying tapes as the driving *Kenton in Hi-Fi* (Capitol ZD 10); richly sonorous and imaginatively scored *Four French Horns Plus Rhythm* (Dyna-Tapes DY 3001); glittering *Vibe-Rant* by Teddy Charles, et. al. (Dyna-Tapes DY 4001); Elliot Lawrence's more conventional but highly danceable *Swinging Dancers* (Fantasy FST 904); Joe Loco's perkily Latin-American-colored *Loco-Motion* (Mercury MBS 2-10); Dennis Farnon's ingenious departures from strict dance styles in *Caution! Men Swinging* (RCA Victor BPS 78); and even, or perhaps especially, Ray Conniff's *'S Marvellous* (Columbia GCB 14), in which schmaltzy wordless singers mellifluously augment and sometimes replace the usual instrumental sidemen.

Hungarian Paprika

Nevertheless, none of these, except perhaps the *French Horn Plus Rhythm*

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Electronic Firsts

by MONROE UPTON

Author of "Electronics for Everyone"

THE circuits of today's most versatile and up-to-date electronics gear are dependent upon a device older than our country: the little capacitor. You could no more build a modern electronic machine without capacitors than you could film a Western without horses. In the 18th Century, it was news from Europe of the discovery of this fascinating piece of apparatus, then known as the *Leyden jar* or *phial*, that started the astute Benjamin Franklin on his brilliant career as an electrician. In 1745, the Dutch professor Pieter van Musschenbroek and his assistant, while trying to transfer some of the charge from the friction machine to the water in a jar, received terrific shocks. Thus they learned the hard way that a jar partly filled with water, when held in the hand of a person who is grounded, will "condense" the electricity generated by friction. The discovery proved a bonanza to the electricians, who had gone about as far as they could with the lightning-like discharge from the friction machine direct. The jar's discharge was much more useful.

Some time later the condenser (capacitor) revealed the existence of what we now call *alternating current*. Because the electricians were unable to predict the polarity of an iron bar when magnetized by a condenser, such a current had been suspected. The suspicion was nailed down by America's great scientist, Joseph Henry, while he was at Princeton. Henry made over 1,000 experiments with needles, magnetizing each needle inside a spiral that received the condenser discharge. He came to this conclusion: "The discharge, whatever may be its nature, is not correctly represented (employing for simplicity the theory of Franklin) by a single transfer of an imponderable fluid from one side of the jar to the other; the phenomena require us to admit the existence of a principal discharge in one direction and then several reflex actions backward and forward, each more feeble than the preceding, until the equilibrium is obtained."

The old "imponderable fluid" theory was now down the drain. It wasn't until J. J. Thomson's discovery of the electron in 1897 that a satisfactory explanation of electricity's behavior was available.

PUZZLEMENTS

Continued from page 31

onances of the loudspeakers can very seriously complicate the distribution of frequencies between the two speakers under these circumstances. More than this, it can interfere with the transient damping of the speakers by the amplifier.

From this explanation my friend could readily see why recommendations have always been that loudspeakers should be connected in parallel rather than in series. "But," he said, "it didn't really sound that different when I tried it in series."

It is true that this big difference is largely a theoretical one. Pursuing the theory further, we can deduce that the over-all frequency response of the two loudspeakers *combined* will be practically the same whether they are connected in parallel or in series. It is just that the *distribution* of relative sound loudness at different frequencies is different in the series case, as compared with the parallel case. But the total output will follow much the same frequency response whichever way the loudspeakers are connected.

The usual reason for connecting two loudspeakers to the same amplifier is to get a broader sound effect, making single-channel sound rather more like stereophonic presentation. So the matter of changing from a parallel to a series connection will slightly modify the character of the pseudo-stereophonic effect achieved, by altering the relative distribution of sound energy between the two loudspeakers at different frequencies.

This leaves as the only important difference the change in effective damping factor for each loudspeaker as an individual entity. "But surely the effect on transient response should be more noticeable than this," my friend observed.

The fact that it is not is explained by the relative inefficiency of most dynamic loudspeakers: 20% is a very high efficiency for a cone-type loudspeaker; 5% is more representative, and many run even lower than this. Any resonance in the enclosure, or any other source of possible ringing that might *need* electrical damping, has at best a

Continued on next page

GROUNDED EAR

Continued from page 4

14 Kc and extends beyond. Response of the Midget goes beyond 12 Kc.

Sound produced by the Highlander is similar to that of the Black Box. The Highlander is beautifully finished in solid mahogany and veneer, with a handsome solid-mahogany grille. It can be mounted on wrought iron or brass legs, or used on the floor or in a bookshelf. The Black Box is utilitarian, in black matte finish. It can be built into present cabinets, in the wall, or into wall dividers; or it can be covered with fabric, wood, or plastic for various decorative effects. Both are solidly made of ¾-inch materials. There is a choice of several painted colors for the finish on the Midget.

I listened mostly to the Highlander and I found the sound far more impressive than the size, price, or measurements led me to expect. It delivers an excellent bass without too much bass boosting even at whisper levels. Moreover, driven by a well-damped amplifier with good low-frequency characteristics, the bass is cleaner and better defined than I expected. The big drums on records come through deep and low with really awsome effect, and the organ pedal sounds pretty good, too. Placing the vents in the rear was a happy idea because it spreads the sound source more widely. Highs are clean and very well balanced to the woofer.

Though the response to 45 cps is excellent, the cutoff below that is sharp and the system has very little response at the rumble frequencies of turntables and changers. All in all, the sound was admired by visitors and would, I'm sure, please a good percentage of hi-fi shoppers, especially those who want the most

Continued on next page

PUZZLEMENTS

Continued from preceding page

remote chance of getting it — even if an amplifier with infinite damping factor (or zero source resistance) is used, because the drive still has the resistance of the loudspeaker's *own* voice coil in series with it.

To illustrate: assume that the loudspeaker is 10% efficient. The reflected impedance due to radiation resistance will be 1/10 of the voice-coil resistance. From the acoustic point of view, critical damping may need a resistance of only 1/10 of the actual voice-coil resistance. So if this loudspeaker is fed through another impedance equal to the voice-coil resistance, the effective damping factor is reduced merely from 1/10 to 1/20.

Thus, the practical story is a very different one from that idealized by the protagonists of a high-damping-factor amplifier. In practice, the difference in effective damping on the loudspeaker by connecting in series or in parallel is so small, with average loudspeaker efficiencies, that the over-all difference in performance often is not even noticeable.

GROUNDED EAR

Continued from preceding page

for the least money and in the least space. The Black Box was very similar. The Midget, of course, has no real depth in the bass, but did deliver a clean and well-balanced sound with enough bass to set the beat.

University Loudspeakers is using a single ducted vent in its new Ultra-Linear system. The speaker is resonant at 20 cps, and the enclosure is resonant at 30 cps; it is roughly the same size as the Highlander. I hope to be able to test and report on it more fully some time in the future. Meanwhile, it is apparent that through the use of ducting, bass-reflex enclosures can produce highly impressive sound in far smaller volumes than were thought needed.

The Hegeman Horn

Usually, I make no attempt to judge speakers at hi-fi shows, but one that impressed me despite the handicaps of the last New York show was the new speaker system designed by Stuart Hegeman and marketed by EICO. This is a unique design which is called a horn but which, rather obviously, doesn't look like a horn nor quite meet the definition of a horn. It is a vertical enclosure in which the back of the cone works into two long folded chambers that have a horn taper, but which terminate not in a big mouth but in two small, narrow slots. I suppose one could say they are horns whose mouths were loaded with slots. In any event, the air column of the horns is nearly 6 ft. long, and the taper is very gradual, so that the column resonances are very low in frequency. The midrange is radiated directly and omnidirectionally by the front of the cone, and the highs are directed by a unique and effective diffuser. In addition to the horn loading, there is a carefully proportioned throat chamber just back of the cone whose resonances help balance the middle-range response.

Clearly, this is one of the most individual speakers on the market, and one whose design will no doubt engender a great deal of discussion. Its performance demonstrates again that the important matter in speaker systems is not what they look like nor how they can be analyzed, but how they sound. What I heard of this one sounded very good indeed, with a notably clean, well-defined bass, and fine transient response. There was a larger Hegeman speaker at the show which presumably used the same principles, whose sound was to my ears absolutely first rate; but that one, I understand, is not in production. At any rate, what with the ducted-port bass reflex, acoustic-suspension infinite baffles, and now this "horn" that occupies one square foot of floor space, it is apparent that there is no longer any necessary correlation between quality and the size of a speaker system.

TRANSISTORS

Continued from page 35

details. Unfortunately, at this state of the art it is *not possible* to match transistors in all important respects, and so the even-order distortion is not completely eliminated. How much is eliminated is a measure of how well matched the transistors are in gain, cutoff current, input characteristic, frequency response, and falloff of gain with high currents. Using unmatched pairs of transistors, push-pull amplifiers can have quite bad even-order distortion.

Single-Ended Push-Pull. Again, two identical transistors are used, as indicated in Fig. 5. The two separate secondaries of the driver transformer are phased so that when one transistor tends to conduct more, the other tends to conduct less. The difference of the two collector currents flows through the load.

The circuit can be biased to operate either Class A, Class B, or Class AB. Ordinary biasing methods applied to each transistor do the job.

If a special transformer with two secondaries is not available, the stage can be driven by two separate tandem drivers. This has been called "quasi-complementary" operation.

As is the case with conventional push-pull circuits, even-order distortion theoretically should not be present in the output. But in practical cases matching transistors closely enough is not possible, and the second-harmonic distortion may be quite great.

Note that no output transformer is necessary because the output is single-ended. But two batteries are usually required, or else a double-ended power supply.

This type of circuit is also possible with vacuum tubes and, in fact, has been used occasionally.

Complementary Push-Pull. This differs from previous types of circuits in that it cannot be duplicated with vacuum tubes, since it requires two transistors of opposite conductivity: one *p-n-p*, and one *n-p-n*. Again, the biasing can be set so that the operation is Class A, Class B, or Class AB.

As Fig. 6 shows, both the input and the output are single-ended, so that coupling from the driver and to the load is quite easy. In many cases no transformer is necessary.

When the input signal is positive, the lower (*n-p-n*) transistor tends to conduct more, while the other one tends to conduct less. The difference between the two currents will flow through the load. On the next half-cycle, the upper transistor conducts more, and the current difference is in the opposite direction, meaning current flows through the load the other way.

While coupling to the stage is not difficult, biasing presents more of a challenge. In Fig. 6, the two bases are at the same voltage, as are the emitters. This means the stage is biased for Class-B operation. Biasing to eliminate crossover distortion is difficult, since the necessary bias voltage is different for the two bases. Biasing for Class-A operation is possible, however, if capacitor input coupling is used.

The bias points can also be set by driving each side separately with a tandem-coupled transistor, the two driving transistors also operating as a complementary pair.

Two batteries are usually required here, as in the single-ended push-pull case.

Theoretically, if the two transistors were identical but opposite, second-harmonic distortion would be eliminated. But matched pairs of *p-n-p* and *n-p-n* transistors are even harder to find than matched pairs of the same conductivity. The necessary parameters cannot be matched in opposite types of transistors for a variety of theoretical and practical reasons.

The complementary circuit, then, is simple in some respects, but more complicated in others. It has worse distortion from differences in the two transistors.

Others. There are other forms of push-pull output operation. In one of these, for example, one transistor is biased at saturation. Thus, one transistor truly "pushes" while the other "pulls." This and other uncommon circuits are not important and are not used much.

READERS' FORUM

Continued from page 15

$1,000 electronic spinet model. They like music that is melodic and harmonious, with a little fortissimo thrown in occasionally for accent. And this the average electronic organ, divided or no, supplies. Properly designed to produce variable attack and decay rates, as well as legato, staccato, and vibrato, it is truly a versatile instrument in a small package. With a good skipper at the helm anything from swing to symphony can be executed.

Some of the exponents of a particular brand of instrument are fast on the draw when it comes to panning their competitor's product. I well recall how quickly the opportunists jumped on Richard Dorf with both feet on one occasion. Many electronic organ enthusiasts will recall the series of articles on commercial organs and associated circuitry written by Mr. Dorf and which appeared in a contemporary publication several years ago, as well as in his book entitled *Electronic Musical Instruments.*

The Baldwin Company co-operated beautifully in supplying detailed data on their instruments and Mr. Dorf did an excellent job of portraying the material in language which any man-on-the-street type of individual could understand. Unfortunately, when he referred to the tones produced by the various stops Mr. Dorf used the word "distortion." Up jumped not one but a plurality of devils who seized upon this statement as proof positive that the Baldwin organ was prone to distortion, and therefore mediocre.

It so happens that the Baldwin instrument generates a good sawtooth wave. Any budding electronicist with a flair for music knows that a perfect sawtooth wave shape contains all harmonics, both even and odd, in inversely descending order. That is, as the numerical designation increases, the amplitude of the harmonic decreases in accordance with a mathematical retrogression comprising a Fourier series.

There is nothing outstandingly musical about a raw sawtooth wave. To utilize its possibilities, the amplitude of some of the harmonics is increased or decreased and some may be eliminated entirely. This is called tone shaping. It also results in a DISTORTED sawtooth wave shape. So why not call a spade a spade instead of palming it off as an 1847 soup slinger, and say that the various tones, or stops, are distorted (or modified) sawtooth waves? But the publicity fellows will get in their two-cents' worth to make a fast buck, come Halifax or high water.

Some good organs are designed utilizing frequency division and some not so good are available without it. And so the argument rages. Or, to paraphrase Shakespeare, "To divide or not to divide . . . ."

There is also another aspect to the evaluation of organ music which involves, at least in the opinion of some persons, traditional values. I refer to those dyed-in-the-wool individuals who insist that they must have the white noise along with the harmony in order to call the whole agglomeration music. Because the lack of funds or space or both prevents these people from having a medieval edition with 20 ranks of pipes in the living room, I would extend the following suggestion.

Make a tape recording of the pipe organ of your choice. It would undoubtedly have to be a European instrument, since no American installation would provide all the thumps of keys striking moth-eaten felt, squeaking pedals, rattling valves and chattering stop slides which are considered essential to absolute authenticity. In addition, the opportunity for a climaxing crescendo created by the collapse of the bench as the posterior of the organist lands in the pile of splintered lumber (literally, aged in wood!) would be much greater if an Old Heidelberg or Augustinian job were selected.

The music component would be removed by suitable filtering, leaving a perfect white-noise recording. This tape could then be synchronized with the output of a contemporary Hammond chord organ costing one-tenth or one-one-hundredth that of a Kilgan or a Mighty Wurlitzer. (I will supply details if requested to do so — for a fee, of course). Then we will have an everyman's instrument with all the romance and antiquity of sound of the sixteenth-century model for the purists and at the same time can supply the modest needs of the bourgeoisie (including myself) sans noise by merely opening the tape switch.

Incidentally, just why these various and sundry *divertissements* are called white noise has never been satisfactorily explained to me. What's white about it? I would be inclined to call it the black plague.

By this time, I presume that I have committed rank heresy and have been written off by the classicists as a menace to idealism. As I bring this blast to a conclusion I am contemplating the storm cellar in the back yard. Perhaps tomorrow I will install some supplementary props to bolster up the roof.

John F. Ginter
Madison, Wis.

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ERRATA

Although we got by for several months consecutively without serious editorial *gaffes*, the law of averages finally caught up with us. To wit:

In the December 1957 issue, page 20, the contact arrow is missing from the switch in Fig. 1. The arrow should be hinged at point S, of course, and make contact alternately to points 1 and 2.

In the January 1958 issue, page 36, there are two errors that may fairly be called egregious. Please delete, in your copies, the Audio Aids headed "Acoustic Lining" and "Transformer Voltage Booster." Styrofoam plastic is *not* a good material for acoustic lining in loudspeaker enclosures; it has about the same absorption properties as wood. The power transformer voltage "booster" will indeed boost the AC voltage on one half of the secondary winding, but it will *reduce* the AC voltage on the other half. This may damage the rectifier tube; it will certainly increase the ripple amplitude of the power supply, which will increase the hum level. Don't use it.

Finally, in the March 1958 issue, page 19, Fig. 10, the second chart line should be labeled "0.1%" rather than "1%." Our apologies are offered herewith to readers and to the Dyna Company for increasing tenfold the Dynakit preamp's IM distortion.

AUDIO AIDS

Continued from page 37

article [see Seagrave, "Spotlight on Phono Mounting," December 1957 issue] provides clearance for horizontal motion, which is the direction of objectionable pickup-jiggling motion. With about one diameter of free spring, the frequency of horizontal motion is also about 5 cps (this may be adjusted with the aid of the leveling nuts).

It is necessary to damp the springs so that an accidental jarring is rapidly quieted, and so handling the equipment doesn't set the system into prolonged hysterics. I used bits of plastic foam stuffed inside the springs, and adjusted the amount until the damping was satisfactory.

John D. Seagrave
Los Alamos, N. Mex.

Spare-Fuse Storage

Since that spare fuse for my amplifier always seems to be buried in some obscure corner in time of emergency, I have hit on a new method of storage which saves me much time and fuss.

I simply strap the spare fuses to the chassis with a strip of black plastic tape. Scotch tape or paper masking tape would serve the purpose equally well. Thus, the fuses are on location and ready for instant use when needed.

Alan M. Palmer
Brooklyn, N.Y.

SOUND FANCIER

Continued from page 39

tape, gave me any more, if as much pleasure than all four of the current Hungarian gypsy-music reels: Edi Csoka's *Gypsy Magic* (Livingston 723 BN), Béla Babai's *Haunting Hungarian Melodies* (Period PST 1), Lendvay Kálmán's *Gypsy Passion* (Sonotape SWB 7005), and János Hosszú's *Cymbalom in Hi-Fi* (Period PST 9). Perhaps I'm a sucker for this idiom with its side-slipping fiddling, clattering cymbalom, and constant oscillations between very slow rhapsodic sentimentality and very fleet vivacity. But in any case these tapes not only rank among the best stylistic examples I know on records, but in stereo are of uncommon sonic interest — most of all perhaps in the very brilliantly recorded and beautifully performed Sonotape and the Period cymbalom documentation, of which the latter gives the most varied techniques characteristic of this extraordinary hammered-string instrument, solo, duo, and in accompaniment, that I've ever encountered outside Budapest cafés themselves.

Interpretative and Acoustic Uncertainties

Returning to symphonic domains, a number of LP's on hand this month strike me as somehow less than completely satisfactory for reasons which may or may not similarly affect my evaluations of the corresponding stereo versions which, although already announced, have still not — after the fashion of too many currently advertised tapes — reached me. Stokowski's remake of his famous reading of the Glière *Ilya Mourametz* Symphony (cut edition; Capitol P 8402) is wonderfully rich and glowing in most respects, but I doubt that even stereo can disguise the fact that his present Houston Symphony strings are a far cry, especially in their higher registers, from the Philadelphian ones he used to exploit so caressingly; it could make it even more obvious. Certainly Rachmaninoff's Second Symphony, an exotically colored and tunefully rich work, is not sufficiently magical in Paray's Detroit Symphony performance (Mercury MG 50142) to be saved by stereo enrichment of the unduly dry acoustical quality of the Ford Auditorium. And I doubt whether Eugene List's somewhat oversober and impersonal readings of Gershwin's Concerto in F and *Rhapsody in Blue* with the Eastman-Rochester Symphony under Hanson (Mercury MG 50138) can benefit too much by stereo. But in this case, the LP is flawless in itself.

The problem of unpleasantly dry acoustics which I raised in the case of the Paray disc above, and which has been a subject of considerable critical

controversy among listeners to live performances in Detroit's Ford Auditorium, is a particularly fascinating one for audiophiles. For me, it seems that the best way of solving it (short, of course, of moving to an innately more reverberant recording location) is by choice of suitable music, such as Paray's coupling of the Haydn *Miracle* and Mozart *Haffner* Symphonies (Mercury MG 50129). Here again the sonics are definitely lusterless, but the effect on the music itself is by no means harmful as on the lush romanticism of Rachmaninoff or the airy impressionism of Debussy. In the latter vein, I do find that stereo is a great help, if not a cure-all, for in Paray's Ford Auditorium tapings of *The Afternoon of a Faun* and *Ibéria* (Mercury MBS 5-8), the sonorities are indeed notably richer and more glowing.

Miscellaneous LP Recommendations

Rather than cite more such uncertainties or harp further on the difference between single- and dual-channel recordings, let me wind up for the special benefit of nonstereoists with a few heterogeneous examples of LP's I've enjoyed without even wondering what they might sound like in stereo, although some of them (those starred) eventually will appear in stereo versions. But at least until I actually hear the tape versions, I am quite happy with these discs just as they stand now: *The Weavers on Tour** (Vanguard VRS 9013), a second volume of jaunty folksinging in actual-performance recordings made in Carnegie Hall, and a worthy sequel to the first disc, reviewed here last January; Erich Kunz's Vol. 2 of *German University Songs** (Vanguard VRS 1010), which is a little heavy in Teutonic sentiment for my taste, but superbly done of its kind; *Tropical Cruise** (Audio Fidelity AFLP 1841), one of the best samba-bolero-mambo-beguine-etc. collections I've yet come across, with mercifully few but good vocals, and ultrabrilliant recording of the maracas, drums, piano, and brass of Pedro Garcia's topnotch Del Prado Orchestra; *Sultan of Bagdad** (Audio Fidelity AFLP 1834), more intoxicating "Port Said" *divertissements* by Mohammed El Bakkar and his Oriental Ensemble, to which my only objections are that the festive mood is too seldom varied and I'd welcome some instrumental-only relief from the constant singing and chanting — effective as these are; *Resort Favorites for Dancing* (Unicorn UNLP 1049), unhot but highly danceable "business-man's bounce" toe ticklers by Harry Marshall's Orchestra; and *Bright Flight* (Vanguard VRS 8512), a collection of unhackneyed arrangements starring the truly sparkling piano (incidentally a far better sounding instrument than those of most pops and jazz bands) of Ronald Bright.

AUDIOLAB

Continued from page 28

showed evidence of conservative design and operation of its components. The AC line leakage was entirely negligible (10 μa).

Summary

The McIntosh MC-60 lives up to its reputation as one of the finest amplifiers made for high-fidelity home music systems. It meets its published specifications, and in the case of distortion, greatly exceeds them. Its hum level is inaudible under any conditions. Its output tubes are operated well below their ratings under normal home-use conditions.

Although it is a "basic" amplifier, it is extremely flexible in its application to different installations. All inputs and outputs are available on a terminal strip or on octal sockets for use with plug-in wiring. A power socket provides all power needed for operation of the McIntosh C-8 preamplifier (or most other preamplifiers not having their own power supplies).

In our opinion, one of the very tangible advantages of the MC-60 over its competitors is the fact that under ordinary listening conditions, it draws only 155 w from the power line — little more than half as much as other high-power amplifiers. This not only means lower power bills, but fewer problems with heat dissipation and consequent longer component life.

$85 MUSIC SYSTEM

Continued from page 29

is used as a ground connection between the two units.

I pushed each cup down over its terminal and that solved the problem. The hum disappeared forever.

What amazed me most was that the FM tuner did not require any further alignment. I had been warned by friends that I would probably have to call in a serviceman to align this instrument after it was assembled, and I was prepared to seek help if required; but it wasn't necessary. Station after station came in perfectly and the set has worked that way since it was finished.

Friends who visit us won't believe at first that we put our system together ourselves and that it cost $85. Many of them have sets that cost three times as much and they say the quality of their reception is no better.

Now we're saving up for a good record changer and then, we hope, a tape recorder. Meanwhile, we're thoroughly enjoying broadcast music and it seems to have an extra flavor because it comes through a rig that we assembled ourselves.

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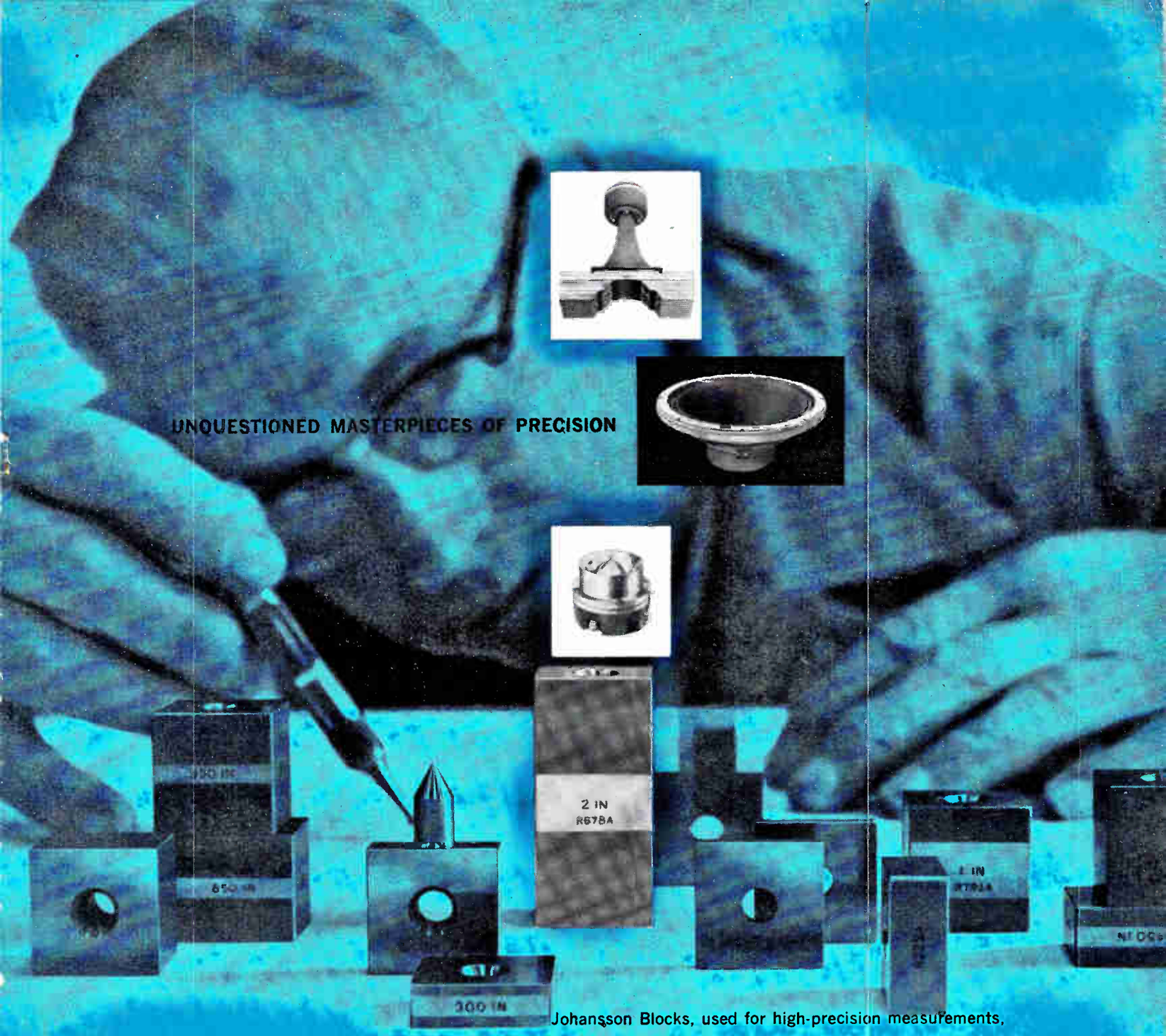

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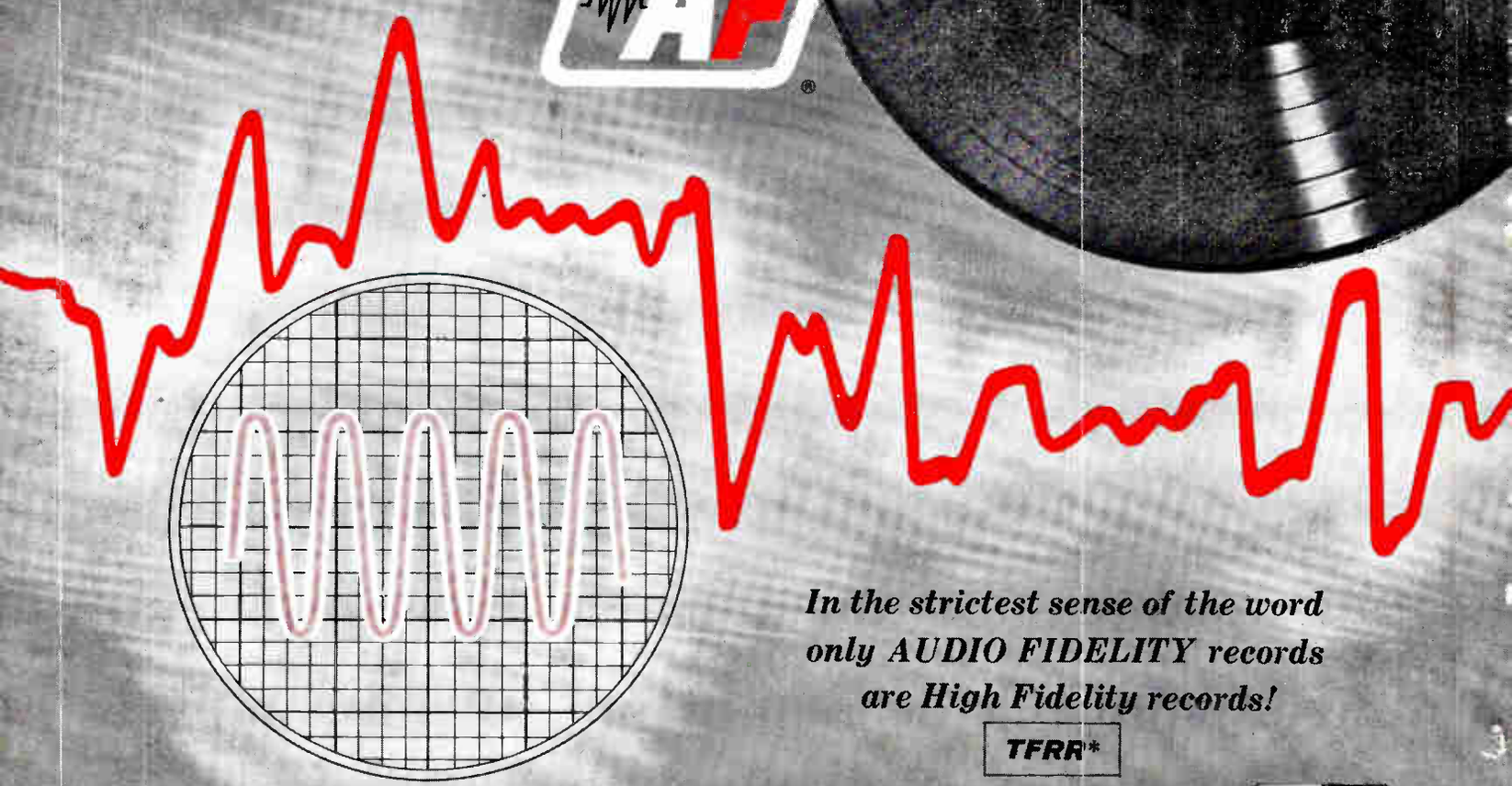

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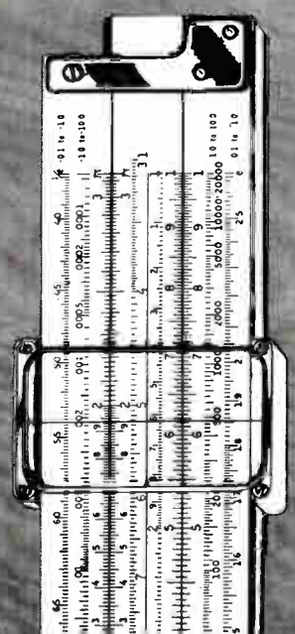

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