SEPTEMBER • 35 CENTS

Mono Pickups vs. Stereo Discs

ICD

audiocraft

for the HI-FI hobbyist

Make a printed-circuit oscillator and square wave generator

The Eico HFT-90 FM tuner: this month's Audiocraft Kit Report

How to add feedback to transistor audio amplifier circuits

THE Garrard PAGE

Serving the owners of Garrard—
world's finest record playing equipment...
and other discriminating listeners
interested in high fidelity.

Subject:

Your new records
—Monaural and Stereo—
played on the Garrard...
Changer • Transcription Turntable • Manual Player

Standard
Garrard Tone Arm
with Stereo Cartridge
(underside view
through a
translucent record)

What records?
Any records . . . stereo or monaural.

How do they sound?
Uniformly excellent—on any Garrard Player.

Rumble (lateral and vertical), wow and flutter are inaudible, since motors and drives are entirely Garrard built; with pulleys concentric to .0001 of an inch; and rotors dynamically balanced to the remarkable accuracy of .0008 in/ozs. These characteristics, developed originally by Garrard to insure proper performance of very low gain magnetic cartridges, have now been even further refined, and make any Garrard an ideal stereo player.

Which Garrard model?
Any Garrard Record Player or Changer.

They all come wired and ready *now* for stereo *and* monaural cartridges . . . (Older Garrard models already have the triple pronged plug-in heads to facilitate rewiring.) And Garrard changers have been tested and enthusiastically endorsed by the leading stereo cartridge manufacturers.

Transcription Turntable or Automatic Changer?
As long as it's a Garrard—this depends entirely on your preference, your budget, and your convenience.

Garrard builds all types . . . automatic changers, transcription turntables and manual players . . . all to the identical standards of quality in design, engineering and performance. Every Garrard is a high fidelity instrument; every Garrard automatic changer is a single record player as well. For this reason, it is a fact that most people, even the most critical, prefer the Garrard changer to *any transcription turntable.*

Considering the exciting (but sometimes confusing) developments now taking place in records and playing equipment, we repeat the Garrard policy:

Garrard models change. Garrard ideals do not. Meaningful new features are added. Time-proven features are carefully retained. Gadgets, for the sake of gadgetry, are sternly rejected. The all-important fact to remember is that thirty-five years of experience in designing, testing, and building fine record players, make possible the present Garrard models.

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

RC98	RC88	RC121/II	301	TPA/10	Model T/II
Super Changer	Deluxe Changer	Intermix Changer	Transcription Turntable	Transcription Tone Arm	Manual Player
$67.50	$54.50	$42.50	$89.00	$24.50	$32.50

GARRARD SALES CORPORATION, PORT WASHINGTON, N. Y.

Canadian inquiries to: Chas. W. Pointon, Ltd., 6 Alcina Ave., Toronto.
Territories other than U.S.A. and Canada to: Garrard Engineering & Mfg. Co. Ltd., Swindon, Wilts., England

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Port Washington, New York.

Please send your new comparator guide which compares all Garrard players and their advanced features.

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FOR ANY HIGH FIDELITY YOU OWN...

STEREO IS ONLY 60 SECONDS AWAY

WHEN YOU CONVERT WITH THE HARMAN-KARDON AX20

60 seconds. That's all it takes to create a complete stereo electronic center with the new Harman-Kardon Nocturne, Model AX20. To convert your present system—component or console—to stereo, simply plug the AX20 into your present amplifier.* *This one connection does it all.*

With the AX20 there's no shuttling back and forth between two different instruments (you can even tuck your present amplifier out of sight); no adapter box to complicate matters. This one unit—the AX20—controls the power to both amplifiers. It also controls treble, bass, volume, contour, balancing and equalization for both.

The AX20, in brushed copper and black, is strikingly handsome in appearance and outstanding in its performance characteristics. The amplifier delivers 20 watts of hum-free, distortion-free power (40 watt peaks). An exclusive new high gain phase inverter utilizing both positive and negative feedback drives the output tubes with minimum phase shift and excellent stability. As a result, the power amplifier has instantaneous recovery time resulting in uniquely clean and faithful transient response. The AX20 actually produces more clean useful power than conventional 30 watt amplifiers.

The preamplifier is a dual stereo device incorporating ganged bass and treble tone controls, loudness control, contour control, rumble filter, balance control, mode switch, speaker selector and function switches. Selectable equalization is provided for records and tape (7½ and 3¾ IPS). The second preamplifier delivers ½-volt output at low impedance.

The Nocturne, Model AX20 (less enclosure) $99.95
Model AC20 enclosure (optional) $8.95

Prices slightly higher in the West

For complete information on the AX20 and other fine Harman-Kardon stereo and monaural high fidelity instruments write to Dept.AC-9, Harman-Kardon, Westbury, New York.

*To round out your stereo system—add an appropriate second speaker and stereo cartridge or tape deck — or both.

THE AX20 IS PERFECT FOR MONAURAL NOW—STEREO LATER

The AX20 is the perfect unit for those who desire monaural high fidelity today with the assurance of simple conversion to stereo later. Because it incorporates dual stereo preamplifiers plus a powerful 20 watt amplifier—just add a basic amplifier (the new Harman-Kardon HK20 is ideal) at any time and your system is complete. The remarkable AX20 costs no more than conventional monaural 20 watt amplifiers. The HK20 price, with cage, $59.95.

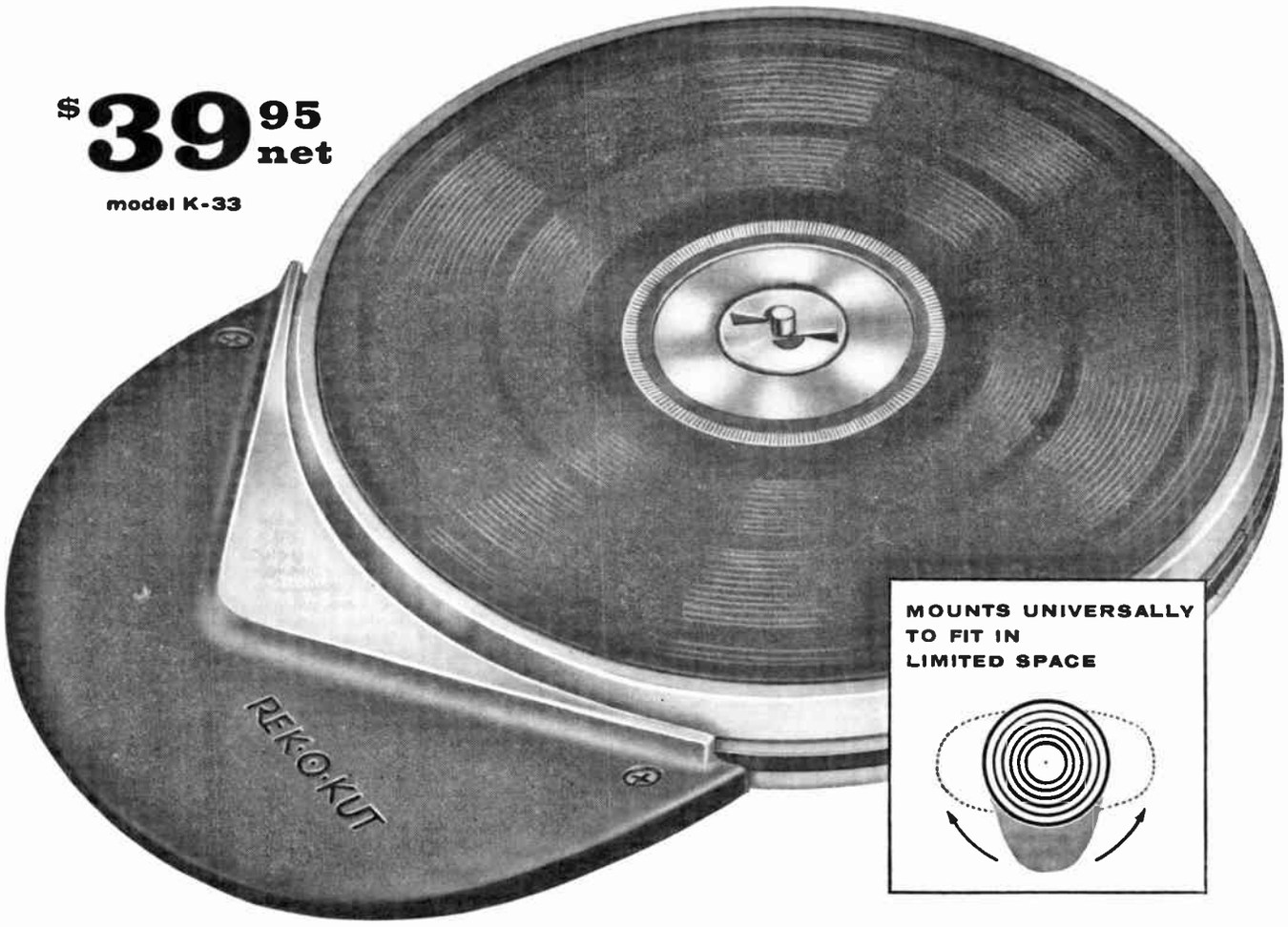
harman kardon

now...a Rondine Turntable
IN KIT FORM!

for less than the cost of a "high fidelity" changer!

$39.95 net

model K-33



Just in time for the era of stereo...a revolutionary break-through! A Rondine Turntable...IN KIT FORM...saves you money...lets you enjoy stereo at its best—free of vertical rumble! Because *you* assemble it, you save. Because it offers the same Rondine engineering, you get accurate, silent operation...for keeps! Mount the exclusive lathe-turned tapered aluminum turntable (it's mated to its own self-lubricating bearing-well) to the rugged deckplate. Fasten the motor to its mounting...add the belt, cover plate and power switch. You're done in thirty minutes or less...thanks to the simplicity of Rek-O-Kut design! Styled by noted industrial designer, George Nelson! Ask your dealer for this new Rondine from Rek-O-Kut...winner of top test ratings three years in a row ...style leader chosen for display at the Brussels World's Fair!

ADVANCED FEATURES OF NEW RONDINE K-33 STEREO TURNTABLE!

- Single-speed (33⅓ rpm) Crown-Spindle Belt Drive. Custom-made endless-woven fabric belt with thickness held to ±.001. Adjustment for belt tension.
- Assembly time for mounting: about 30 minutes with simple tools. Template supplied.
- Noise level:-47db. (NARTB standards.)
- Motor: 4-pole induction motor, designed and built to Rek-O-Kut specifications.
- Built-in strobe disc: for checking speed.
- Turntable: Heavy Cast Aluminum, lathe-turned. Tapered for easy disc handling.

• *Bases and mounting boards available.* • *Also see the all-new, improved, factory-assembled Rondines at your dealer!*

PERFECT TURNTABLE MATE... AUDAX TONEARM —— the only stereo tonearm in kit form!

Assemble in 15 minutes... no mechanical skill needed! A professional tonearm precision-engineered to highest broadcast standards. You save over 50% simply because you assemble it yourself. Ingeniously simple for foolproof operation, dependable performance. Takes all stereo cartridges. 12" arm—KT-12—$15.50. 16" arm—KT-16—$18.50.

Send for new 1958 Catalog.

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RK-58

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SEPTEMBER 1958

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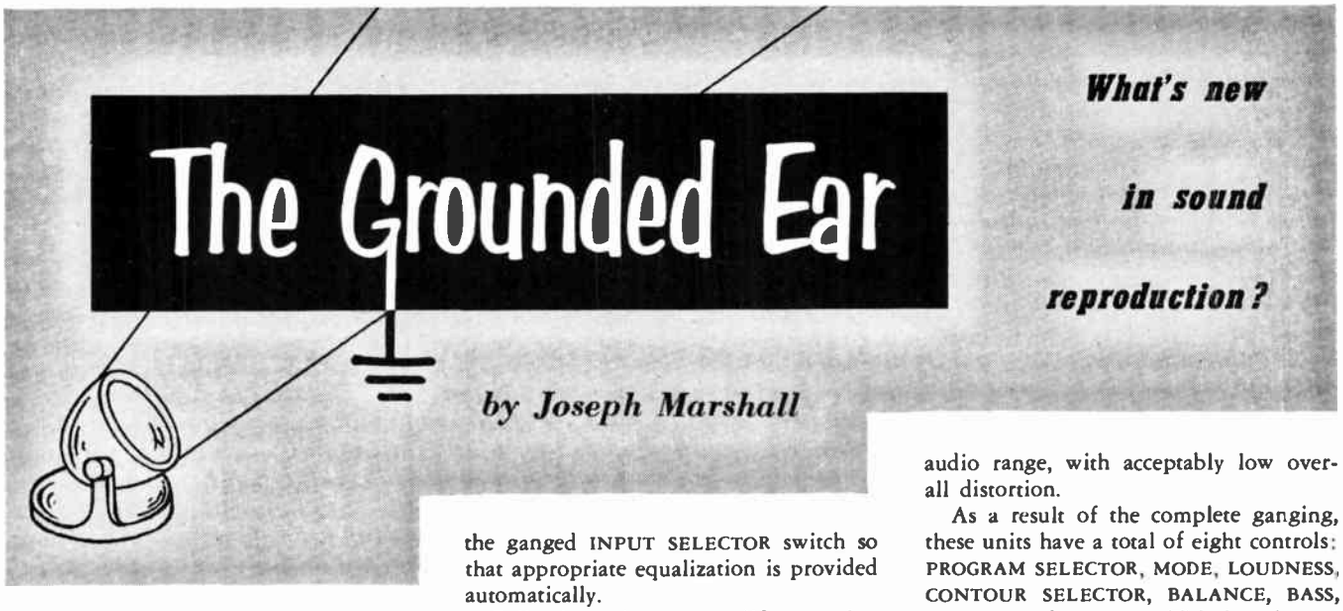


The Grounded Ear

What's new in sound reproduction?

by Joseph Marshall

The Ganged Approach to Stereo

One of the first problems a designer (or purchaser) of a stereo system faces is this: should the controls of the two channels be independent or ganged, or some combination of both? Independence of the controls provides the greatest flexibility, but, considering the fact that each channel may require as many as six or seven controls, the resulting multiplicity of knobs can be very confusing and may require considerable skill in adjusting properly. On the other hand, ganging of the controls produces a system

Pilot SP-215 stereo preamp.

no more complicated than a single-channel system, but at the price of flexibility.

The Pilot Radio Corporation line of stereo equipment is a good example of the ganged approach. Pilot was kind enough to supply samples of its SP-215 preamp and SM-224 integrated amplifier so I could judge the merits and demerits of the system under several conditions.

The preamp portions of the two units are almost identical. Each of the two

Pilot SM-244 stereo amplifier.

channels has provisions for five inputs, including one for a magnetic phono pickup with RIAA equalization, and a direct tape-head input with NARTB equalization. The equalizers are switched in by the ganged INPUT SELECTOR switch so that appropriate equalization is provided automatically.

Following the preamplifier section there is the MODE SWITCH, with four positions. Two are for stereo and provide a means for reversing the two stereo channels. The other two are for monophonic sound and feed either the Channel-A or Channel-B inputs into both channels in parallel. Consequently, in monophonic use the system operates with the speakers as a spaced pair. There is no provision for paralleling the inputs of both channels in order to eliminate vertical response from stereo pickups when playing monophonic records.

Next in each channel there is a loudness and volume-control section, with a contour selector switch providing a choice of four loudness-compensation curves and a flat curve. The CONTOUR SELECTOR and VOLUME controls for both channels are also ganged.

The loudness section is followed by the BALANCE control. This is another ganged pair of controls, one in each channel, so arranged that as the gain of one channel is increased the gain of the other is decreased correspondingly.

In the SP-215 preamp the output is through cathode followers. But there are two additional channels in parallel with the playback channels to feed a tape recorder. Each of these has an amplifier and a VU meter and will deliver 90 mv at 0 VU. There are independent level controls for each of these tape channels. The 215 will be of special interest to those interested in stereo tape recording because only a very simple recorder is needed in addition to the SP-215, to provide complete stereo recording and playback facilities.

The new SP-210, which I have not used, is very similar but does not have the metered tape channels.

The SM-244 has the same preamp section but terminates in a pair of 12-watt amplifiers having a paraphase inverter and two EL84's for each channel. These deliver 10 w apiece over the full audio range, with acceptably low overall distortion.

As a result of the complete ganging, these units have a total of eight controls: PROGRAM SELECTOR, MODE, LOUDNESS, CONTOUR SELECTOR, BALANCE, BASS, TREBLE, and ON-OFF. This is only two more than the average monophonic system.

There is no question about the virtue in simplicity of operation of this ganged system. Once the balance is adjusted, operation is precisely the same as for a monophonic system. No special skill is needed and even the ladies in my household had no trouble obtaining satisfactory quality.

I used the SM-244 with a pair of AR-2 speakers spaced about 6 ft. apart in our town apartment. The combination delivered very high-quality sound in both stereo and monophonic modes, and from monophonic or stereo discs, tapes, and radio broadcasts. For those who start completely from scratch and will use identical speakers, the 244 provides in a compact form an excellent and economical stereo amplifier.

Similarly, I found that if the SP-215 is used with identical amplifiers and speakers, the ganged arrangement is perfectly satisfactory. The balance control provides enough adjustment for the slight differences in gain which could be expected.

But my initial assumption that a ganged system would not be wholly satisfactory with dissimilar amplifiers and speakers was confirmed when I tried the SP-215 with a variety of odd preamplifiers and speakers. The balance control had enough range to take care of differences in sensitivity and gain. And it was usually possible by shifting the combinations around to obtain a reasonably good quality. But I missed the ability to trim up the response of different speakers with individual tone controls, and obtained better results, I thought, with control units which did provide independent tone controls for each channel. Whether the improvement would be sufficient to justify the inconvenience of the added controls would depend on the point of view, and the circumstance.

by RICHARD D. KELLER

book reviews

Principles of Electronic Instruments

Gordon R. Partridge; pub. by Prentice-Hall, Inc., Englewood Cliffs, N.J.; 392 pages; $11.00.

This text could form the basis of a most interesting and practical college or technical-school course on electronic instruments, and prove useful as well to the graduate student or engineer who is developing special-purpose instrumentation.

The major part of the book deals with instruments to measure electrical quantities by electronic methods (VTVM's, electrometers, phasemeters, etc.), and the rest treats nonelectrical quantities, with emphasis on transducers which convert the quantity in question into an electrical signal which can then be measured by instrument.

The level of mathematical material varies considerably, depending on the topic. Operational transform techniques, calculus, algebra, and arithmetic are used as required. A number of modern commercial instruments are used to exemplify some of the principles involved.

In the industrial world today, electronic instruments find a place in measuring almost any quantity one might mention — acceleration, velocity, displacement, force, strain, thickness of materials, mass and weight, pressure and vacuum, temperature, light intensity and color, radioactivity, chemical quantities, medical and biological measurements, applications to safety and inspection devices, and many others. The ideas presented will open many interesting possibilities.

Transistor Electronics

Ed. by David Dewitt and Arthur Rossoff; pub. by McGraw-Hill Book Co., Inc., New York; 380 pages; $4.95.

This text is one of a rash of recent books on transistor devices and circuit theory. It takes a mathematical approach, but does not present actual circuit component values. Specific prototype uses are stressed rather than a comprehensive, all-inclusive handbook-type coverage. The early chapters deal with semiconductor physics, quantum mechanics, energy band theory, and Fermi-statistics, while later ones cover transistor devices themselves, relating device properties to physical theory.

The text seems to be well balanced and up-to-date, and it contains numerous problems after each chapter.

Sound

Alexander Efron; pub. by John F. Rider, Publishers, Inc., New York; 72 pages; $1.25, paper-bound.

This booklet is another fine addition to the Basic Science Series; it is both rigorously accurate and easily readable for anyone. There is no math.

Scores of excellent illustrations and analogies are used to demonstrate the physical and psychological aspects of sound from the originating vibrations to the cochlear response of the inner ear. It is interesting and educational, and regardless of how well versed you are in high fidelity, you'll be surprised at what you can learn from these pages.

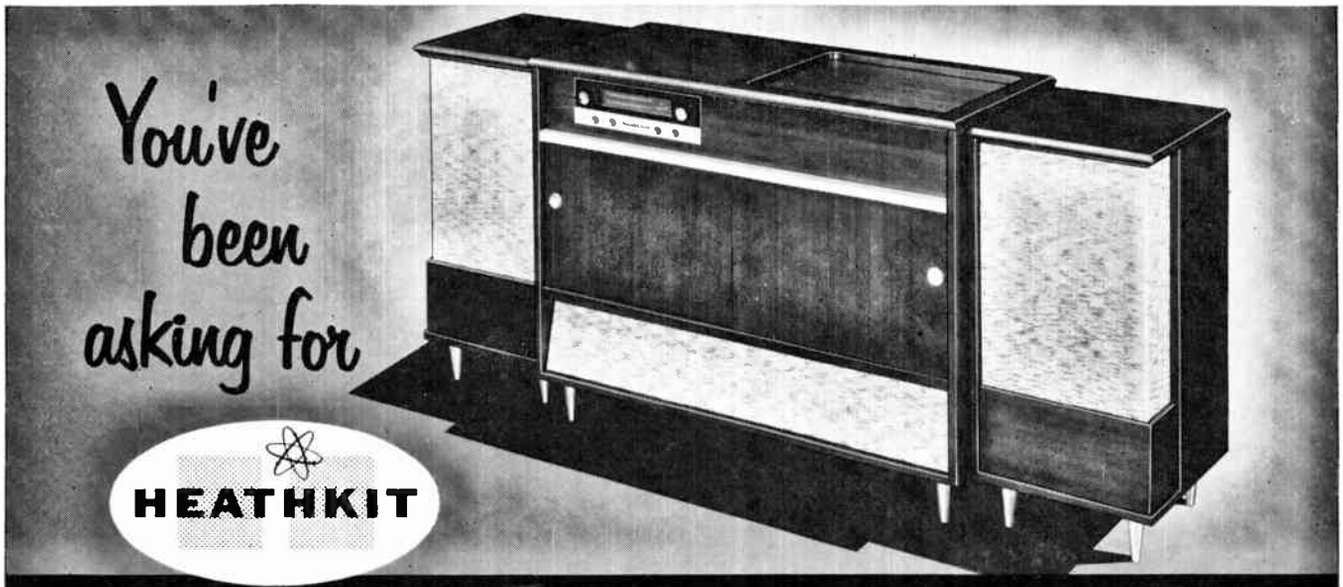
Tape Recorder Manual, Volume 1

Pub. by Howard W. Sams & Co., Inc., Indianapolis, Indiana; 144 pages; $2.95, paper-bound.

Full servicing and operating information on recent tape recorders made by nine different manufacturers is presented in this first of a new series of Photofact Publications.

The coverage includes detailed photographs of each piece of equipment with all parts identified, general information and specifications on each recorder, exploded views showing all mechanical parts and how they fit together, parts lists, and complete schematic wiring diagrams.

The particular models included in this volume are the Ampex 612; Bell Sound RT-75; Columbia Records 560A; Ekotape 250, 257, 252, 253, 254, 255, 260, and 261; Ellamac "Language Master"; Magnecord F-35B; Silvertone 7074, VM 710, 711, and 750; and Wilcox-Gay 651 and 674. Anyone working with any of these recorders will find the exceptionally complete and detailed information quite worth while and helpful.



stereo sound equipment . . . and here it is!

stereo tape deck kit

HEATHKIT MODEL TR-1D **$143.95**

Enjoy the wonder of Stereophonic sound in your own home! Precision engineered for fine performance, this tape deck provides monaural-record/playback and stereo playback. Tape mechanism is supplied complete. You build only the preamplifier. Features include two printed circuit boards—low noise EF-86 tubes in input stages—mic and hi-level inputs—push-pull bias-erase oscillator for lowest noise level—two cathode follower outputs, one for each stereo channel—output switch for instantaneous monitoring from tape while recording. VU meter and pause control for editing. Tape speeds 3¾ and 7½ IPS. Frequency response ±2 db 40-12,000 CPS at 7½ IPS. Wow and flutter less than .3%. Signal-to-noise 55 db at less than 1% total harmonic distortion. NARTB playback equalization. Make your own high quality recordings for many pleasant listening hours.

stereo equipment cabinet kit

CENTER SECTION MODEL SE-1 **$149.95**

SPEAKER WING MODEL SC-1L or R **$39.95** ea.

Beautifully designed, this stereo equipment cabinet has ample room provided for an AM-FM tuner—tape deck — preamplifier — amplifiers — record changer — record storage and speakers. Constructed of ¾" solid-core Philippine mahogany or select birch plywood, beautifully grained. Top has shaped edge and sliding top panel. Sliding doors for front access. Mounting panels are supplied cut to fit Heathkit units with extra blank panels for mounting your own equipment. Easy-to-assemble, all parts are precut and predrilled. Includes all hardware, glue, legs, etc. and detailed instruction manual. Speaker wings and center unit can be purchased separately if desired. Overall dimensions with wings 82" W. x 37" H. x 20" D. Send for free details.

DELUXE AM-FM TUNER KIT

HEATHKIT MODEL PT-1 **$89.95**

Here is a deluxe combination AM-FM tuner with all the advanced design features required by the critical listener. Ideal for stereo applications since AM and FM circuits are separate and individually tuned. The 16-tube tuner uses three circuit boards for easy assembly. Prewired and prealigned FM front end. AFC with on/off switch—flywheel tuning and tuning meter.

STEREO PRE-AMPLIFIER KIT

HEATHKIT MODEL SP-2 **$56.95**

This unique two-channel control center provides all controls necessary in stereo applications. Building block design lets you buy basic single channel now and add second snap-in channel later for stereo without rewiring. 12 inputs each with level control—NARTB tape equalization —6 dual concentric controls including loudness controls—built-in power supply.

55 WATT HI-FI AMPLIFIER KIT

HEATHKIT MODEL W-7M **$54.95**

First time ever offered—a 55-watt basic hi-fi amplifier for $1 per watt. Features EL-34 push-pull output tubes. Frequency response 20 CPS to 20 KC with less than 2% harmonic distortion at full output throughout this range. Input level control and "on-off" switch provided on front panel. Unity or maximum damping factors for all 4, 8 or 16 ohm speakers.

12 WATT HI-FI AMPLIFIER KIT

HEATHKIT MODEL UA-1 **$21.95**

Ideal for stereo applications, this 12-watt power package represents an outstanding dollar value. Uses 6BQ5/EL84 push-pull output tubes. Less than 2% total harmonic distortion throughout the entire audio range (20 to 20,000 CPS) at full 12-watt output. Designed for use with preamplifier models WA-P2 or SP-1. Taps for 4, 8 and 16 ohm speakers.

For complete information on above kits—Send for FREE FLYER.

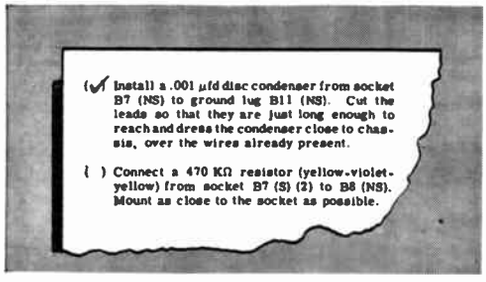
HEATH COMPANY • a subsidiary of Daystrom, Inc. • **Benton Harbor 18, Mich.**

easy-to-build

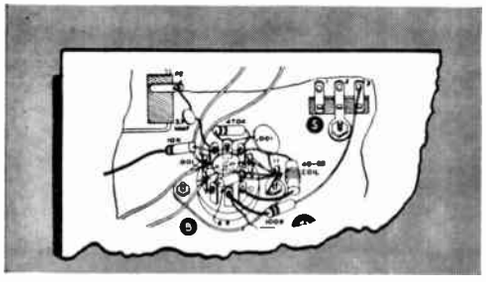
high quality

HEATHKITS®

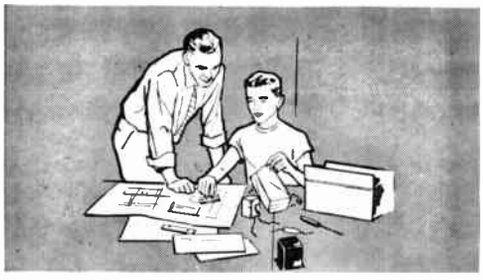
Look . . . how simply you can assemble your very own high fidelity system! Fun-filled hours of shared pleasure, and an everlasting sense of personal accomplishment are just a few of the rewards. Heathkits cost you only HALF as much as ordinary equipment and the quality is unexcelled. Let us show you how easy it really is! . . .



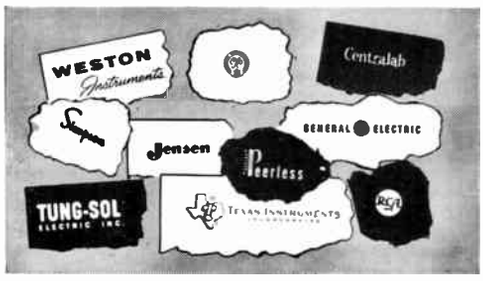
Step-by-Step Assembly Instructions . . .
Read the step . . . perform the operation . . . and check it off—it's just that simple! These plainly-worded, easy-to-follow steps cover every assembly operation.



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



Learn-by-doing Experience For All Ages . . .
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.



Top Quality Name-Brand Components Used in All Kits . . .
Electronic components used in Heathkits come from well-known manufacturers with established reputations. Your assurance of long life and trouble-free service.

HEATHKIT

bookshelf 12-watt amplifier kit

NEW

MODEL EA-2

$27.95

There are many reasons why this attractive amplifier is a tremendous dollar value. You get many extras not expected at this price level. Rich, full range, high fidelity sound reproduction with low distortion and noise . . . plus "modern" styling, making it suitable for use in the open, on a bookcase, or end table. Look at the features offered by the model EA-2: full range frequency response (20—20,000 CPS ± 1 db) with less than 1% distortion over this range at full 12 watt output—its own built-in preamplifier with provision for three separate inputs, mag phono, crystal phono, and tuner—RIAA equalization—separate bass and treble tone controls—special hum control—and it's easy-to-build. Complete instructions and pictorial diagrams show where every part goes. Cabinet shell has smooth leather texture in black with inlaid gold design. Front panel features brushed gold trim and buff knobs with gold inserts. For a real sound thrill the EA-2 will more than meet your expectations. Shpg. Wt. 15 lbs.

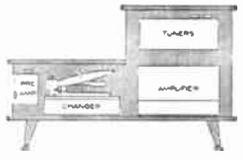
TIME PAYMENTS AVAILABLE ON ALL HEATHKITS WRITE FOR FULL DETAILS

HEATHKIT

chairside enclosure kit

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



CE-1T Mahogany
TRADITIONAL

Be sure to specify model you prefer

$43.95 each

HEATHKIT

high fidelity FM tuner kit

For noise and static free sound reception, this FM tuner is your least expensive source of high fidelity material. Efficient circuit design features stablized oscillator circuit to eliminate drift after warm-up and broadband IF circuits assure full fidelity with high sensitivity. All tunable components are prealigned so it is ready for operation as soon as construction is completed. The edge-illuminated slide rule dial is clearly numbered for easy tuning. Covers complete FM band from 88 to 108 mc. Shpg. Wt. 8 lbs.

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

MODEL W-5M

$59.75

high fidelity amplifier kits

HEATHKIT 70-WATT

MODEL W-6M

$109.95

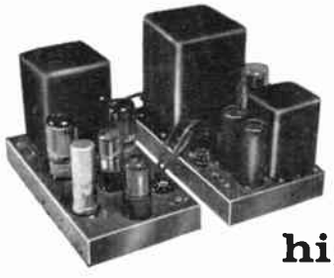
To provide you with an amplifier of top-flight performance, yet at the lowest possible cost, Heath has combined the latest design techniques with the highest quality materials to bring you the W-5M. As a critical listener you will thrill to the near-distortionless reproduction from one of the most outstanding 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

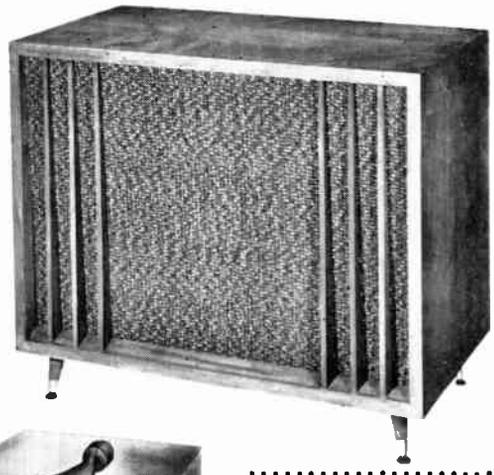
MODEL XO-1 **$18.95**

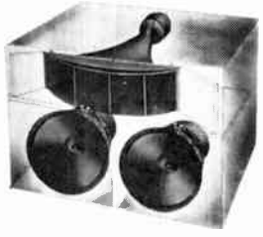
One of the most exciting improvements you can make in your hi-fi system is the addition of this Heathkit Crossover model XO-1. This unique kit separates high and low frequencies and feeds them through two amplifiers into separate speakers. Because of its location ahead of the main amplifiers, IM distortion 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.

NEW LOW PRICE!

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)

$299.95 each

HEATHKIT BASIC RANGE

HEATHKIT RANGE EXTENDING

high fidelity speaker system kits

MODEL SS-2 **$39.95**

A truly outstanding performer for its size, the Heathkit model SS-2 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!

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a subsidiary of Daystrom, Inc.

☐ Please send the Free HEATHKIT catalog.

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

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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.

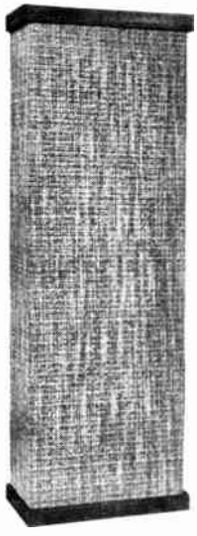
Audionews

SCOTT STEREO PREAMP

Many special features have been included in the H. H. Scott *Model 130* stereo preamplifier: lights which give a visual indication of the mode of operation; dual pickup level adjustments; a phase reverse switch, which allows the listener to reverse the phase of either channel 180° with respect to the other; and a third, or center-channel, output. Front-panel controls include a PICKUP selector, TAPE MONITOR, SCRATCH FILTER, RUMBLE FILTER, PHASE switch, LOUDNESS-VOLUME switch, INPUT SELECTOR, STEREO BALANCE, STEREO SELECTOR, LOUDNESS, and separate tone controls for each channel. The 130 measures 15½ by 5 by 12½ in., and sells for $169.95.

SPEAKER ENCLOSURE

Audiospeaker's *Anechoic* speaker enclosure is a small totally enclosed box which stands 4 ft. high and occupies approximately 1 sq. ft. of floor space. Standard and utility models are made for 8-, 12-, and 15-inch wide-range or coaxial speakers, and they range in price from $39 to



Audiospeaker "Anechoic" speaker enclosure.

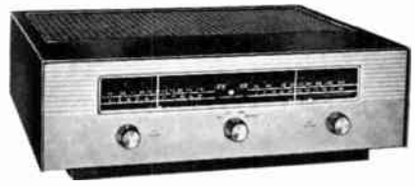
$89. Because of the acoustic design, placement is said not to affect bass response; the speaker is given a strong acoustic resistive load at all frequencies.

COMPONENTS STEREO-VERTOR

Recently announced by Components Corporation is the new *Stereo-Vertor* for playing both 45/45 and MSD stereo records. The unit demodulates an FM-multiplex subcarrier, and so serves in three ways for stereo reproduction. It is designed for use with one monophonic preamp, two power amplifiers, and two speaker systems. Price of the Stereo-Vertor is $39.50. Also available is a test record (*No. 58-45/45*) for checking cartridge balance, channel separation, and rumble; it sells for $1.00. Components also claims that all their professional turntables are ideally suited for stereo records because of negligible vertical rumble.

STEREO TUNER

Harman-Kardon has recently made available the *Duet, Model T-224* stereo FM-AM tuner. It provides for reception of stereo broadcasts without the necessity of a second tuner, and has an FM multiplex



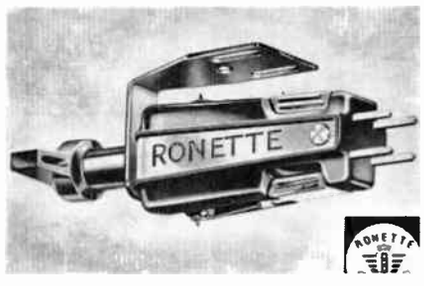
Harman-Kardon stereo tuner.

jack on the back. The FM section has a low-noise front end, an Armstrong circuit with pentode limiter, wide-band Foster-Seeley discriminator, and AFC. Manufacturer's specifications include: sensitivity — 7 μv for 30 db quieting, and 3.5 μv for 20 db quieting; frequency response — ±0.75 db from 30 to 15,000 cps including standard 75 μsec de-emphasis; IM distortion — less than 0.5% at 30% modulation and less than 3% at 100% modulation. AM specifications include: frequency response — ±3 db from 20 to 4,000 cps; distortion — 3% IM, 1% harmonic; sensitivity — 80 μv per meter, 10-μv terminal sensitivity. Price of the Duet is $114.95.

TURNOVER STEREO CARTRIDGE

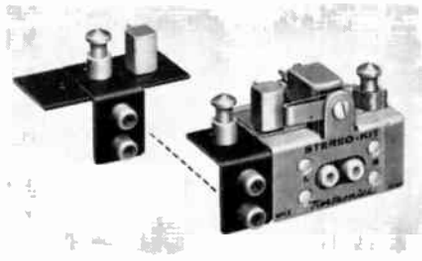
Ronette is now marketing a four-terminal turnover stereo cartridge and a four-terminal single-stylus stereo cartridge. These are similar in size to the TX-88 Superfluid cartridge, and will employ the Duo-Clip stylus assembly. Both will mount on ½-inch or 5/16-inch centers.

Ronette turnover cartridge.



STEREO CONVERSION KITS

Two kits for converting existing monophonic tape recorders to stereo are being offered by Nortronics. *Model SK-100* allows conversion to half-track, two-channel stereo, and sells for $23.50;



Tape conversion kit.

Model SK-50 is for conversion to quarter-track, four-channel stereo, and its price is $26. Additional playback and/or record amplifiers are necessary depending on the function desired. Also available are two erase kits to complement the stereo kits. The *EK-100* matches the SK-100 and sells for $14, and the EK-50 (also $14) fits the SK-50.

WINSTON ANALYZER

The *Win-Tronix Model 800* hi-fi/audio system analyzer is a complete hi-fi and audio test laboratory in one portable instrument. It incorporates the functions of six different instruments including an audio VTVM, audio signal generator, audio output wattmeter with speaker loads, IM distortion meter, harmonic distortion meter, and db and noise meter. Specifications are said to be comparable with laboratory equipment. The integration of the various functions requires only two cable connections for all tests. Dealer net is $169.95. Further information may be obtained from Winston Electronics, Inc.

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.

The only stereo cartridge and arm

approved by High Fidelity Consumer's Bureau of Standards

- The independent, bias-free High Fidelity Consumer's Bureau of Standards has established rigid performance standards against which all equipment must be tested before the Bureau's official Seal of Approval can be given.
- The triumphant new ESL GYRO/JEWEL stereo cartridge and GYRO/BALANCE stereo arm are the only true high-performance stereo components approved by the High Fidelity Consumer's Bureau of Standards at this time. The ESL C-60 Series cartridge, for matchless monophonic reproduction, also enjoys the Bureau's distinctive Seal of Approval.
- Here's why the best costs less: Inferior or makeshift stereo products all too soon may require replacement. No need to buy one substandard component after another, when a single purchase can bring you the superlative new ESL stereo cartridge and arm, years ahead in design and long-lasting in construction.
- In addition, the ESL GYRO/JEWEL (only $69.95) and GYRO/BALANCE (only $34.95) will more than save their own cost by greatly extending the life of valuable records and styli. Economize today with ESL—the perfectionist stereo equipment of tomorrow!

FOR LISTENING AT ITS BEST

Electro-Sonic Laboratories, Inc.

Dept. C • 35-54 Thirty-sixth Street • Long Island City 6, N.Y.

First hi-fi performance standards set by new Consumer's Bureau

Never before has it been possible for a consumer to know positively whether the hi-fi equipment he buys is of true high fidelity quality, because no such performance standards have previously existed.

This vital need has been fulfilled by the High Fidelity Consumer's Bureau of Standards, an independent, objective organization of informed consumers having no connection with any manufacturer or trade group.

This Bureau has carefully set up rigid minimum standards of performance which must be met by any component before it becomes eligible to display the Bureau's coveted Seal of Approval. Equipment is tested by an independent laboratory of unquestioned competence and integrity (Hirsch-Houck Laboratories of former Audio League fame).

The Bureau's distinctive Seal of Approval (above), for the first time provides the consumer with an intelligent and reliable means by which he may instantly identify truly superior high fidelity products.

Electronic Firsts

by MONROE UPTON — Author of "Electronics for Everyone"

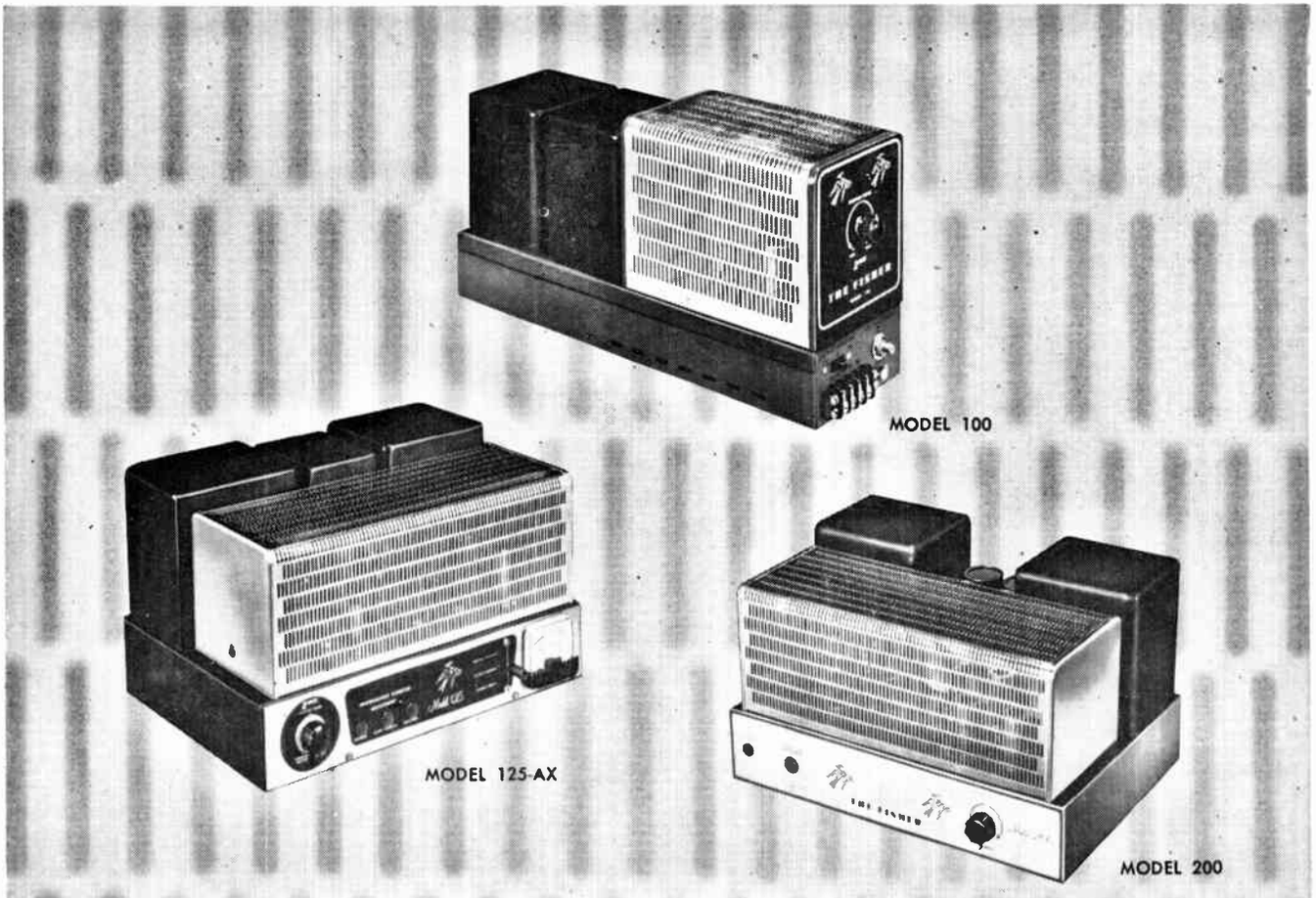
IN 1883 Thomas A. Edison, trying to prevent his carbon-filament lamp from blackening inside, sealed a wire in the glass envelope close to the filament. With a positive voltage on the wire, a small current flowed; with a negatively charged wire, there was no current. (We realize now that only the positive wire attracted the negative electrons shed by the incandescent filament.) Charles Ambrose Fleming, in England, adapted this "Edison Effect" to make a diode detector for wireless by replacing the wire with a metal plate.

The temptation is great to account for the genesis of the first true radio tube, the *Audion*, by paraphrasing the immortal Tinker to Evans to Chance double play with Edison to Fleming to De Forest. All Lee De Forest had to do was put a grid between Edison's filament and Fleming's plate. But De Forest had no assists. His search for a better detector that led him to the Audion began in 1901 in his Chicago hotel room with a Welsbach gas burner. The crashing sparks of a spark-coil transmitter caused one section of the gas mantle to burn more brightly. So! Was there some connection between wireless waves and heated gases?

In 1903, in his New York lab, a detector with two platinum wires extending into the gas flame of a Bunsen burner worked so badly that he switched to a carbon-arc lamp, which proved "noisy," and he ended up with an incandescent filament in an evacuated glass bulb.

Close to the battery-heated filament he put a platinum plate, positively charged by a second battery. He hoped that the voltage of the signal, perhaps by an ionizing effect on the gas, would change its resistance to the battery, providing a sort of relay action.

Seeking more positive control, De Forest next connected the antenna to tin foil wrapped around the outside of the bulb. Moving this new control electrode inside the bulb, he made it a second plate, opposite the first plate. His final move was to place it *between* the filament and the first plate, punching holes in it so it wouldn't block the passage of the gas. A piece of wire, bent back and forth to form a grid, proved more practical than the plate full of holes, and the Audion was born.



The best amplifiers in high fidelity bear this name-

THE FISHER

LOOK CLOSELY! The name "THE FISHER" on a power amplifier tells you that it is the product of twenty-one years of high fidelity leadership.

LISTEN CAREFULLY! The clean tonal output of THE FISHER is the result of advanced engineering. Power output is constant over the entire audible range, without fall-off in the low bass tones or overemphasis in the highs. Tremendous reserve power for orchestral peaks, and freedom from overload relieve listener fatigue and add to the enjoyment of your system.

JUDGE WELL! Whatever your needs, the FISHER amplifier you select will meet your requirements perfectly. Terminal connections match all speaker impedances. Conservative construction throughout assures every owner virtually unlimited years of trouble-free, dependable service.

THE FISHER 200

60 watts; 160 watts of reserve peak power. IM and harmonic distortion inaudible. **$179.50**

THE FISHER 100

30 watts; 70 watts of reserve peak power. Z-Motic Variable Damping Factor Control. **$119.50**

THE FISHER 125-AX

125 watts on regular program material. Speaker outputs for 4, 8, 16 ohms and 70.7 volts. **$229.50**

Slightly Higher in the Far West

WRITE TODAY FOR COMPLETE SPECIFICATIONS

FISHER RADIO CORPORATION · 21-31 44TH DRIVE · L. I. CITY 1, N.Y.

STEP-UP TO STEREO...ON A BUDGET

with E-V Stereo's Standard

STEREO'S STANDARD

IF THIS IS YOUR PRESENT or PROPOSED SPEAKER SYSTEM

costing between **$60-$90**

Includes an 8" coaxial speaker such as:
E-V CORONET* (with SP8B), Net $65
E-V BARONET* (with SP8B), Net $74.50
SP8B: Wide range, economical, super-efficient coaxial speaker. Small high-frequency propagator insures fine dispersion.

costing between **$90-$120**

Includes a two-way separate system such as:
E-V CORONET IA, Net $102
E-V BARONET III, Net $111.50
E-V REGAL IA, Net $103

or includes a 12" coaxial speaker such as:
E-V MARQUIS* (with SP12B), Net $98
E-V ARISTOCRAT* (with SP12B), Net $107
SP12B: Added efficiency with lower resonance. Extends fundamental low range Excellent dispersion for widest stereo effects.

costing between **$120-$140**

Includes three-way speaker such as:
E-V MARQUIS* (with 12TRXB), Net $129
E-V ARISTOCRAT* (with 12TRXB), Net $138
12TRXB: Has all the features of the SP12B—plus a separate high-frequency driver with electrical crossover for still lower distortion. Gives widest spread of vital stereo range to achieve large stereo listening area.

costing between **$140-$200**

such as the new E-V REGAL III
REGAL Super-compact, specially designed system with tailored components to give enhanced range and purity of tone with least loss of efficiency. Does not require high powered amplifier. Net $147.50

Includes a 15" three-way speaker such as:
E-V EMPIRE* (with 15TRXB), Net $178
EMPIRE* 15TRXB: Similar to 12TRXB, but with added bass efficiency from large cone, and delivering lower bass response.

*E-V systems which can be expanded with E-V Building Blocks whenever your budget permits.

NOTE: All E-V enclosures also available in limed oak or walnut finishes.

STEP ONE

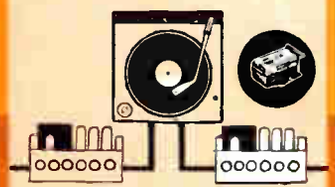
You need the totally compatible E-V STEREO CARTRIDGE

* the first stereo cartridge
* the *only* field tested stereo cartridge

Thousands already in use prove it

* Plays ALL RECORDS BETTER Unexcelled for stereo; superior even to your present cartridge for monaural
* Highest vertical and horizontal compliance For superior tracking, longest record wear
* Best channel separation over 20 db between channels
* Flattest response Flat beyond audibility to RIAA curve
* Hum and rumble far below any magnetic cartridge
* Two ceramic elements deliver precise RIAA curve with *no hum!*
* Exclusive E-V Built-in Vertical Rumble Suppressor allows record changer use for stereo
* .7-mil replaceable (diamond or sapphire) stylus is the ideal size . . . gives you better reproduction, longer record wear

Then choose a second amplifier and preamplifier. If this is your initial high fidelity system, start with any stereophonic dual amplifier-preamplifier. Play monaurally until you add a second speaker for stereo.



The E-V Totally Compatible Stereo Cartridge is the industry's standard. Choose the model to fit your needs:

MODEL 21D—Stereo with .7-mil Diamond Stylus, Net $19.50

MODEL 26DST—Dual Stylus Turnover from .7-mil Diamond Stereo to 3-mil Sapphire Monaural, Net $22.50

or the E-V Velocity Stereo Cartridge

MODEL 21MD—Stereo with .7-mil Diamond Stylus, Net $19.50

MODEL 26MDST—Dual Stylus Turnover from .7-mil Diamond Stereo to 3-mil Sapphire Monaural, Net $22.50

STEP TWO

Add-on E-V BARONET*...
smallest folded-horn corner enclosure for best musical balance and response range: phenomenal bass range; extended two full octaves. Matches the Coronet and other comparable speaker systems. With SP8B, Net **$74.50**, or BARONET III with SP8B and T35B VHF driver, Net **$111.50**

OR

Add-on E-V ARISTOCRAT*...

popular folded-horn corner enclosure . . . compact, economical . . . delivers most extended bass range for its size. With SP12B, Net **$107.00**; with 3-way 12TRXB, Net **$138**

OR

Add-on E-V MARQUIS*...

matching *along-the-wall* counterpart of the popular Aristocrat. Response down to 40 cps. With SP12B, Net **$98.00**; with 3-way 12TRXB, Net **$129**

OR

Add-on E-V REGAL III...
super-compact, specially designed system with tailored components to give enhanced range and purity of tone with least loss of efficiency. Does not require high powered amplifier, Net **$147.50**

OR

Add-on E-V EMPIRE*...
direct radiator Klipsch-licensed low-boy enclosure tailored for use along the wall or in corner. Smooth, extended bass response. With Electro-Voice 15TRXB 3-way speaker, Net **$178**

OR

Add-on the new E-V CORONET*...
true, balanced high fidelity reproduction in extremely small economical space-saving form: only 10 inches of wall space required. Complements Aristocrat, Marquis, Baronet or comparable speaker system. With SP8B 8-inch speaker, response down to 70 cps., Net **$65.00** or add-on CORONET IA with SP8B and T35B VHF driver, **$102.00**, or add-on REGAL IA, Net **$103**

Add-on STEREON IA
The all-new Electro-Voice speaker system that solves your space problem—saves you money. Where space doesn't permit you to add a second full-range speaker, a Stereon is the answer. It's compact, because the Stereon reproduces only those frequencies *needed* for stereo. Bass below 300 cps does not contribute to the stereo effect . . . so bass from both is handled by your *present* full-range speaker through the accessory XX3 Stereon Control Filter. (Finest E-V mid-bass, treble and high frequency components give smooth response from 300 to 19,000 cps.)

STEREON IA—for systems of normal efficiency, Net **$99.50**
XX3 STEREON CONTROL FILTER Net **$30**

Systems shown are but a few of the multitude of E-V combinations found in every price class. Ask your dealer or write Electro-Voice for information on the industry's most complete line of high fidelity speakers and enclosures.

Electro-Voice®

ELECTRO-VOICE, INC., BUCHANAN, MICHIGAN

Foremost in Electro-Acoustics—Microphone, Phono-Cartridges, High-Fidelity Loudspeakers and Enclosures, Public Address Speakers, Marine Instruments, EVI Professional Electronic Instruments and Military Material.

Gentlemen:
It was indeed a pleasant surprise to see the No. 2, December 1955, issue offered again as a back copy. My set is now complete except for No. 4, February 1956. Is it at all possible to get that issue?

Peter Rosamilia
255 Montclair Ave.
Newark 4, N.J.

If any reader has a copy of Vol. 1, No. 4, that he will sell, please write to Mr. Rosamilia at the address above. — ED.

Gentlemen:
Three or four years ago, I bought what I thought to be a two year subscription to the *Audio League Reports*, little knowing their publications appeared as infrequently as rain in the desert, and, in consequence, my money actually bought me what, in all likelihood, would be a lifetime subscription. Sporadic and all, the little bulletins were interesting and so written that the audio enthusiast

obtained factual information about products tested, not readily available elsewhere. Many subscribers undoubtedly shared regrets with me when we learned the organization had closed shop.

Congratulations to AUDIOCRAFT for featuring reports by the same personnel with the same quiet yet factual tone and style reminiscent of the Audio League. It is a rare pleasure to read reports which do not bow too low to sensitive advertisers, and at the same time treat the subject in an understanding way, quite different from the antiseptic, almost antagonistic manner of other consumer testing organizations. It is to be hoped AUDIOCRAFT will continue to carry them.

Another feature I have especially enjoyed since the inception of the magazine is "The Grounded Ear,' and just as heartily detested "Sound-Fanciers' Guide," in the latter not the content but the style.

H. C. Palmer
Timmins, Ont.

Three-Terminal Troubles

THE first stereo pickup cartridge intended for sale to the public had three output terminals: two hot leads, one each for the two separate channels, and a ground lead common to both channels. The next cartridge on the market had four terminals; there were individual ground leads for the two channels. Since then stereo cartridges have been released with three- or four-terminal construction in what appears to be haphazard fashion. No consistent pattern can be discerned. There are inexpensive ceramic cartridges with four output terminals, and quite expensive magnetic stereo cartridges with only three terminals. And vice versa, of course.

We think it can be assumed that manufacturers of high-quality cartridges have not based their decisions in this matter on cost considerations. An extra terminal (particularly on a cartridge in the high-price brackets) represents at best a miniscule part of the total price. We have been assured that the internal construction of a four-terminal unit is no more costly than that of a three-terminal one. Why, then, are three-terminal cartridges made?

Presumably they are made to facilitate installation in existing tone arms, many of which have two signal leads and a separate ground lead, put there for professional balanced-line applications; or in some record players with tone arms having three contact terminals, which are easily converted to three-wire operation. There may be some slight advantage in three-terminal construction also for makers of packaged ready-to-play stereo phonographs, who can tailor amplifiers specifically for a common ground connection at the cartridge. But when you think about this twice, it becomes obvious that a three-terminal cartridge has absolutely no advantage even in these applications. It is the simplest thing imaginable to connect together the two ground terminals of a four-terminal cartridge, if you want or need a common ground at the cartridge.

On the other hand, it is difficult or impossible to *separate* the ground leads for the two channels of a three-terminal stereo cartridge. There are two major disadvantages of a three-terminal unit, either of which amounts to a sufficient reason, in our opinion, to warrant cessation of their manufacture — with the possible exception of those cartridges made specifically for ready-to-play phonograph manufacturers, and not sold for general use.

First, there is the problem of hum. If you have more than one common ground connection between the two amplifying chains of a stereo system, you have a hum-producing ground loop. The only way you can avoid a ground loop with a three-terminal cartridge is to keep the left-channel amplifier, preamp, and speaker system isolated from the corresponding units for the right channel. That pretty much rules out a ganged gain control, a balance control, or any of the channel switching that is so convenient in a stereo system. If you have a second common ground at the input of a stereo preamp-control unit, you may get by with only a slight increase in hum. But if you try to use a pair of conventional preamps with the common stereo controls between them and the amplifiers, you get into real trouble. We tried it with a three-terminal magnetic pickup, and got not only hum but motorboating (low-frequency oscillation) if we tried to turn up the gain to a listenable level. Even high-output ceramic three-terminal cartridges were unusable in this setup. Four-terminal cartridges, with separate grounds to the preamps, worked.

Far more serious is the other disadvantage: shock hazard. There isn't much doubt that some stereophiles will use, as a first step in converting to stereo, the audio system of an AC-DC radio or phonograph for the second channel. The chassis of such a set may be at a high AC potential with respect to ground. A three-terminal cartridge will make an electrical connection between this chassis and the ground circuit of the main system, which is connected to any exposed metal knobs, escutcheon plates, and metal covers. If the main sound system is wired to an earth ground this may blow a house fuse; if not, touching any metal of the system may give the operator a severe shock and, possibly, kill him. Four-terminal cartridges, with separate ground circuits, eliminate this possibility.

We believe that this is so strong an indictment against three-terminal cartridge wiring that their manufacture for general use should be discontinued. We have been informed that some manufacturers have already switched to four-terminal models. In the meantime, every potential user should be warned against connecting one to an AC-DC or transformerless appliance of any kind. —R.A.

How compatible are

Part I: Monophonic cartridges and stereo discs.

ALL through the last months of 1957, and well into the middle of 1958, one question has been heard again and again: "Are the new stereo records compatible?" Many answers have been offered, all based on different lines of reasoning. But no one has answered the question fully for the audiophile who has a large investment in equipment, a great many monophonic records, and a keen interest in what is going on.

In an attempt to provide all these answers, I undertook a lengthy project in which all kinds of conventional cartridges were tested with stereo records, to determine just what would happen to both the cartridges and the records. Since the equipment on which the records are played also enters into the wear problem, a number of record players, record changers, and turntables were used. With the latter, many different arms were tested and, in almost all cases, most of the currently available cartridges were tested in these arms.

From the first, this much was obvious: stereo records are compatible when played on equipment that does *not* give the best monophonic reproduction. With most package sets I found very little difference between stereo and conventional records. The intermodulation and harmonic distortion was so high already as to mask any increase because of a different record type. On a high-quality music system, however, it is easy to distinguish quality differences between the two types of records. A stereo record did not sound as good as the monophonic version of the same performance. This can be attributed at least in part to vertical stylus motion.

Another thing I learned immediately was that a minimum of rumble was absolutely essential in order to avoid waveform deterioration. This includes vertical as well as lateral rumble. Rumble can ruin records because it makes the stylus tip rattle about in the groove. In the case of the stereo record, this could be seen in the output-wave shape. Thus I had to select a very low-rumble unit that I could use to check cartridges, and as a control for checking other turntables.

Turntables and Arms

The control turntable was an enormously heavy affair, with a deck of boiler plate and an immense table made of thick, heavy steel. It was isolated in a heavy sponge-rubber pad atop a wooden box, the top portion of which floated in silicon jelly. As a control it was perfect. Of course, it would be out of place in a home; it was a huge and messy affair. However, it did its job. It performed without a measurable trace of rumble or motion of any sort, no matter what went on around it.

As the control arm, I selected a studio type (the Gray 106) with plug-in shells. I found that viscous-damped arms were unsuitable for stereo records unless of a type that could not tilt from side to side. The older Gray arms are "tiltable" in this way, but the new model was found to be well suited to stereo. Further, it has a wristlike action which keeps the stylus vertical (as viewed from the front) when a warp passes under the head.

Other arms found suitable were the Fairchild, the Rek-O-Kut, the new Pickering Unipoise as well as the 190-D, the Grado, and the GE. This list is not complete. Not all arms were tested: this article is not intended to be a buying guide. A selection was tested only to determine the basic types of arms and arm pivots which were suitable and which were not. Since many good arms have been sold in the past ten or more years, I will list the criteria for stereo arms rather than the arms we tested, to prevent overlooking any good or bad arm types.

The vertical pivot must be free; the arm must have complete freedom of vertical motion.

The arm should be designed for mounting so as to pass through two areas of minimum tracking error. This will permit one very large area of small tracking error across the record. Tracking error destroys separation and adds to harmonic content.

The arm should have very good lateral bearings. Many arms (contrary to expectations) did not have very high lateral compliance.

The resonant frequency of the arm must be below 40 cps. It must be well damped and should not cause an easily measured peak in the response. Should this happen, separation will be damaged at many of the upper harmonics of this resonant frequency.

Turning again to the record-playing device, I found that some of the better-known record players were quite unsuitable for playing stereo records, much less testing them. Several exhibited rumble in the 10- to 20-cps range that overloaded the amplifier. Others created so vast a hum field about the motor that ballistic voltmeters were unusable. These were lateral faults, things that should cause trouble with conventional records! Vertically, nearly all the record players released in 195[illegible] or before were intolerable. Some record changers which had been redesigned for stereo were fairly good, although one was even worse than its prestereo version. The following points are of maximum importance when selecting a record-playing device.

Check the bearing surfaces between the table and deck. There should be a minimum of play. Play results in rumble.

The motor must be well isolated from the deck. Put a cigarette lighter on the deck. Start the motor and put the arm, with a new magnetic stereo cartridge in it, on the cigarette lighter. Listen through a speaker of known good bass characteristics, with an amplifier having good bass reproduction.

The deck must be mounted on some sort of sound-absorbing or resonating material. If these are springs, make sure

Will stereo discs stand up under repeated playings with present monophonic cartridges? That's the big question haunting the industry today

STEREO DISCS ?

by JOEL EHRLICH

they are adjusted so that all vertical and lateral motion is absorbed.

Check for hum. Put a high-impedance magnetic cartridge in the arm, connect it to a preamp, turn up the gain, and listen for hum. See if it can be cured. Check the unit for a separate ground lead. Make sure you can isolate the ground of one channel from the other.

Monophonic Cartridge Performance

The most interesting part of these tests, certainly, was finding out what would happen to a stereo record when played with a conventional cartridge, and what would happen to the cartridge. Here is how I did it: new records were used with each cartridge. The cartridge outputs were connected through a preamp into a sound system and monitored through a pair of speakers. In addition, a tape recorder was connected to the tape output of the system. A ballistic AC voltmeter was bridged across the output of the preamp along with a key switch so as to be able to connect to either channel at will. By this same switch, I was able to connect an oscilloscope to either channel to check the wave form of the channel visually.

Initially, each record was played with a stereo cartridge. Then it was played with the cartridge under test. After each play for the first ten plays, it was played again with the stereo cartridge. After the tenth play it was played also with a vertical cartridge (Western Electric 9A). Thereafter, the record was played with the stereo cartridge after each ten plays with the regular cartridge. I checked results with the vertical cartridge after every 25 plays.

The records used were 12 in. in diameter, but they were all played only from 10 in. inward with the monophonic cartridges. When checking with the stereo and vertical cartridges, I was able to use the outer 2 in. of each record as a control, comparing it with the inner portion that had been played with the conventional cartridge.

Two different arms were used, one containing the stereo cartridge and one containing the monophonic cartridge. The vertical cartridge was in its own arm on a separate turntable.

Each cartridge was tested on three different types of record: stereo program material, stereo test frequencies (individual channels and both channels), and vertical modulation only. This last proved to be the most difficult for the cartridges to track, and the most damaged by all monophonic cartridges.

The cartridges were mounted in slides and were checked initially in a Gray 108-B arm. This test made certain that the cartridges were performing properly on monophonic material. The cartridges were then mounted in 106 slides and were interchanged on the two 106 arms. The stereo cartridges were mounted on one arm, while the conventional cartridges were mounted on the other. Both were mounted on the same turntable.

The first fact noted was that the harmonic output from the stereo records was higher than that from conventional records. When playing these stereo records with the stereo cartridge, however, this was not found to be true. Consequently, I attributed this to the incompatibility of the records. There was quite a bit of "breaking up" and very high stylus talk, when playing the stereo records with conventional cartridges. This varied from cartridge to cartridge and seemed to be a function of the length of the stylus cantilever, the longer ones being quieter in general. The breakup was also reduced. This was not unexpected, since such long stylus arms would be expected to have higher vertical compliance than a similar stylus arm of shorter length.

The major damage caused to the stereo record by the conventional cartridge was gouging of the vertical groove modulations. This varied from cartridge to cartridge; several caused no damage whatever. The vertical compliance of the stylus was the variable factor here.

Signal output of the cartridges for vertical modulation affected the sound obtained from stereo records quite a bit. Some cartridges had significant vertical output, and the resultant sound was rather unusual. Since only out-of-phase information is carried vertically, the over-all sound changed no small amount. The resultant sound was, however, no better than that of a cartridge with no vertical output.

As was to be expected, the lateral compliance of the cartridges had a lot to do with the sound. This paralleled experiences with conventional discs. Also, since the output was somewhat lower from the setreo disc, the very low-output cartridges were a bit hard put to keep signals above the noise and hum level of the test rig.

The records themselves were surprisingly sturdy and long-lived. On playing the outer edges of the records and comparing them with unused records of the same material, very little wear was found. Since these portions were played only with stereo cartridges, it is obvious that the stereo record and cartridge were quite amenable to one another. But that will be covered in Part II of this article.

It was found that the first thing to deteriorate on the stereo records, upon subjecting them to play by monophonic cartridges, was the channel separation. The separation between the two channels became less and less, after a given number of playings, at a rate that varied with the particular cartridge. This was first discovered in the frequency-test records during play of the portions in which a signal was recorded first on one channel, then on the other, and then on both. Progressively greater amounts of signal could be heard on both channels during stereo play of the former portions of the record, as the number of monophonic playings increased.

With program material, this became apparent later as the sides tended to blend with the center. As this grew worse, too, the stereo effect disappeared entirely and only a monophonic record remained. Of course, this was discernible only during the playing with a stereo cartridge. Once the record lost all its stereo effect, no further damage was done by the monophonic cartridge as long as the usual care was taken to keep the record clean. Concurrent with the lack of stereo effect, the stylus talk and breaking up lessened. The harmonic distortion also went down, but surface noise rose

Continued on page 45

THE EICO HFT-90 FM TUNER KIT

with a unique front end that guarantees on-the-spot, drift-free tuning

FM TUNERS present kit manufacturers with their most formidable challenges. Ideally, any kit should be so designed that the builder has no need for test equipment to put the finished product in peak operating condition. This is an ideal seldom achieved completely. In the case of an FM tuner, wherein slight variations of lead dress and parts placement may affect alignment significantly, it would seem to be an impossible one. Yet, through ingenious circuit design, careful layout or the use of printed-circuit boards, and prealignment of IF transformers in "typical-circuit" factory jigs, several manufacturers have managed to produce tuner kits that are in reasonably good alignment upon completion. But of all we have worked with to date, the EICO HFT-90 came nearest to being in perfect alignment when we finished it. A careful instrument alignment produced no significant improvement.

Certainly this can be attributed in large part to its unitized front-end assembly: the RF amplifier, reflex converter, and first IF transformer, which is factory wired, aligned, and enclosed within a heavy metal shield. Permeability tuning is used for the RF and oscillator tanks. The assembler has only to bolt this unit on the chassis, make input, output, and power connections to the appropriate lugs, and the entire critical front end of the tuner is finished.

Following the front-end assembly are two straight IF amplifier stages; another stage which functions as either an IF amplifier, for very small input signals, or as a limiter for stronger signals; a ratio detector; and a cathode follower for the audio output. An automatic-gain-control (AGC) voltage is fed back from the limiter grid circuit to the first IF stage. The tuner is self-powered by a full-wave, very well filtered, transformer power supply. There is a switched AC power outlet on the back panel.

Two outputs are furnished. The first, preceding the normal de-emphasis circuit, is intended to feed a multiplex demodulator unit, when they become available, for stereo FM broadcasts. The second output, for a standard audio signal, goes to a front-panel volume control (combined with the AC power on-off switch) and thence to a 6C4 cathode follower. Any reasonable length of shielded cable can be connected from this output to a preamp or amplifier.

The HFT-90 has a long, legible dial which is illuminated by the dial slider. The slider is actually a tiny cylindrical vacuum tube, much like a magic-eye tube. But the green glow within the tube has the shape of an exclamation point (!). As you tune through a station, the upper section of the exclamation point contracts; the stronger the station, the greater its contraction. You get maximum contraction too when you're centered on the station. Thus the slider itself serves as a tuning indicator.

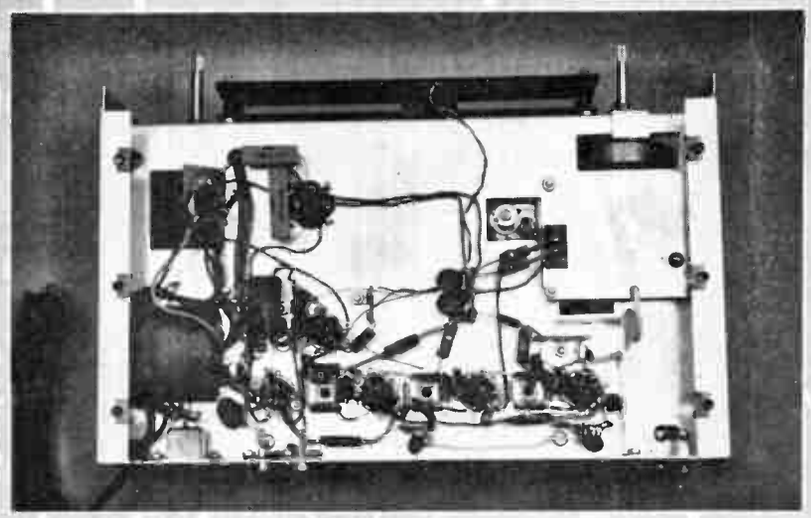
For built-ins, the kit can be obtained with the polished brass escutcheon but without the metal cage cover, at $39.95. The factory-wired price is $65.95. To make a handsome table-top or bookshelf unit, the lacquered cover is available for another $3.95. Over-all dimensions are 3⅜ in. high by 12 in. wide by 8¼ in. deep.

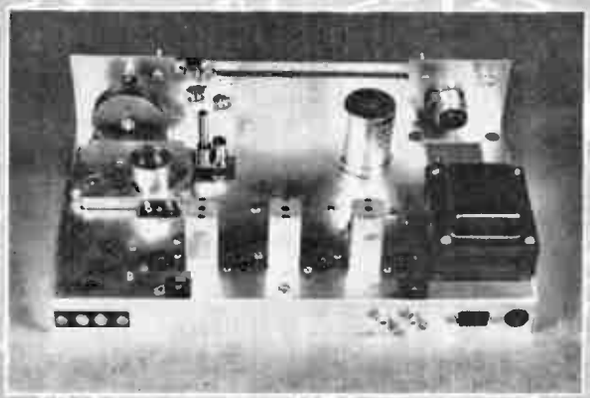
Construction Notes

As is true of EICO kits in general, everything needed for construction of the HFT-90 is supplied but solder and tools. The instruction manual is cleverly divided into two parts: an outer section, containing installation and operating instructions, specifications, and quite complete maintenance data; and an inner section devoted to construction of the kit. Included in the latter are general construction hints, parts identification data, and eleven diagrams, with step-by-step assembly and wiring instructions on the same pages as the pertinent diagrams. The center section is removable, for disposal after your kit is built.

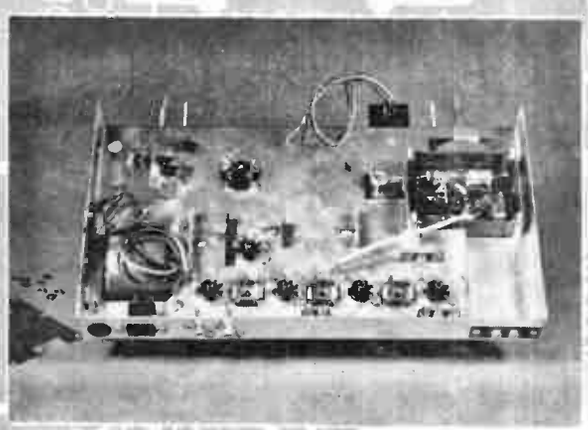
We encountered no errors in the assembly instructions, and no omissions that could lead to anything more than

Here is the completed tuner, as seen from below. Note extreme simplicity of wiring.





At an early stage of assembly, tuner looks like this with larger components in place.



This is a bottom view of the unassembled tuner before wiring operations are begun.

slight inconvenience to the builder. Following are a few notes that might save some time, however.

Page 3C, instruction 12: see Figure 7 (page 14C) for identification of the angle brackets.

Page 5C, instruction 11: adjustment for free rotation of the drive shaft may be easier if you carefully split the "special" fiber washer to make it thinner.

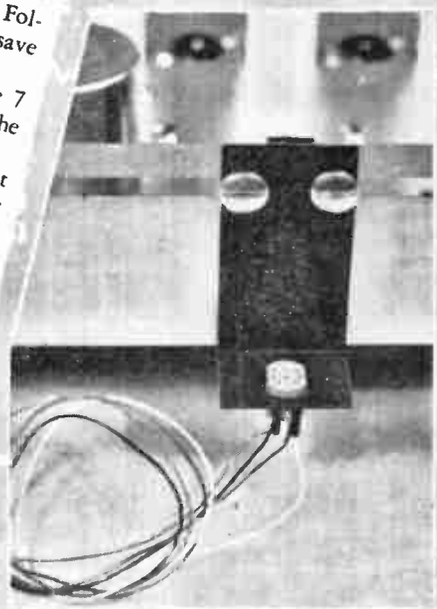
Page 11C, instruction 13: in our kit this 100-K resistor was not color-coded, but was marked plainly as to value and 5% tolerance.

Page 11C, instructions 26 and 27: it will be easier to install the 100-ohm resistor if the order of these two steps is reversed.

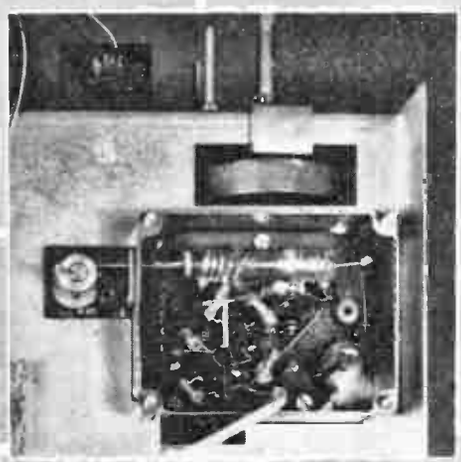
Page 19C, instruction 6: when fastening the control plate to the bezel, remember that the narrow edge of the bezel is at the top.

Page 20C, instruction 13: although it isn't necessary, it may help to preserve the labels on the bottom plate if you give them a few coats of plastic spray.

It took us just 11 hours to build the HFT-90, including one hour at the beginning to read the instructions through and check parts. Anyone less concerned about taking notes and looking for amdigdities could do it in less time, certainly, particularly if he were to do it in only one or two sessions. On the other hand, we don't think it a good idea for any kit builder to rush; one mistake can result in disappointment and, perhaps, a lot of time wasted in tracking down the error.

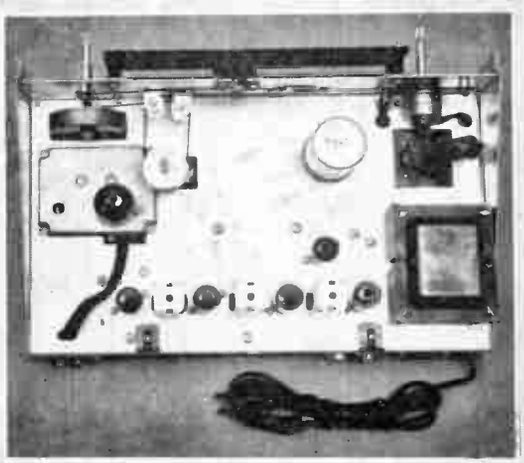


Tuning indicator, unassembled. The neon tube plugs into socket.



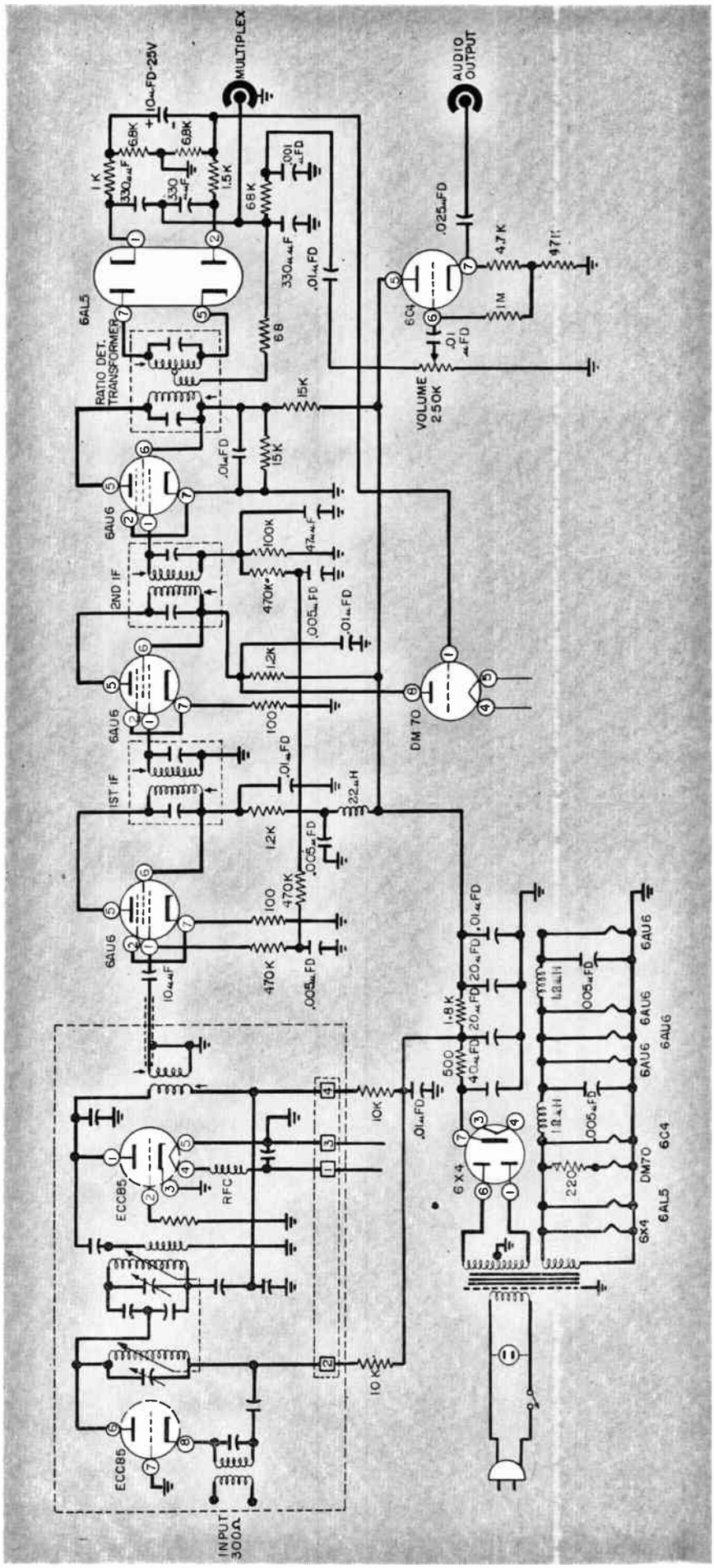
The EICO HFT-90 front end comes already wired and pre-aligned.

Top view of completed tuner, with tubes inserted, ready to operate.



AUDIOCRAFT Test Results

The tuner worked the first time we turned it on, and it worked very well indeed. This is shown in Fig. 1, a chart of sensitivity before and after instrument alignment. These and the following tests were made for us by Hirsch-Houck Laboratories. Sensitivity was measured in accordance with the IHFM (Institute of High Fidelity Manufacturers) proposed FM Tuner Standards. In this test a signal generator is frequency modulated



100% by a 400-cps tone, and its output at various signal levels is applied to the tuner input terminals through a standard 300-ohm network. The 400-cps tone is removed from the tuner's output by means of a null filter, and the remaining components, consisting of noise and distortion, are measured on a comparative basis with the level of the tone. It is apparent that this combines the old IRE quieting sensitivity test with an indication of the distortion and hum characteristics of the tuner.

The proposed IHFM standard defines "usable sensitivity" as that input-signal level for which the noise and distortion components are 30 db lower than the output-tone level; that is, the input-signal level necessary to reduce noise and distortion to 3% of a fully modulated signal output. On this basis the usable sensitivity of the HFT-90 was 12 μv before alignment, and 10 μv after. Such a minor difference would not be audible. Full limiting was obtained at about 100 μv.

EICO's specifications are 2.5 μv for 30 db quieting, and 25 μv for full limiting. Note, however, that the figures are not directly comparable, since the IHFM FM Standards have been proposed only recently. The manufacturer's specifications are those for the simple quieting sensitivity test. Moreover, our test figures are in terms of "hard" microvolts: the voltage output of the signal generator. Voltage at the tuner's input terminals is only half the hard-microvolt value, because of the 300-ohm input network. It is the latter (the "soft" microvolt) that virtually all manufacturers use in specs. In any case, the practical sensitivity of the HFT-90 was high enough for nearly any application.

The manufacturer specifies a 260-Kc IF bandwidth, which was confirmed by our tests. This, with the 400-Kc linear range of the detector, makes for non-critical tuning, low capture ratio (6 db), close-station separation, and insensitivity to drift, which are unique among FM tuner kits, to the best of our knowledge. AM rejection is also exceptionally good, at 34 db. The tuner will handle high carrier modulation at quite low signal levels, as Fig. 2 shows. With this combination of features it is possible to depend simply on indications of the traveling tuning eye to tune for minimum distortion — and that is an unusual feature even among factory-aligned tuners much higher in price.

Warm-up tuning drift of the HFT-90 is outstandingly low, meeting the 20-Kc specification easily from a cold start. This and the wider-than-normal bandwidth mean that you can turn the tuner on, tune in a station immediately, and not have to retune even once. Line-voltage variations do not affect the oscillator

Continued on page 46

Range-Balancing Controls

by William Sherwood

Here's an easy way to balance speaker response and satisfy almost any taste

WHENEVER a speaker system involves multiple drivers and dividing networks, there may be a problem in balancing the acoustic output of the drivers that handle the various frequency ranges. This is caused, primarily, by differing efficiencies of the speakers used. A further contribution to the problem can be made by the acoustic properties of the room in which the speaker system is used. In order to achieve proportionate over-all balance, level controls are often used on the individual drivers. While the step-wise action of level controls leaves something to be desired, they are both inexpensive and convenient. More appropriate devices can be designed, but they are expensive and rather complex to make, and would involve critical amplification circuitry.

The most common instance of the use of level controls for balancing various bands within the frequency range is found in the three-way speaker system. Here the frequency spectrum of the amplifier's output is divided into three sections through the use of a dividing network. Normally the least efficient of the drivers in such a system is that which handles low frequencies. The speakers that carry the middle and high ranges are each equipped with a continuously variable level control (actually a variable resistance). By adjusting the two level controls independently, the user is able to obtain a high-middle-low-range balance that is satisfactory for the particular speakers used in the system and for the acoustics of the room in which the system is played.

It is strange that the basic theory of level controls as applied to the multiple-speaker system has not found a corollary application to single-cone wide-range speakers. Perhaps the answer lies partly in the fact that level controls are usually associated with dividing networks and these are not necessary for wide-range speakers. Yet the two primary reasons for using level controls (varying speaker efficiencies in different frequency bands, and varying room acoustics), both apply in the case of wide-range speakers too. In fact, the problem of satisfactory balance throughout the necessary frequency spectrum is more often a problem with wide-range speakers than with multiple-speaker systems.

In experimental work conducted with wide-range speaker design at Audiospeaker Laboratories it was found extremely difficult to reproduce the low- and high-frequency bands with the same efficiency as was obtainable in the middle range. Tests run with a variety of wide-range speakers showed this to be a common ailment. Almost invariably there was a distinctly audible rolloff below 200 cps (often below 400 cps) and above 8,000 cps. In many cases the apparently "high" efficiency of a speaker occurred in the middle range only, and the speaker was far less efficient at the extremes of the frequency range. Quite obviously a problem of balancing was at hand.

In order to correct for these varying efficiency characteristics (and for varying room acoustical conditions, as well) a solution was found in the practice of using level controls in conjunction with a dividing network in multiple-speaker systems. To apply this to a wide-range speaker meant devising a method whereby level controls could be used in at least two of three separate frequency bands. The result was the circuit which we call the Audiolab* range-balancing control, shown in Fig. 1. It can be seen that this is a sort of "dividing network" itself, although the frequencies separated in the circuit are joined together again before they reach the speaker. The purpose of

Continued on page 36

*No connection with AUDIOCRAFT' Audiolab Test Report department. — ED.

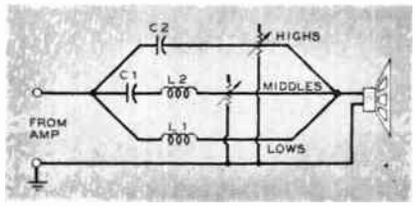
TABLE I

Lower Crossover Frequency	Speaker Impedance, Ohms	L1, mh	C1, μfd	Upper Crossover Frequency	Speaker Impedance, Ohms	L2, mh	C2, μfd
	4	1.6	100		4	0..6	10.0
400	8	3.2	50	4,000	8	0.32	5.0
	16	6.4	25		16	0.64	2.5
	4	1.0	65		4	0..	6.5
600	8	2.1	33	6,000	8	0.21	3.3
	16	4.2	16.5		16	0.42	1.65
	4	0.8	50		4	.08	5.0
800	8	1.6	25	8,000	8	0..6	2.5
	16	3.2	12.5		16	0.32	1.25

TABLE II

Inductance, mh	Coil turns	Inductance, mh	Coil turns
.08	52	0.8	178
0.1	58	1.0	198
0.16	77	1.6	246
0.21	89	2.1	275
0.32	111	3.2	329
0.42	129	4.2	370
0.64	161	6.4	440

Fig. 1. Range-balancing control circuit.



TRANSISTORS

by PAUL PENFIELD, Jr.

in audio circuits

Conclusion: Feedback Design

AS IN vacuum-tube amplifiers, negative feedback has three main effects in transistor amplifiers. It tends to lower the gain; to reduce distortion, noise, and hum originating in the amplifier; and to change the input and output impedances of the amplifier.

Unfortunately, there is no simple mathematical analysis of feedback for a transistor amplifier as there is for a vacuum-tube amplifier. But this fact should not prevent us from giving a word description of the effects, even though it cannot be made exact.

In a vacuum-tube amplifier the effect of over-all negative feedback can be predicted with some precision. If the voltage gain of the amplifier is A, and a fraction β (minus for negative feedback) of the output is added to the input voltage, the final voltage gain is reduced to approximately $A/(1-\beta A)$. The output impedance of the amplifier, which was formerly some value R_o becomes $R_o/(1-\beta A)$. If, on the other hand, a voltage proportional to the output current were fed back to the input, the gain would be reduced as before, but the output impedance would rise above its former value.

The distortion, noise, and hum produced in the amplifier will be reduced to $1/(1-\beta A)$ of what they were previously — the same factor by which the gain is reduced. The practical use of negative feedback to reduce distortion stems from the fact that by building an amplifier with an original gain A higher than necessary, the distortion can be considerably reduced, the penalty being a loss in gain which has been designed for.

These same general features apply also to transistor amplifiers. Since the input impedance of transistor amplifiers is not extremely high, however, the mathematical expressions quoted above no longer apply. In addition, the input impedance of a transistor amplifier can be affected by feedback.

Negative feedback may be applied around the entire amplifier, or around a single stage or a pair of stages.

Over-All Feedback

There are two ways of obtaining the feedback signal from the output, illustrated in general by Figs. 1 and 2. In

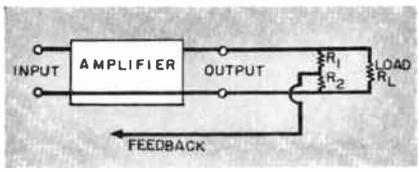


Fig. 1. Voltage feedback from output.

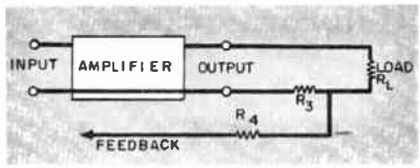


Fig. 2. Current feedback from output.

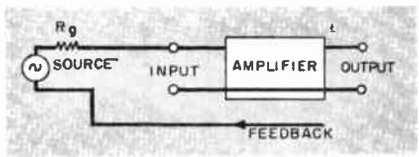


Fig. 3. Series feedback to the input.

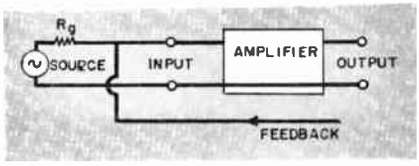


Fig. 4. Parallel feedback to the input.

Fig. 1 we see that the feedback signal is proportional to the output voltage, so this type of connection is known as "voltage feedback." Distortion, hum, and noise in the output voltage tend to be reduced by voltage feedback. In other words, the output voltage is stabilized. On the other hand, in Fig. 2 we can see that the feedback signal is proportional to the output current. This type of connection, known as "current feedback," tends to stabilize the output current.

Note that the distinction between these two stabilization actions is not merely academic. It is true that if the load were a pure resistance, then the output voltage and output current would be proportional to each other, and the same feedback signal would result. But in other cases, as when the load value varies with frequency, or is nonlinear, it makes a great deal of difference whether we try to stabilize the output current or the output voltage. If we use voltage feedback, tending to stabilize the output voltage, the effect on the load is the same as if the internal resistance of the amplifier were lowered. And similarly, current feedback gives the effect of a higher output resistance for the amplifier.

Current feedback, being proportional to the output current, will not be very effective in reducing gain and distortion if the amplifier load is a very large resistance. This is just another way of saying that, since the load resistance is high, the current through it is practically the ratio of the open-circuit output voltage to the load resistance, and thus the current feedback has no effect. This happens when the load resistance is much higher than the output resistance of the amplifier with feedback.

Similarly, when the amplifier load is very small, voltage feedback will not be very effective. This happens when the load resistance is much smaller than the output resistance of the amplifier with the feedback connected.

At the output of an amplifier, then, voltage feedback tries to stabilize the output voltage by reducing the output resistance of the amplifier, tending to make the output voltage a replica of the input; current feedback attempts to stabilize the output current by raising the output resistance of the amplifier, tending to make the output current a replica of the input.

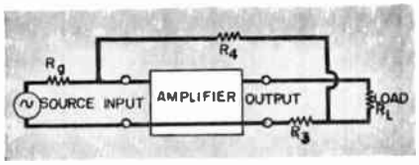
At the input the story is similar. The feedback can be attached by either a series or parallel arrangement, as shown in Figs. 3 and 4.

In Fig. 3 the feedback is applied in series with the input. Since the feedback

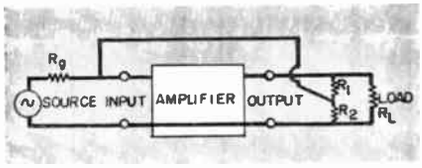
voltage is out of phase with the input, the signal source sees, in addition to the amplifier input, this out-of-phase voltage, which tends to reduce the current flowing. The effect, consequently, is the same as if the amplifier input resistance were increased. Less current flows, and the output signal will tend to be similar to the open-circuit source voltage.

In Fig. 4 the feedback is applied in parallel with the input. This has the effect of increasing the current supplied by the source, or of decreasing the resistance the source "sees." The output signal will tend to be a replica of the short-circuit source current.

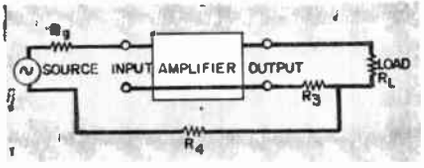
The distinction between the source open-circuit voltage and short-circuit current is important when the source has reactive elements like inductances in it. In fact, this feature played an important role in the designing of input stages to match certain transducers, mainly magnetic phono cartridges. Recall that the amplifier input resistance used to terminate the cartridge is important. An easy way to adjust this input resistance is by adjusting the feedback applied to the input stage.



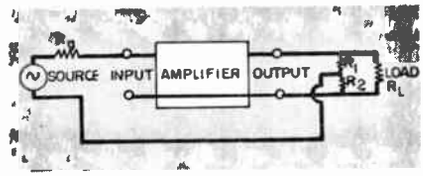
Current-output, parallel-input feedback.



Voltage-output, parallel-input feedback.



Current-output, series-input feedback.



Voltage-output, series-input feedback.
Fig. 5A (top) to D. Feedback methods.

At the input, then, parallel connection for negative feedback reduces the input resistance of the amplifier, and tends to make the output the same as the short-circuit current of the source. It is not effective when the source resistance is much lower than the amplifier input resistance with the feedback connected. And series connection increases the input resistance, trying to make the output the same as the open-circuit source voltage. It is not very effective when the source resistance is much higher than the input resistance of the amplifier with feedback.

At both the output and the input we have two possibilities, or a total of four possible ways to apply feedback around an entire amplifier. These four are all

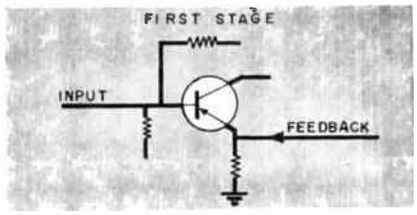


Fig. 6. One method of introducing series-input feedback to transistor stage.

shown in Fig. 5. In Fig. 5A, current feedback from the output is fed in parallel with the input. Thus the output current will tend to be a replica of the source short-circuit current. The others are analyzed in the same sort of way — for example, in Fig. 5B the output voltage tends to be similar to the source short-circuit current.

Notice that in Fig. 5B, the feedback does not change the amplifier voltage gain. This is evident since the voltages the source and load face are the same regardless of any feedback loops in parallel with the input or output. But the current gain of the amplifier is much lower with feedback than without, so the product of the two gains, which is the power gain of the amplifier, is lower. Similarly, in Fig. 5C the current gain of the amplifier is not affected by the feedback, but the voltage gain *is*. The reader should be able to verify for himself that in Fig. 5D the ratio of output voltage to input current is the same with or without feedback.

We have tacitly assumed that the feedback is in fact negative — that is, in such a direction as to decrease the gain of the amplifier. In all the examples of Fig. 5 the output voltage should be inverted with respect to the input voltage for the feedback to be degenerative, or negative.

All the methods of connection shown in Fig. 5 are quite practical for use with complete transistor amplifiers except for the series input connection in Figs. 5C and 5D. As pictured, the input source cannot use the amplifier ground, which might be necessary to avoid hum pickup.

Series feedback at the input *can* be used on the first stage, however, a popular connection appearing in Fig. 6. This is similar to the solution of the same problem in vacuum-tube amplifiers.

Feedback Effects and Stability

So far nothing has been said about how much the feedback will reduce the gain and the distortion. The reason, as mentioned before, is that no simple general theory exists.

Feedback in vacuum-tube amplifiers is usually measured in decibels of gain reduction, and the same principle can usually be used with transistor amplifiers. Unfortunately, the exact gain reduction a given circuit produces depends upon the amplifier and the load and source resistances. This effect is usually tacitly ignored in specifying vacuum-tube feedback, and can also be ignored with transistor amplifiers for many practical purposes.

For vacuum-tube amplifiers, as mentioned earlier, the simple theory tells us that the distortion reduction is the same as the gain reduction, in decibels. This is often not true in transistor amplifiers; determining the distortion reduction in general is a messy business. Only in very exceptional cases, though, are gain reduction and distortion reduction far different.

The amount of feedback applied to an amplifier cannot be too great, or the amplifier will begin to oscillate. This happens when the phase shift at some frequency above or below the range of frequencies of interest becomes 180°, but the gain is still great enough that a small signal at the input of the amplifier gets fed back larger than itself. Oscillation

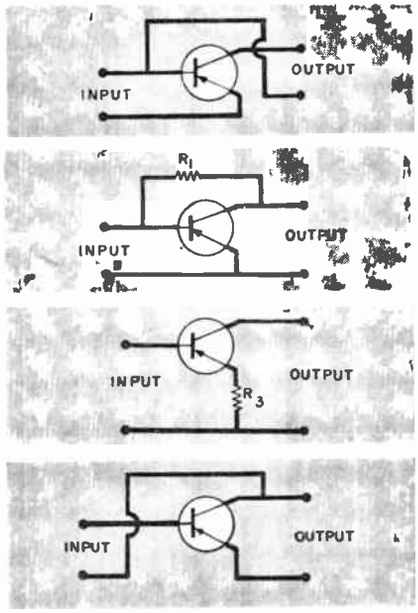


Fig. 7A (top) to D. Four types of feedback illustrated in Fig. 5 applied to a single grounded-emitter stage.

then occurs which is limited only by nonlinearities.

Vacuum-tube amplifiers have this problem also, but not so severely, for two reasons. First, the frequencies at which this type of phase shift occurs are usually far outside the audio range. And second, the phase shift is usually smaller at any given attenuation.

Transistor amplifiers, on the other

Continued on page 38

Prepared by Hirsch-Houck Laboratories

AUDIOLAB

Test Reports

An objective analysis of high-fidelity components

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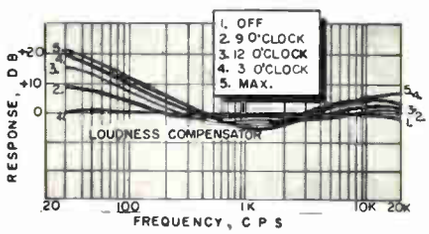
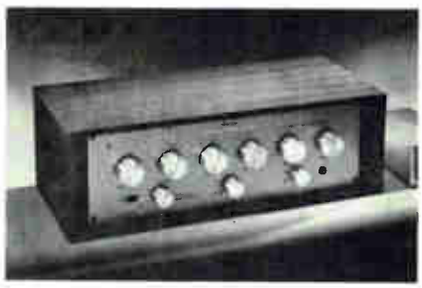
MARANTZ AUDIO CONSOLETTE

Like the Marantz power amplifier, the Audio Consolette is notable for the quality of its components and general construction. Many of the resistors in critical low-level circuits are deposited-carbon types (low-noise), and the record-equalization components, both resistors and capacitors, have 2% tolerances. All variable controls are Allen-Bradley potentiometers, which generally have lower noise and longer life than cheaper controls used in most home hi-fi equipment. The unit employs terminal-board construction, with shock mounting of tubes and exceptionally neat wiring throughout.

While these features are interesting for the technically minded reader, the Audio Consolette has a number of unusual operating conveniences which are evident to anyone using it. On the surface, it would seem to be quite conventional, with the usual array of tone controls, input selector, and bass and treble equalizers for records. The tone controls are unusual, however, in the choice of turnover frequencies. The bass control affects only frequencies below about 300 cps, while the treble control takes over above 2,500 cps. The boosting action of both controls appears to be quite mild until they are nearly at their extremes of rotation. They have almost no effect on the middle frequencies, with the result that large amounts of boost or cut can be applied at the frequency extremes without making the sound muddy or shrill.



Loudness compensation.

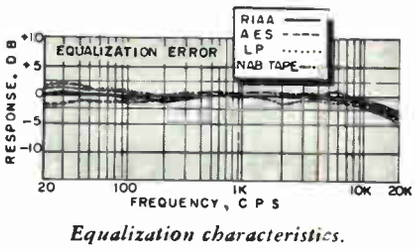


Marantz Audio Consolette.

A treble cutoff filter is provided, with 12-db-per-octave slopes above frequencies of 5, 7, and 10 Kc. Unlike many such circuits, this one uses a high-Q toroidal inductor in the output circuit of the preamplifier. This filter has virtually no effect on the lower and middle frequencies, and can be used most effectively to clean up the sound from worn records (or AM broadcasts) without noticeable loss of highs.

A unique loudness compensator is a feature of the Marantz Audio Consolette. It is a continuously variable control, which is normally fully counterclockwise (OFF). In this position the response is flat. As the compensator is advanced clockwise, it does not affect the volume level appreciably, but begins to boost the bass starting at the lowest frequencies. In the first half of its rotation this control does not boost the highs, but as more and more compensation is used, the high frequencies are boosted as well as the lows. Since this control is not tied in any way to the volume control, it is possible by careless use of the controls to overload the amplifier system. For instance, between the tone and loudness controls a total of 40 db of boost is available at 20 cps. This much boost would probably be intolerable even at low levels, but as the volume is increased it is obvious that something is going to be overdriven. A modicum of common sense will prevent such an unfortunate situation from occurring.

The bass and treble record-equalization characteristics are separately switched, and provide practically any desired type of equalization. Flat settings are available for use with microphones. On recent units, an NARTB tape-playback equalization position has been added.



Equalization characteristics.

The six input positions include low- and high-level magnetic-cartridge inputs, a microphone input (which can also be used as a cartridge input for a third pickup), and three high-level inputs. The Marantz Audio Consolette is probably unique among high-quality pream-

plifiers in that it has no individual level controls for the various inputs. Since the loudness compensator is not associated with the volume control, this does not pose any serious problem. Practically all program sources have their own level controls, and the most practical approach seems to be to let the phono cartridge establish the base level and to set all other program sources to match it.

A front-panel slide switch permits feeding the output of the selected channel, unaffected by any controls except record equalizers, to a tape recorder and connecting the playback amplifier into the reproducing system to monitor the tape as it is being recorded. This switch is also used to connect a tape playback system to the reproducing system, and the high-level tape output is selected by it independently of the regular input-selector switch.

The power supply is a small external box containing selenium rectifiers for plate and heater supplies (all heaters are run on DC), and three switched AC outlets. On the panel of the Consolette is a heavy duty ON-OFF power switch which can control up to 675 w. This can be a very important consideration when one or more high-powered amplifiers are used, since most inexpensive power switches which mount on volume controls are not rated for handling this much power and will have a short life as a result.

Hum and Noise

Reference Level: 0 db = 1 v

Input	*Tuner*	*Mic*	*Low Phono*	*Med. Phono*
Sensitivity	.05 v	.001 v	.0011 v	.0017 v
Hum and Noise				
Max. Gain.	—73 db	—42 db	—50 db	—50 db
Min. Gain	—88 db	—88 db	—88 db	—88 db
Max. Gain (Input shorted)	—76 db	—50 db	—50 db	—50 db
Standard Gain Setting	—80 db	—58 db	—70 db	—65 db
Crosstalk from Radio or Aux	None	None	None	None

Test Results

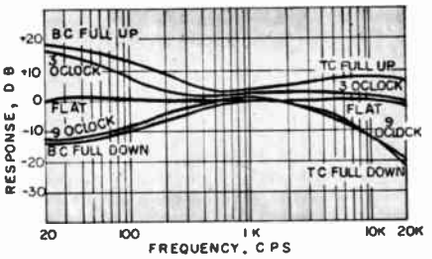
The response curves for the tone controls, loudness compensator, and cutoff filter are more or less self-explanatory. The flatness of the response with the tone controls in the indicated flat position is noteworthy.

The record equalization, as one would expect from the 2% components used in the circuits, is extremely smooth and precise. In particular, the low-frequency boost has not been skimped, and even the AES curve, with its great bass compensation, is maintained down to 20 cps. The NARTB tape equalization is as good as the record equalization.

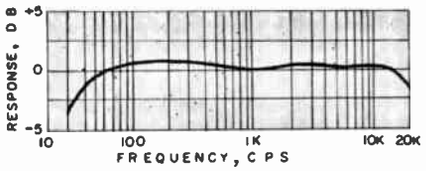
As we found in our test of the Marantz power amplifier, the very low distortion specifications of the Audio Consolette are met without difficulty. It is rated at less than 2% IM distortion at 15 v equivalent RMS output and 0.1% at 2 v output. We measured 1% and 0.1% respectively, and the latter figure includes the .08% residual distortion of our analyzer. These measurements are at maximum gain. When the gain is reduced, as it is always in practice, the distortion rises appreciably, but is still less than 0.2% at 1 v output and 1% at 4.5 v output with a gain of unity (1 v into the TUNER input at 1,000 cps giving 1 v output).

Combined hum and noise at maximum gain are 50 db below 1 v output on low-level inputs. This is essentially all noise, and the hum is indeed inaudible under any conditions we could impose. The gain of this unit is very high, so this figure does not convey a true picture of its low noise characteristics. More revealing is the measurement taken at standard gain (unity on high-level inputs, 40 db on low-level inputs). Under these conditions the hum and noise is 70 db below 1 v on the low magnetic-phono input, and 80 db below 1 v on the tuner input.

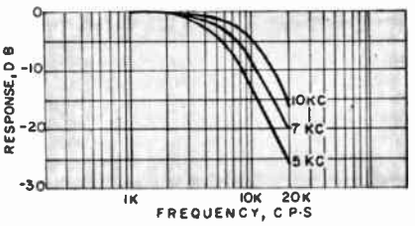
Power-line leakage current to the chassis was only .012 ma.



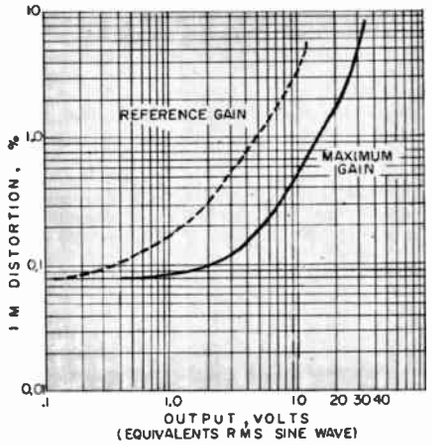
Tone-control action.



Frequency response.



Scratch filters.



Intermodulation distortion.

Summary

The Marantz Audio Consolette, for which the highest claims are made, lives up to these claims in full measure. In caliber of construction and quality of components it takes second place to none. Its distortion is negligibly low under any reasonable conditions of use. Its record equalization is very precise over the entire audio range. Its hum is truly undetectable and its noise level is also unusually low. The gain on phono inputs is sufficient for use with the lowest output cartridges without using input transformers or preamplifiers.

In listening tests, we found the action of its controls to be exceptionally smooth and pleasant. The chief criticism which could be leveled against it (in our opinion) is the lack of input level controls. In cases where the various program sources cannot be set to a common level, there can be disconcerting level changes when switching inputs.

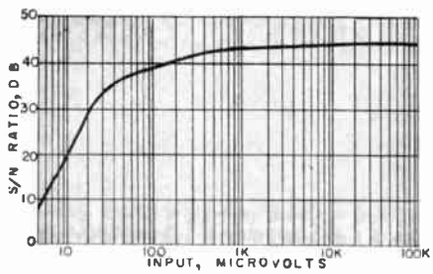
CHAPMAN GLOBEMASTER FM-AM-SW TUNER

The British-made Chapman Globemaster tuner offers an unusual combination of features. It combines a relatively simple FM tuner with a high-quality AM tuner, which covers not only the standard broadcast band, but which has continuous short-wave coverage in three bands from 1.1 Mc to 23 Mc.

All AM bands use a tuned RF stage, converter, two IF stages with selection of wide or narrow bandwidth, and a diode detector; a tuning eye and AGC circuit are also included. The FM tuner circuit is rather basic, with a pentode RF stage, converter, two IF stages (the second acts

as a limiter) and a ratio detector. An audio stage and cathode-follower output are common to both tuner sections, and a screw-driver-adjusted volume control is located at the rear of the chassis. Both high- and low-impedance outputs are provided. The low-impedance output (600 ohms) is nominally 2 v, and the high-impedance output, which is ahead of the audio section, has a 100-mv output.

By comparison to almost any current American high-fidelity equipment, the Globemaster is rather stark. The chassis is cadmium plated, with a dull gray finish. All chassis markings appear to be made with a pen and India ink, and some of them wore off almost to the point of illegibility after a short period of use. The front panel is attractive, with



Sensitivity characteristics.

a bronze satin finish and a large rectangular dial. Three operating controls are located on the panel: a combined ON-OFF switch and AM bandwidth selector, with 7-Kc and 10-Kc positions (in typical British fashion, the OFF position is fully clockwise), a bandswitch, and the tuning control.

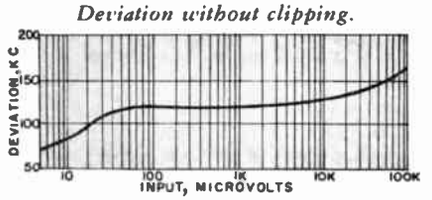
The instruction sheets accompanying the tuner include a schematic diagram (not too legible in places because of being partially freehand drawn) and alignment instructions. The latter are especially important in the case of a tuner having several ranges and many components unfamiliar to American servicemen.

Test Results

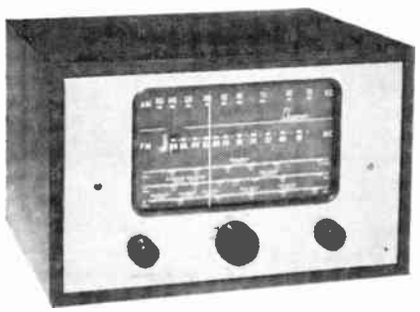
When we placed the tuner in service, we were immediately aware of severe distortion on all ranges, as well as low output. The high-impedance output had much less distortion, but was too low to drive our amplifiers properly and also suffered a severe loss of highs with about 6 ft. of shielded cable connected to its output.

We were almost ready to give up our test when we decided to check through the circuitry carefully. This disclosed the fact that the wire carrying plate voltage to the cathode-follower output stage was

Deviation without clipping.



missing, and in fact had never been soldered in the circuit! When we made this connection, the tuner came to life in a satisfying manner. Another fact relevant to this matter was that this tuner

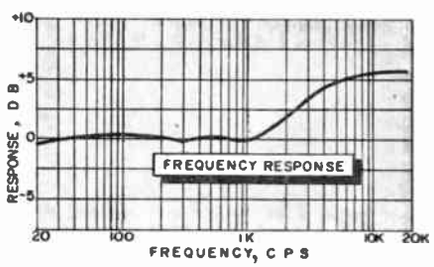


The Chapman "Globemaster."

was the second unit submitted to us for test. The first had an FM section which was inoperative.

The sensitivity of the FM tuner was 10 μv for 20 db quieting and 20 μv for 30 db quieting. These are what we would consider reasonable figures for a tuner with the simple circuits of the Globemaster, but the manufacturer's specifications call for 4 μv at 20 db quieting. Since the input level had to be at least 20 μv before a 100%-modulated signal could be received without visible wave-form clipping, we would rate the effective sensitivity of this tuner at 20 μv.

Although there was not *clipping* of the output wave form of the tuner for FM deviations up to 120 Kc at moderate signal strengths, there was a visible amount of asymmetry in the audio signal,



Frequency response.

indicating a large amount of even-harmonic distortion. This was further evidenced by the IM distortion at the smallest deviations, becoming worse as the deviation became larger. Thinking that the tuner might have been misaligned, we tried touching up the detector alignment without improvement. The IF alignment also proved to be optimum.

The warm-up drift of the FM tuner was small, and we did not miss an AFC circuit. The tuning was affected appreciably by line-voltage variation, however. The limiting action was also rather ineffectual, and the audio output level from the ratio detector varied over an enormous range with changes in received signal strength. Over most of the range of input signals from 10 μv to 1,000 μv, a ten-fold increase in signal strength caused a five-fold increase in audio output level. As a result, when tuning across the FM band, if the audio level was set high enough to hear the weaker stations, the stronger ones blasted our ears, and if the volume was set for the stronger signals, weaker ones were quite inaudible. The tuning eye required an extremely strong signal to produce an appreciable closing of its pattern, so it did not help much in tuning (it was much more effective on AM).

Finally, the de-emphasis of the high frequencies in the FM audio did not conform to the U.S. standard of 75 μsec. It was approximately 50 μsec, with the result that the high frequencies were unduly emphasized. This amounted to about 5 or 6 db of boost for all frequencies above 5 Kc.

AM Listening Tests

Although we did not make any measurements on the AM tuner, we did listen to it critically. We are happy to say that the AM portion of the Globemaster is as outstanding as its FM section is mediocre. The sensitivity appeared to be very adequate on the standard broadcast band, and the tuning eye operated well. AGC action was good. The 10-Kc position of the AM bandwidth switch had a definitely flat-topped IF response, with quality comparable to some of the most expensive American AM tuners, and vastly superior to most AM tuners we have seen. It was good enough so that enjoyable stereo reception via a pair of AM and FM stations could be had.

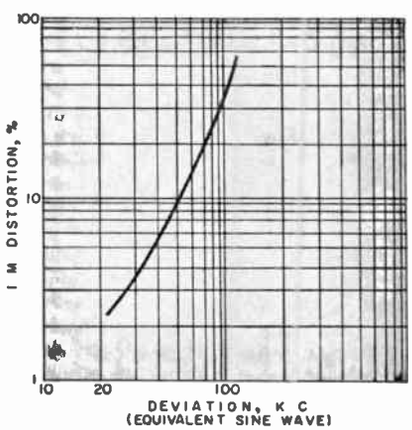
On the short-wave bands, the sensitivity seemed highly variable. At some frequencies we could hear the background noise peak, while at others no signals could be heard. Most international short-wave stations have very strong signals, and we obtained clear reception from many distant points.

Summary

Despite its excellent AM tuner section, we find the over-all shortcomings of the Chapman Globemaster outweighing its virtues. Possibly our experiences with

Continued on page 47

Intermodulation distortion.



Measuring Elapsed Tape Time

In order to simplify the playback of passages as you record, first, time how long your machine takes to rewind a tape. Then divide this by the playback time for that size reel. For example, assume that it takes three minutes to rewind a reel which plays for thirty minutes at 7½ ips. This will give a figure of 1/10; a 3¾-ips tape similarly will give a figure of 1/20. Then, simply rewind for the recording time multiplied by the appropriate ratio.

Pvt. Kendall Thurston
U.S. Army Receiving Station
Fort Ord, Calif.

Kitchen Safety

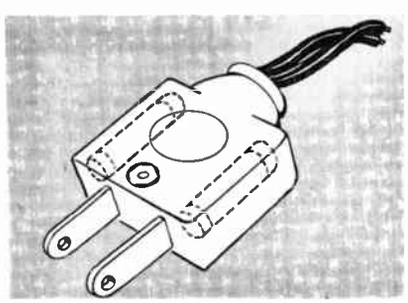
Rufus P. Turner's timely editorial in the December 1957 issue points out the danger of ordinary 110-volt house current. One simple way to eliminate a common hazard is to remove the AC-DC radio from the kitchen. The combination of wet hands, grounded metal objects, and knives that can easily touch chassis mounting screws leaves too much to luck.

The kitchen can be made a much safer room by replacing the typical AC-DC radio with one of the new larger-size battery-operated transistor portables that will run 500 hours or more on one battery. Another method would be to install an extension speaker from the family hi-fi rig.

Henry F. Robbins
New York, N.Y.

Fuse Plug

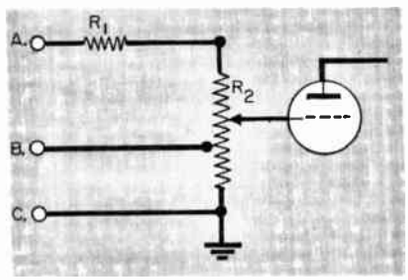
Many electronic kits have no fuse in the power line, and there is always the possibility that an error in wiring might cause a short circuit and damage the equipment. One solution is to install an Elmenco two-fuse plug (which sells for about 35¢) at the end of the AC power cord. The connections to the two prongs of the plug are made through two fuses which are inserted into the insulated plug case, and they can be inserted or removed without opening the case. If you don't want to add the plug permanently, it can be put on one end of a 3-foot length of lamp cord with a female receptacle at the other end, and used between the wall socket and the equipment plug. To decide what fuse to use, add ½ amp for each 25 w consumed by the piece of equipment.



H. Skalamera
New York, N.Y.

Dual-Input Adapter

Here is a simple method I use in amplifier construction to furnish inputs for both a ceramic cartridge and a preamplifier or other inputs. It makes use of a tapped volume control with the ceramic cartridge utilizing the full resistance of the volume control and the tap to ground for the preamp and other inputs. Obviously, all inputs cannot be connected at the same time unless a switching arrangement is used. This would, of course, destroy the simplicity for which the idea was intended. Here is a schematic of the arrangement. R1 is a 200 K, ½ w resistor, and R2 is 2 meg; the volume control is tapped at 500 K or 1 meg as the need dictates.



Connect the ceramic cartridge between points A and C to furnish a 2.2 meg load. Connect the preamp, tuner, or crystal cartridge between B and C, for a 500-K or 1-meg load.

When the ceramic cartridge is used, the volume control is continuously operative over the whole strip; only the lower part (from B to C) is operative when a tuner, preamp, or crystal cartridge is used.

Frank Damico
Jamaica, N.Y.

Sound-Fanciers' Guide

by R. D. Darrell

WHATEVER else stereo discs may do, they certainly shake things up — imperiously demanding not only a revamping of home sound systems, but an entirely fresh sharpening of one's ears and a revolutionary re-examination of one's whole philosophy of sound.

Like many another audiophile, professional as well as amateur, I've been fretting for months over the delays in getting actual samples for home test of both varied stereo-disc releases and the pickup cartridges to reproduce them. And now, when at last distributors are beginning to catch up with advertisers, I'm in more of a turmoil than ever as I hurriedly fiddle with system improvisation and adjustment, and relisten to the discs themselves as against — where available — their corresponding tape versions, trying desperately to evaluate what I'm hearing and to draw some firm, even if tentative, general conclusions. It's like starting one's audio education all over again, it's hard and exasperating work, and it couldn't be more fun!

At this stage I may be pretty well confused in many respects, but even now I'll venture boldly out on a couple of certainly safe limbs: nothing since the first appearance of LP's and one's initial encounters with stereo sound on tape more powerfully reinvigorates one's sonic curiosity and listening excitement . . . and I'm more strongly convinced than ever before that all our judgments of what we hear are vitally colored, if not predominantly determined, by the particular characteristics of the reproducing equipment we're using. This means, of course, that while all first responses to stereo discs should be qualified in the light of our present enthusiasm (or skepticism), they can be either extremely favorable or unfavorable (or mixed) and still be "right." Stereo discs can and sometimes do sound terrible; they also can and often do sound wonderful. In some part these quality disparities obviously are inherent in the recorded performances or the disc processings themselves, but in far larger part they result from our playback systems' response characteristics and control adjustments. Undoubtedly our personal estimates are further colored by individual tastes.

Strictly Personal

To be specific, little or nothing I have heard from stereo discs played with a minimum-priced stereo pickup has struck me as remotely approaching my own standards for stereo sound from tapes, or even as aurally satisfactory by itself. Perhaps my ears have been conditioned by years of listening to magnetic-cartridge reproduction. At any rate, I had to revise sharply upwards my estimates of many of these discs once I was enabled to play them with one of the first — and not, surprisingly, much more expensive — stereo pickups of the magnetic type. I hope before too long to have the opportunity of trying out others, perhaps especially the first stereo models in the Pickering line which has long served me well for ordinary LP's, and the GE workhorse stable which has so firmly established its monophonic worth with so many audiophiles.

Meanwhile, my first experience with the celebrated Fairchild products — in the form of the XP 4 stereo cartridge and Model 282 stereo arm — has been a very happy one indeed. Using them (together with my old home-built Drisko-designed preamp for one channel, a Fisher TR 1 transistor preamp for the other, and the same amplifier/speaker systems I normally use for stereo tapes), I can at least report with some confidence and very real pleasure on the stereo discs which have impressed me most among the relatively few I've heard so far.

But I should hasten to stress, as I've had occasion to more than once before, that I specify the components I'm using simply for readers' interest only. It isn't my official business to pass judgment on equipment and I've made none of the comparative tests among a wide variety of models which alone would give any weight to my opinions. (When I once find a set-up I like, I tend to stick with it — at least until I hear something else that promises really marked improvements.) For that matter indeed, even my recorded-performance evaluations are always advanced not as authoritative decrees, but merely as highly personal reports on what I've liked best as reproduced on my own home system. They are works which I think will also be liked even as reproduced by quite different equipment and under varied acoustical conditions by other sound connoisseurs, but which I always expect to be re-valued according to each listener's own tastes.

First Stereo-Disc Recommendations

The most sensationally dramatic symphonic work I've heard so far in the new medium is Stokowski's darkly powerful performance of the Shostakovitch Eleventh Symphony, "Year 1905" (Capitol PBR 8448), which is undeniably reactionary and reminiscent musically (*Ilya Mourometz* rides again!), but even more undeniably overwhelming in its dramatic impact. More blazing in its highs and transients, but less substantial in its lows and over-all sonic breadth, is the *Hi-Fi Fiedler* program of Rimsky's, Rossini's, and Tchaikovsky's music (RCA Victor LSC 2100), previously praised here and elsewhere both in its original LP edition and the stereo tapings CCS 40 and BCS 41. Another symphonic showpiece, the Saint-Saëns *Organ* Symphony, conducted by

Swarowsky (Urania USD 1001) is less dazzling and transparent than the other two works above, but it comes very close to the taping (UST 1201), which I ranked among the ten or so "best" of 1957, in its superb blending of organ (played by Franz Eibner) and orchestra, and in its overwhelming climaxes.

More restrained in their exploitation of stereo potentialities, as well as in their genial performances of less showy scores, are Boult's Beethoven *Pastorale* Symphony (Vanguard VSD 2004), which is even more ingratiating and transparent here than in its LP edition; four delectable Vivaldi bassoon concertos (Stereo-Vox ST-PL 10.740), which display some of the most authentic tonal qualities and buoyant playing — by Virginio Bianchi — of this so often misused instrument I've yet to encounter on any records; and the Solisti di Zagreb's performance of Vivaldi's *Seasons* (Vanguard BGS 5001), which I enjoyed so much earlier in both LP and tape versions. All of these are particularly good choices for discophiles who so far have been more or less skeptical of stereo attractions, above all those which strike them as tricky sound effects rather than essentially *musical* enhancements. Here the channel differentials never are exaggeratedly stressed, but are exploited only discreetly in adding spaciousness and definition to the instrumental textures themselves.

The confirmed stereo fan, however, well may get more immediate excitement from such inherently more vivid and "stereogenic" display pieces as Britten's *Young Person's Guide to the Orchestra* and Dohnányi's *Variations on a Nursery Song* (Capitol P 8373), conducted by Felix Slatkin, with Victor Aller as piano soloist in the latter work — a longtime favorite of mine; the indefatigably spirited Dukes of Dixieland at their rowdiest and imaginative best in their Vol. 3, *Marching Along* program (Audio Fidelity AFSD 1851), already deservedly famous in LP and reel form; and the demo-samplers of miscellaneous Stereo-Vox current offerings and sound effects (VST 1), and of Capitol pops and jazz artists, *The Stars in Stereo* (SW 1062). There are also similar demonstration discs, but these have narrators from RCA Victor and Capitol (the latter combining materials issued earlier in the *Introduction to Stereo* and *Study in Stereo* tapes). They are for dealers' use only and (currently at least) not for sale — which also may be the case with similarly narrated "demos" from London and Columbia that I haven't yet had an opportunity to hear except in away-from-home samplings. Yet, despite the uncertainty of such hasty and incomplete auditions, they did sound every bit as good as widespread professional rumor had them; which promises a great deal for the soon-forthcoming regular stereo-disc releases from London and Columbia.

Venture into the intriguing field of printed circuits by making your own etched-circuit board for this wide-range audio oscillator.

Make a Printed-Circuit Oscillator

By THOMAS JASKI

THE AUDIO OSCILLATOR is a fine practical example on which to learn the techniques of design and construction with etched circuits, since it is an instrument for the serviceman as well as the experimenter and the audiophile. Use of an etched circuit can result in a neat and compact oscillator in which no compromise is made with performance.

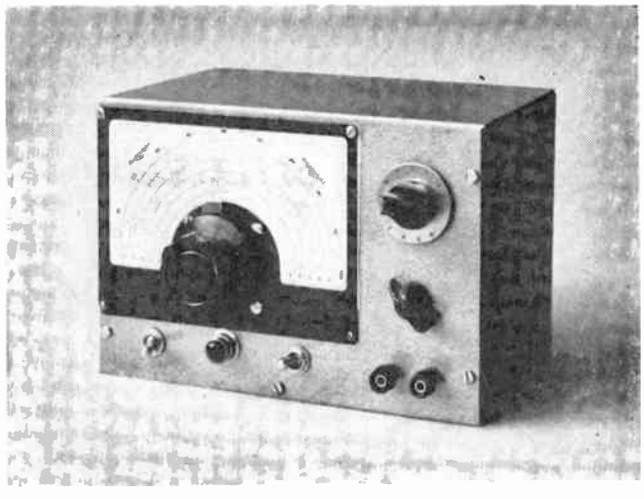
The oscillator described in this article produces sine waves from 15 cps to 1.5 Mc, excellent square waves from 20 cps to 40 Kc, and usuable square waves down to 15 cps and up to 80 Kc. The basic oscillator circuit values are not changed for square-wave settings, so that the same frequency scale (see Fig. 7) serves for all purposes. The completed oscillator is shown in Figs. 2 and 3.

All the components used are standard, and no special printed-circuit parts are required. Standard resistors can be used if some care is given to their selection. For greater certainty of accuracy, precision resistors should be used. Using standard resistors selected from only a limited quantity, I obtained a scale-to-scale correspondence of better than 3%. The two sets of resistors in the two halves of the network were selected to be reasonably close in value, but it is of far greater importance to have those in each group increase by exact multiples of 10. Groups of resistors from the same production batch generally run quite close, particularly in the case of good-quality resistors.

On the other hand, it is, of course, possible to obtain very great accuracy with an almost random choice of standard resistors, by calibrating and drawing a scale for each range, but this is a cumbersome procedure which makes it difficult to read the scale when using the oscillator. For most practical purposes, very accurate frequency settings are not often required. If they are, checking points can be made with an oscilloscope using standard frequencies and Lissajous figures.

Naturally, since this was the first oscillator of its type I made, there were several mistakes in the first trial; some afterthoughts for improvement had to be incorporated. The benefit of these lessons is passed on to the reader, and the new features are included in the circuit and the etched wiring. If you suspect that there are better ways to build this oscillator, a breadboard is the answer; experiment before an etched circuit is laid out.

Fig. 1. External view of completed oscillator. A single frequency scale serves for all settings of the range switch.



Circuit Description

This circuit (Fig. 4) is quite conventional; the oscillator is an RC feedback type, using the two halves of a 6U8 for the oscillator and feedback tubes. Sine-wave signals are obtained from a voltage divider across the output of the triode portion of the second 6U8, and are supplied to the cathode follower. A sine-wave signal of approximately 15 v RMS can be obtained at the highest setting of the attenuator.

Square waves are obtained by applying the whole output of the oscillator to a pair of conventional pentode clippers, the 6AH6 and the first half of the second 6U8. A large coupling capacitor between the pentodes prevents distortion at the low ranges. Most components in the clipper circuits

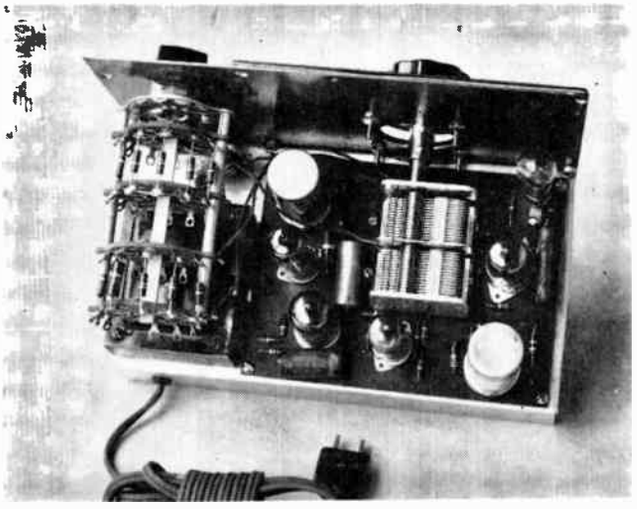


Fig. 2. Top view, with case removed. Etched-circuit board is on the right, power transformer and range switch on left.

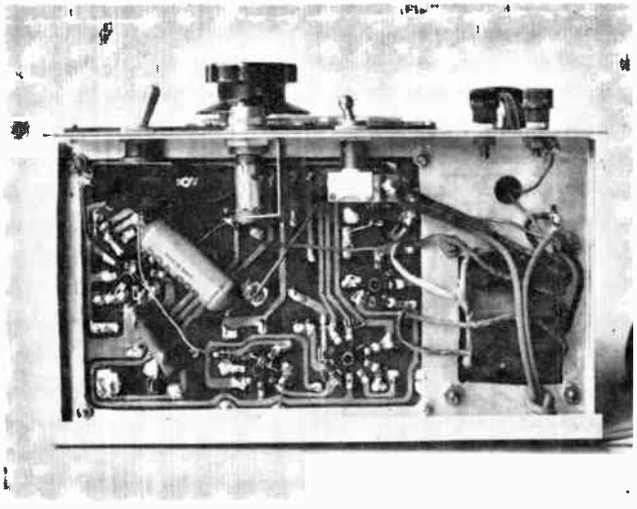


Fig. 3. Bottom view. A few components have been wired to the bottom of the circuit board to facilitate construction.

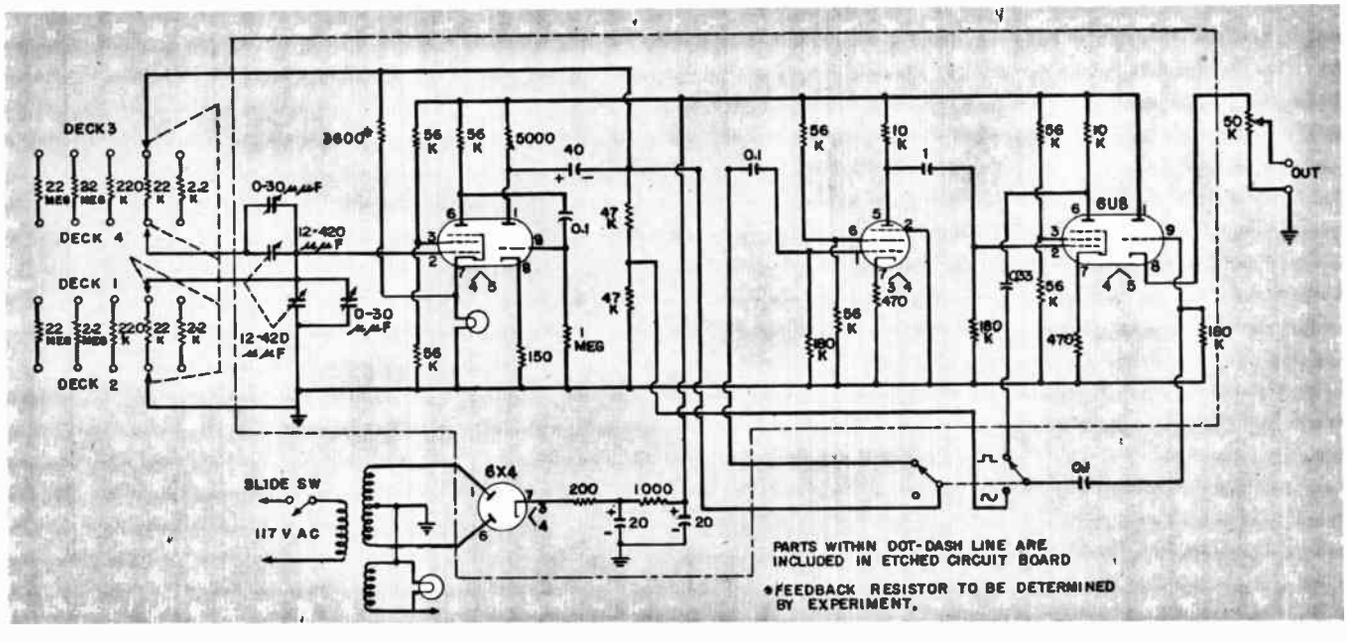
have been chosen to maintain short time constants. For good wave form and reliable oscillation, the feedback resistor (in my case, 3.6 K) must be determined experimentally. This can be done after the oscillator has been assembled and otherwise put into operating condition. The bottom of the circuit board is sufficiently clear and uncluttered to make the installation of another resistor quite easy.

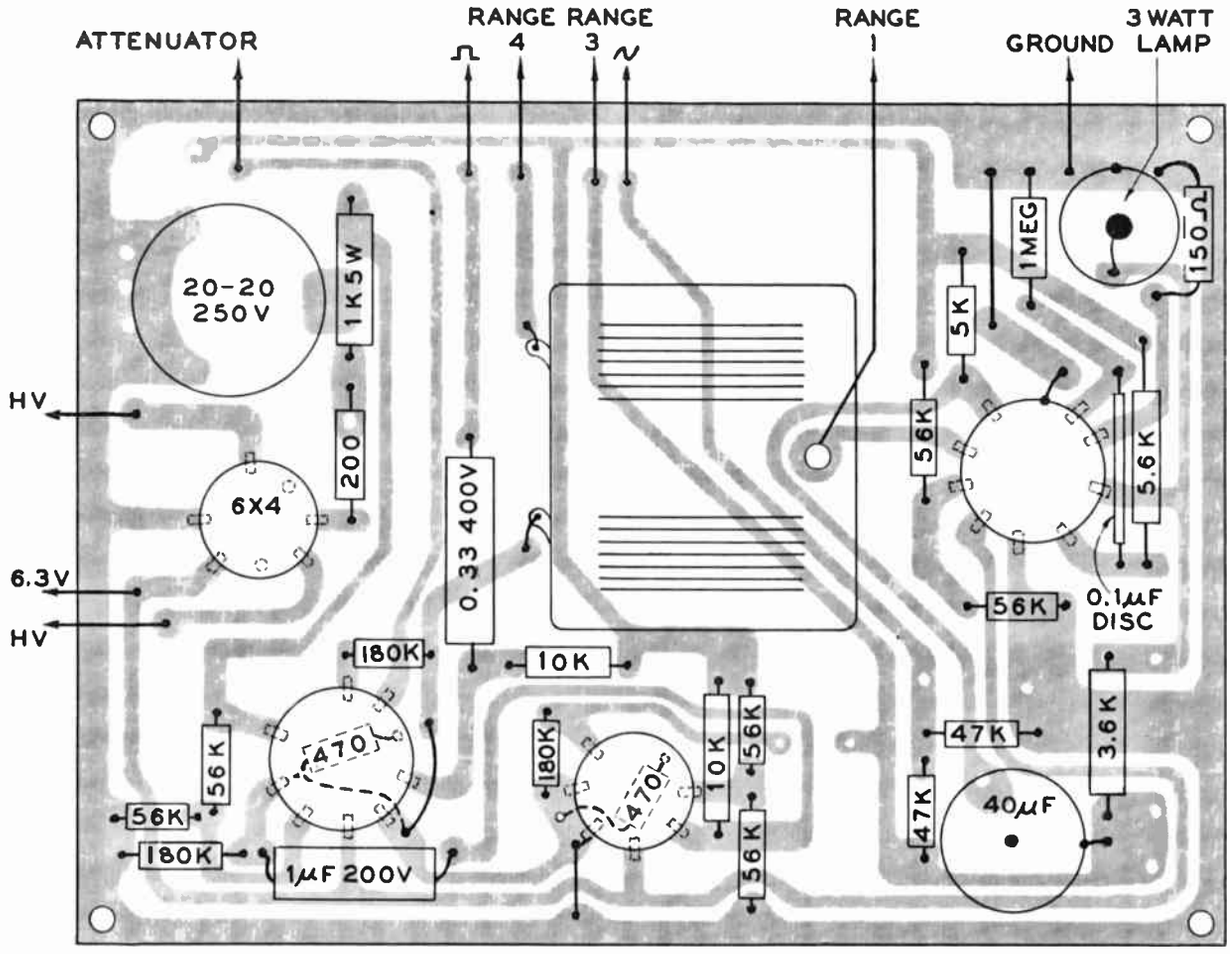
Another approach would be to make this feedback resistor variable, thus permitting continuous control of the wave form and oscillation threshold. It must be remembered, however, that for different settings of this resistor there are also differences in frequency, so that the oscillator must be calibrated with specific settings of the feedback resistor.

Making the PC Board

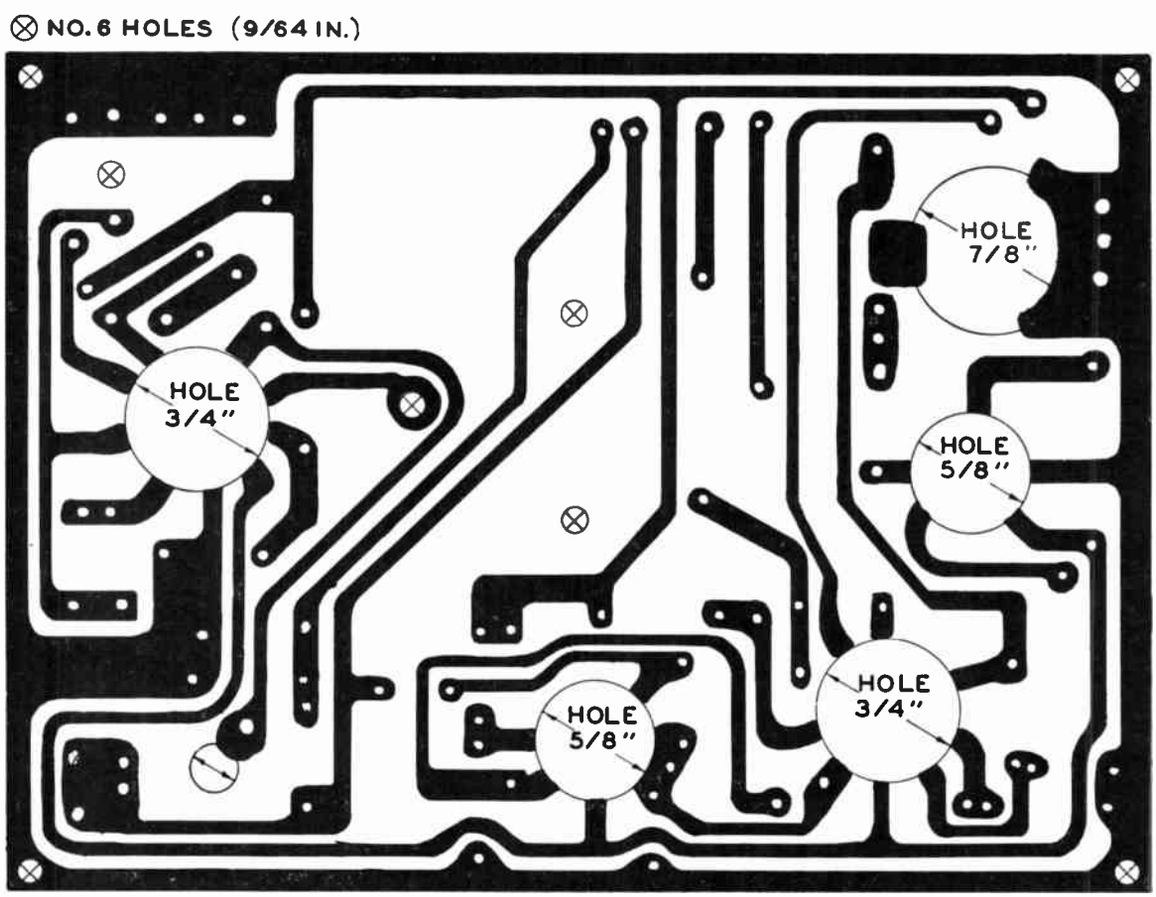
Figs. 5 and 6 show the circuit-board layout. Before the circuit board can be etched, the circuit pattern must be transferred to the laminated plastic and copper board. Various methods can be used. One which I have found most useful, if photoresist is not used, is to cover the board with carbon paper and the layout, fastening them together with tape. To ensure location of the holes, these can be center-punched through layout and carbon. This is a good precaution, since the carbon image on the copper does not always stand out very well. With the design traced on the board it can be painted with a bituminous-resist paint, which is available from several suppliers who manufacture materials for printed-circuit kits. An alternate method is to use tape resist. Scotch electrical plastic tape, available in hardware and variety stores, is excellent for the purpose. Strips of this tape can be stuck to a hard surface and cut with a razor blade and straightedge to provide the narrow resist lines as needed. If using tape, be sure that the ends of the pieces of tape are well pressed together, so that no etchant can penetrate; it must also be pressed down to prevent undercutting by the etchant. *Text continued on page 35*

Fig. 4. Schematic diagram of printed-circuit oscillator designed and described by Mr. Jaski. Most parts fit on etched-circuit board.





Figs. 5 and 6. Below is the printed-circuit diagram, reproduced at actual size. Outline above will help in locating connecting points.



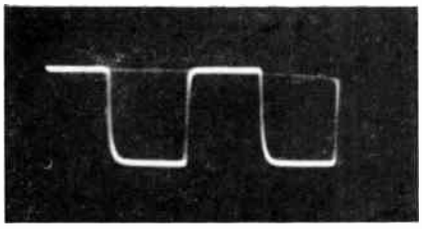


Fig. 8. 10-Kc square wave, 0.25 v.

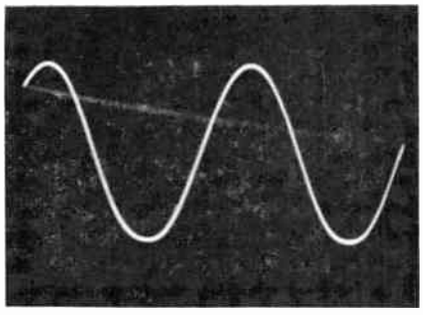


Fig. 9. 1-Kc sine wave, 15 v.

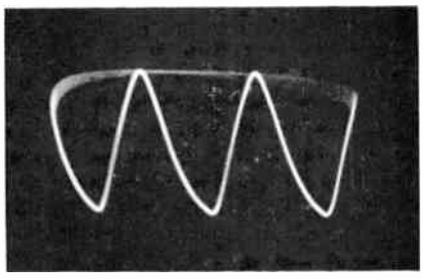


Fig. 10. 100-Kc sine wave, 1 v.

A third method which can be used to provide the resist on the board is photographic. The pattern is drawn in India ink in negative, or a photographic negative of exactly the correct size can be made. Laminate which is already sensitized can be purchased from some suppliers. In that case it is necessary only to expose the board through a drawing (positive) and develop the image with the developer sold by the same supplier. Some others sell photoresist which is a bituminous resist with bottles of the appropriate developer. For these, a negative of the circuit pattern must be used.

Before applying the resist it is essential that the board be perfectly clean. One way to insure this is to soak the board for a few minutes in a solution of bichromate, or to dip it for a minute or so in the etchant (the latter procedure will provide a good "tooth" for the resist). Then the board must be very thoroughly washed, without permitting the fingers to touch the copper surface. Resist is then flowed on evenly, and dried carefully in an oven at about 120° F. or air dried, which takes much longer. All this has to be done in subdued light or darkness, since it is light-sensitive. When the board is dry it can be exposed, through the negative of the circuit pattern, under a No. 2 photoflood at 3 ft. for about 10 min., or at 15 in. for about 3 min. If the exposure is too long, the resist will peel off the copper; if too short, there will be a layer of soluble glue underneath and the image will wash off in the next operation: developing with water. The principle of the glue-top resist, as it is called, is that the parts exposed to the light will

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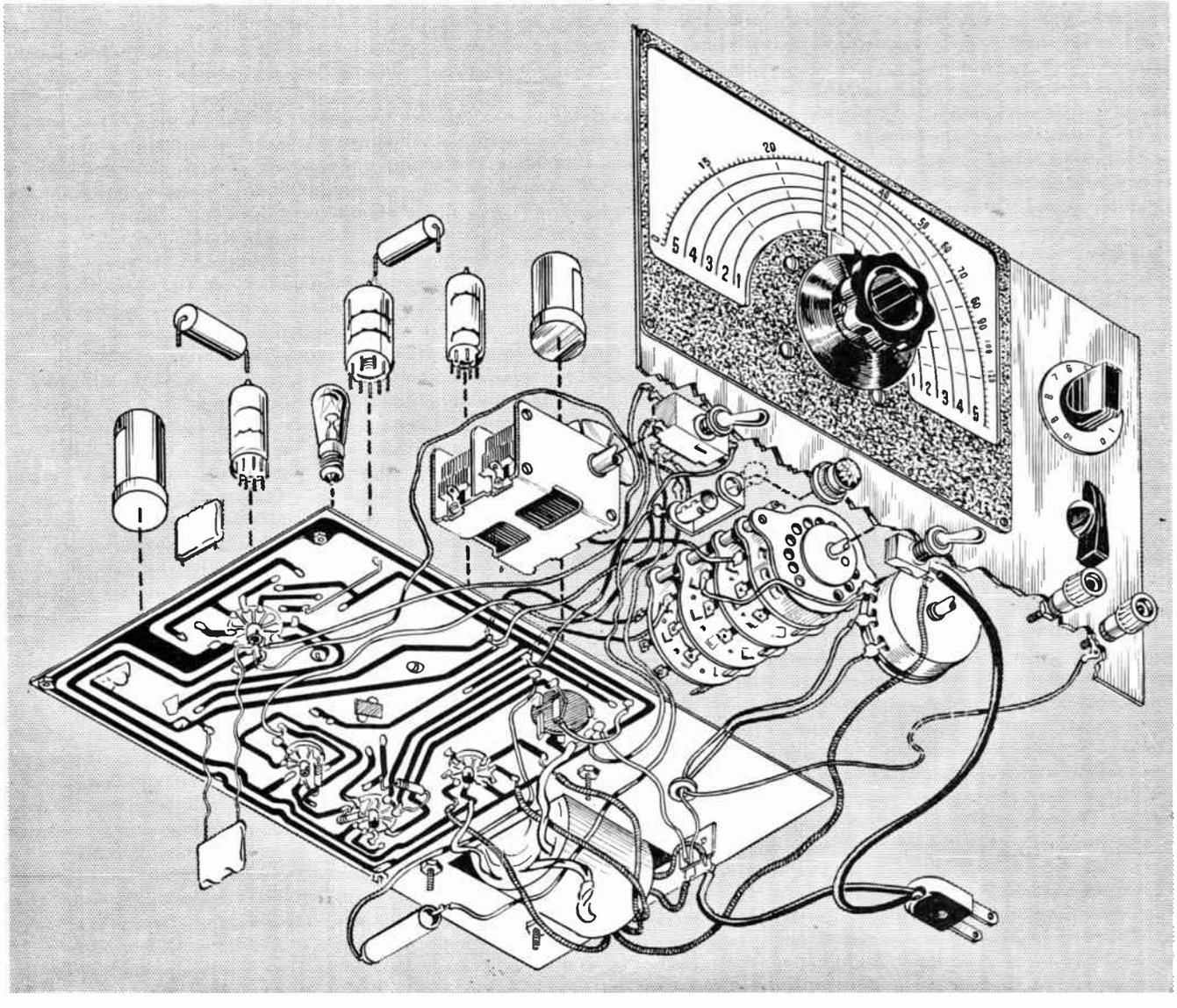
Fig. 7. Exploded view shows relationship of parts in complete oscillator. Top view of printed-circuit board appears in Fig. 5.



BALANCE CONTROL

Continued from page 23

separating the frequency bands is simply to provide a means whereby any of the bands which need de-emphasis can be attenuated with continuously variable level controls. The end result is precisely identical to balancing the three frequency channels in a three-way multiple-speaker system.

In analyzing the circuit, note that one side of the line from amplifier to speaker is split into three sections. The lower section includes an inductance coil L1 (low-pass filter). The middle section contains a capacitor C1, which is a high-pass filter operating at the same frequency as L1, and a low-pass filter L2 operating at the same frequency as the high-pass filter C2 in the upper section. Level controls are shown in the middle and upper-range channels. Only the low frequencies will pass through the lower section, and are not attenuated. The frequencies above, for example, 400 cps (depending on the value of C1 and L1) and below, for example, 8,000 cps (depending on the values of L2 and C2) will pass through the middle section. The remaining high frequencies will pass through the upper section. The strength of the electrical signal reaching the speaker in each of these last two bands depends upon the setting of the level control in each. Usually, the low-frequency response of wide-range speakers is the least efficient of the entire range, and no level control is required; the middle range and the high-frequency range can be attenuated individually in this setup so that the three frequency bands are properly balanced. A low-frequency level control can be added if it is needed, of course.

Values for the coils and capacitors in the network depend upon the impedance of the speaker being used, and on the optimum crossover frequencies. Ordinarily, the optimum crossover points will be about 400 and 8,000 cps; but to cover all possibilities, Table I shows the proper coil and capacitor values for 4, 8, and 16-ohm wide-range speakers with low-frequency band divisions at 400, 600, or 800 cps, and high-frequency band divisions at 4,000, 6,000, or 8,000 cps.

We would recommend nothing smaller than 14- or 16-gauge nylon-insulated copper wire for the inductance coils, and surplus oil-filled capacitors for C1 and C2. Electrolytic capacitors are not recommended. Table II shows the number of turns of such wire necessary to obtain any inductance value given in Table I, when wound on a nonmagnetic coil form 1 in. in diameter and 1¼ in. long. Such a form can be made by securing hardboard end plates to a 1¼-inch length

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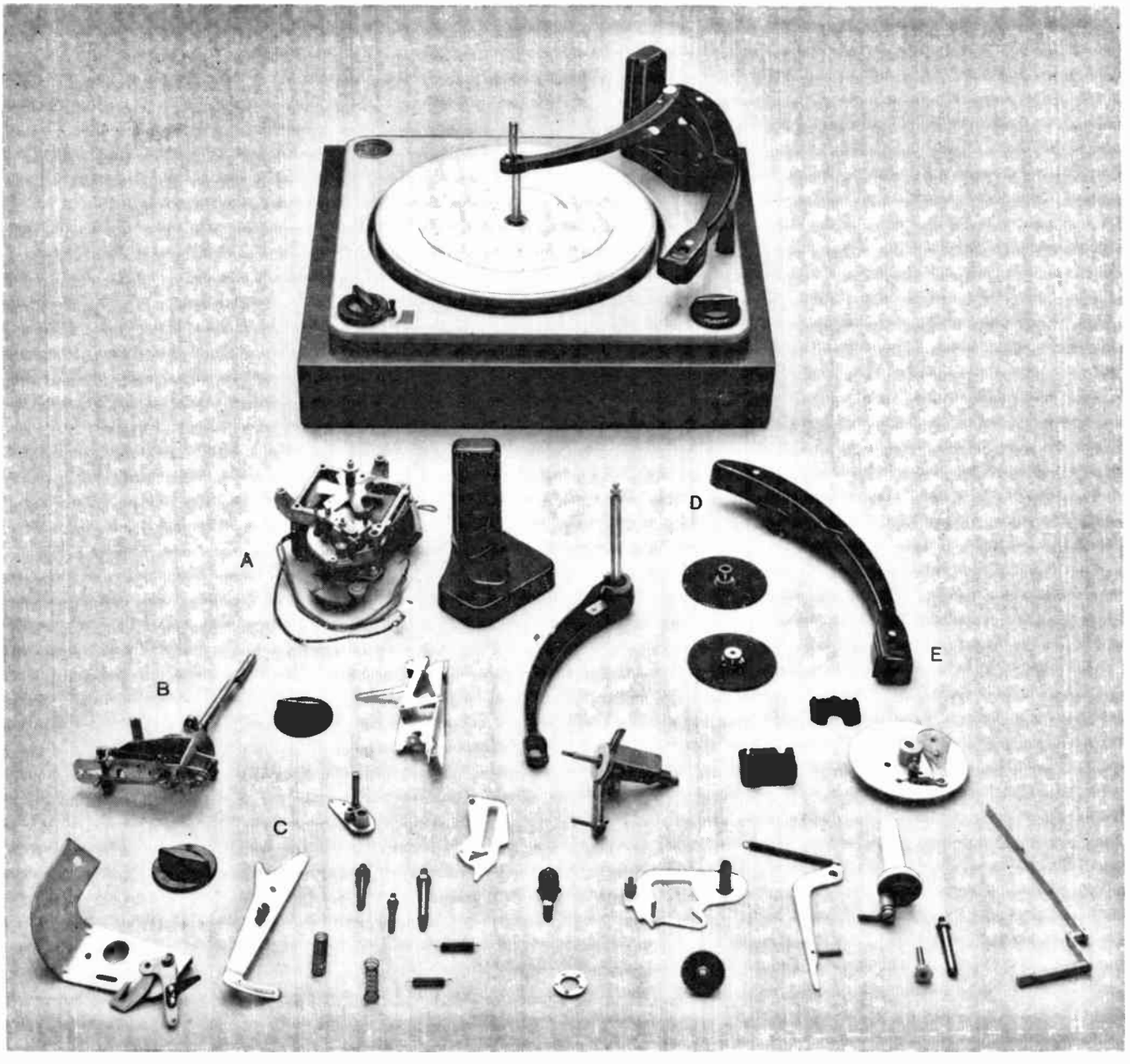

Every part of every *Collaro* changer is precision-engineered to meet the rigid demands of Stereo

The new stereo records require a higher standard of performance from your record changer than do standard LP's because stereo cartridges are extra-sensitive to noise. That's why, in planning your stereo system, you begin with the Collaro. Every part of every Collaro changer is precision-engineered to meet the rigid quality demands of stereo.

The motor (see A above) is dynamically balanced, so rigidly mounted that wow and flutter specifications are superior to any changer.

The spindle assembly (E) reflects this precision quality in every part. The spindle itself is micro-polished for complete smoothness.

The sensitive velocity trip mechanism (part shown in C) has been designed so that the changer can trip at extraordinarily light tracking pressures.

The exclusive Collaro transcription-type tone arm (D) with the new plug-in head (E) is designed to eliminate all resonances in the audio spectrum. The new four-pin head—the only high fidelity changer with this feature—provides the ultimate in noise-reduction circuitry.

There are three Collaro changers ranging in price from $38.50 to $49.50. No matter which you select, you're sure to start your system off right when you choose Collaro—the turntable that changes records.

For new Collaro catalog write to Dept. AC-9, Rockbar Corporation, Mamaroneck, New York.

ROCKBAR Corporation

Rockbar is the American sales representative for Collaro, Ltd.

BALANCE CONTROL

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of 1-inch wooden dowel. Wind the coil tightly and wrap the final layer with friction tape to keep it tight.

For the level controls, continuously variable constant-impedance T-pads should be used (or level controls, such as are manufactured and sold separately by some speaker manufacturers).

It may be argued that the efficiency of the speaker will be reduced when attenuation is applied to it with a range-balancing control. This is not true. Like the chain-and-weakest-link adage, it can be said that a speaker really is no more efficient than its lowest efficiency within the basic required audio range. (Rolloff above and below these points is expected to be usually rather drastic). It is true that, using the range-balancing control, the efficiency of the middle range, primarily, will be reduced quite a bit. But this is exactly the point of the design. A speaker which is 10% efficient at 1,000 cps but only 3% efficient at 50 cps can scarcely be said to have a satisfactory frequency-response characteristic. The purpose of the range-balancing control is to make it possible to have a wide-range speaker approach more nearly a uniform efficiency throughout the audio range. If it results in a speaker only 3% efficient over-all, rather than 3% only at the ends of the range, no harm has been done and a great deal of improvement in the speaker's listening quality has been achieved.

Our work with wide-range speakers using this range-balancing control has resulted in far more satisfactory musical sound in every case. A variety of wide-range speakers was used with fairly uniform results, in which our control was designed with the band divided at 400 and 8,000 cps. It was originally thought the control would be manufactured and marketed, but later it was decided to publish this article instead, so that the hi-fi hobbyist could build his own and save money.

TRANSISTORS

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hand, may have appreciable phase shift within the audio range, sometimes as high as 180° or more; if the high-frequency response-limiting mechanism is the base width of one or more transistors, moreover, the attenuation at any given phase shift is less than that for a vacuum tube. Thus we can have considerable phase shift with very little loss of gain —a most undesirable condition for feedback. The result is that not very much negative feedback can be safely applied to an entire transistor amplifier. For this reason it is often advisable to apply the

feedback around only one or two stages at once.

Single-Stage Feedback

The same general considerations apply to one transistor stage as to an entire amplifier. Let us examine the effects of the various feedback types illustrated in Fig. 5 on a grounded-emitter stage. Note that this configuration has a voltage phase reversal, so the feedback will actually be negative.

The extreme case of Fig. 5A applied to a grounded-emitter stage is shown in Fig. 7A, where all the current in the output is fed back; or where $R_i = 0$ and $R_s = \infty$. Looking at Fig. 7A it is not hard to see that this is really nothing more than the same transistor operated with the base common between the input and the output — that is, in the grounded-base configuration!

This type of feedback, remember, lowers the input impedance but raises the output impedance. Recall also that the common-base configuration *does* feature higher output resistance and a lower input resistance, as predicted here.

An example of feedback of the type shown in Fig. 5B appears in Fig. 7B with $R_s = \infty$. This perfectly practical feedback scheme lowers both the input and output resistance of the stage.

The type of feedback illustrated in Fig. 5C (a common-emitter stage) is obtained simply by inserting an unbypassed resistor in series with the emitter lead. This is a very common type of feedback both for vacuum-tube stages and for transistor stages. Both the input and the output impedances are raised.

Finally, the extreme application of feedback of the type of Fig. 5D is obtained when $R_i = 0$ and $R_s = \infty$. In that case, Fig. 7D shows us that this type of feedback applied to a single stage gives us merely the common-collector configuration, with its high input resistance and low output resistance.

The circuits of Fig. 7 all work to change impedances, reduce gain, and reduce distortion for both low-power stages and high-power stages.

To review, there are two major ways to apply negative feedback to transistor circuits: over the entire amplifier, and stage by stage. The trouble with the former method is that there is likely to be considerable phase shift, especially at the high-frequency end of the audio spectrum, and hence a good chance of instability if much feedback is used. And the trouble with the second method is that each stage has to be designed to handle more power, since the succeeding stages, having negative feedback around them, have lower gain.

Summary of the Series

This is the last installment of this series, "Transistors in Audio Circuits." Many

Continued on next page

TRANSISTORS

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of the topics discussed in the series might seem relatively disconnected on first reading. To show how all these subjects tie together, let's discuss a specific example for a few paragraphs and see how each is used.

Let us say we are to design a high-fidelity, all-transistor power-amplifier/-preamplifier combination.

It is usually easier to design from the output first. You know how much power output you need, and the impedance. First, choose what type of output circuit you want — Class B or Class A, single-ended push-pull or conventional push-pull, and so on. See the discussion in Part X, April and June 1958.

Decide how you want to apply negative feedback. Usually the philosophy is to design the basic amplifier to be as "clean" as possible, so not much negative feedback will be required.

Select a suitable output transistor and design the heat sink so that the over-all thermal resistance is not too great (Part IX, March 1958).

Set the nperating point and choose the driver with the objective of minimizing the output-stage distortion (Part XI, August 1958). Using the graphs of the collector family for the output stages, figure the drive needed. Perhaps another power transistor is needed; perhaps not. Perhaps a push-pull driver is needed, or a phase-inverter driver.

Work backward from the output, stage by stage. For the intermediate stages, determine first how much voltage or current swing is needed to drive the following stage, and select a transistor accordingly. Design the bias network (Part VIII, December 1957, and Part IV, February and March 1957) to give the desired bias and also good temperature stability.

Using the appropriate small-signal parameters for the transistor (Part V, April and May 1957) determine the stage gain and input resistance (Part VI, June and August 1957), so that the requirements of the previous stage are known.

If necessary, supply mixers, tone controls, and volume controls (Part VIII, January 1958).

When enough gain has been obtained, simply stop. But make sure the first stage has low enough noise (Part III, January 1957) and properly terminates the signal source (Part VII, October and November 1957). Equalization (Part VIII, January 1958) can be applied either to the first stage or to a succeeding stage.

These are the main steps in designing a transistor amplifier, and amplifiers are the major application for transistors in audio.

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become insoluble to water by a reaction which is not yet fully understood.

The soluble glue is carefully washed off the board with a cotton wad, and the image of the circuit pattern remains. This image can be made more visible by using a small quantity of food coloring. Sometimes the image can benefit from a hardening bath of chromic acid. Chromic acid is very toxic, and must be used with great care. After the image is completely clear, it should be dried under the photoflood lamp, an infrared lamp, or in an oven. An infrared lamp seems to do the best job. After image-hardening, the board is ready for etching.

The most commonly used etchant is ferric chloride in water. Your board will have to be submerged in this solution for about 40 min. Rocking will reduce the time a little. After etching, the circuit board is again washed and dried, and the remaining resist removed with fine steel wool. The holes for components are punched or drilled, and the board is ready for assembly. When using sockets which project through the board, as illustrated here, it is well to drill these large holes *before* etching. There will be more strength to prevent the laminate from tearing away from the board.

Fig. 7 is an exploded view of the oscillator. The 6.3 v AC for the pilot light will be obtained from the filament circuit at the nearest socket. All tube sockets are standard, with the lugs bent over against the board. The board includes a ground connection for the shield on the first 6U8 socket.

In three places on the board, as shown, wire bridges to ground had to be used. Insulated wire is recommended for these because of the proximity to other parts on top of the board. I have found it useful to drill a few holes in the grounded rim of the board for miscellaneous ground connections. No harm is done if they are not used.

Chassis Construction and Wiring

The next step is to make the chassis. For this, I used 22-gauge galvanized sheet metal because it is easy to work and solder. Yet, with the various stiffening ribs bent over and the corners soldered, there will be adequate rigidity. This will be further improved by the installation of the transformer and attachment of the chassis to the front panel. An aluminum chassis base smaller than the outer cabinet may also be used. A cutout at the front of the chassis, as indicated, will have to be made to accommodate the mechanism of the National dial used. The projecting part of the power trans-

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OSCILLATOR

Continued from preceding page

former will determine the position of the inner chassis.

After you've made the chassis cutouts, install the PC board. Be careful not to put excessive stresses on the laminated board; the material is not hard to break. The power transformer is installed next, and the entire assembly fastened to the front panel, which by this time should carry the dial mechanism, the various switches, and the pilot-light assembly. A single-lug terminal point is installed under one of the power-transformer nuts to provide an attaching point for the power cord.

It will be seen from the diagram that one leg of the power cord is attached to this lug, while the other wire is soldered directly to the on-off slide switch. Connections to the board must now be made. The power-transformer leads are clipped just long enough to reach the proper points on the board, stripped, and soldered.

Wiring of the range switch consists of soldering one group of resistors between the top halves of the rear decks of the switch, and the other group of resistors between the top halves of the front decks. The range switch is connected with hookup wire to the board. Some wires are routed through the grommeted hole in the chassis, and others, directly to the board. The wires from the attenuator potentiometer also go through the grommet. Wiring of the pilot-light assembly and the sine-square switch is obvious.

The cabinet is a standard 5-by-6-by-9-inch utility box. Some of the cabinet edge will have to be removed to accommodate the chassis brackets and to pass the power transformer. The rear cover is provided with some ventilation holes and a slot for the power cord. Alternatively, it may be left off entirely. The front cover serves as the front panel. One of the screws fastening the cover to the cabinet will also serve to hold the upper left corner of the dial in place.

Parts List

1 dual variable capacitor, 14-inch shaft, 12 to 420 $\mu\mu$fd with trimmers.
1 40-μfd electrolytic capacitor, 250 v.
1 20-20-μfd electrolytic capacitor, 250 v.
1 1-μfd metalized paper capacitor, 200 v.
3 0.1-μfd capacitors, 600 v.
1 0.33-μfd capacitor, 400 v.
1 200-ohm resistor, 2 w.
1 1-K resistor, 5 w.
2 10-K resistors, 1 w.
1 150-ohm resistor, ½ w.
1 1-meg resistor, ½ w.
2 470-ohm resistors, ½ w.
2 47-K resistors, ½ w.
7 56-K resistors, ½ w.

1 3.6-K resistor (approx.), ½ w.
3 180-K resistors, ½ w.
1 5-K resistor, ½ w.
2 2.2-K resistors, ½ w, 1%.
2 22-K resistors, ½ w, 1%.
2 220-K resistors, ½ w, 1%.
2 2.2-meg resistors, ½w, 1%.
2 22-meg resistors, ½ w, 1%.
1 50-K potentiometer, 4 w.
1 6X4 tube.
2 6U8 tubes.
1 6AH6 tube.
1 power transformer, 500 v (center tapped) at 40 ma, and 6.3 v at 2 amps.
1 pilot-light assembly.
1 3-w lamp and socket.
1 SPST switch.
1 DPDT switch.
1 red binding post.
1 black binding post.
1 5 × 9 × 6-inch utility cabinet (or larger).
1 2 × 7 × 5-inch chassis base.
1 4-gang, 4-pole rotary switch.
1 dial assembly (as desired).
1 kit for producing 4½ × 6-inch etched circuit board.
Assorted knobs, tube sockets, wire, solder, nuts, bolts, etc.

Calibration and Adjustment

The calibration of audio oscillators has been described frequently [see next section — ED.]. I used signals from another oscillator with some carefully calibrated points, some broadcast stations in the higher ranges, some WWV signals, and the 60-cps line. The method was to use an oscilloscope and Lissajous figures. Enough accurate points were checked to interpolate the intermediate points. If a linear tuning capacitor is used, the scale will be linear also. The minimum capacitance of the tuning capacitor should be adjusted with the trimmers so that a ratio of exactly 1:10 is obtained.

AUDIOCRAFT Construction Notes

To produce the etched circuit board — probably the most tedious part of this construction project — we made a negative of the pattern which appears on page 34 and used it to make a board photographically. It was found that an ammonium-bichromate bath used prior to sensitizing the board is essential. Otherwise, the resist tends to remain on the board in areas where it must be removed, resulting in improper etching. If your board does not appear to be etching properly after 15 min. or so, it may be removed from the etchant and scrubbed with an abrasive cleanser to remove all of the resist material. Then the lines may be repaired with liquid resist (brushed on, as paint is), and the etching continued. If ammonium bichromate is used, however, the board should etch evenly.

Continued on next page

EICO KIT REPORT

Continued from page 22

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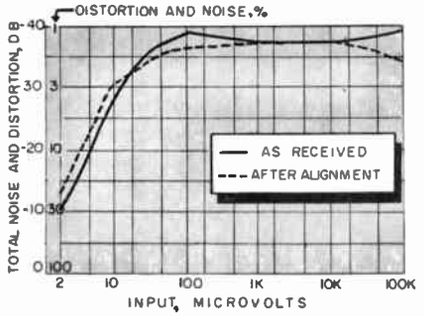

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de-emphasis network. More serious (in our view) is the low-frequency dropoff below 100 cps, amounting to 6½ db at 30 cps. With most speaker systems this wouldn't be audible either, perhaps, but with some it would. Because this low-frequency loss is not apparent at the

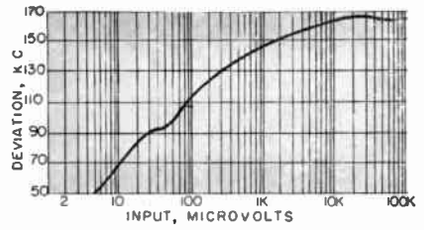

Fig. 2. Maximum undistorted deviation.

Multiplex output, it is evidently caused by the small coupling capacitor in series with the volume control. This too can be fixed easily; we simply connected a .05-μfd capacitor in parallel with C14, the offending component.

We consider the physical design of the tuner to be excellent. In its optional cage cover it is entirely presentable on a bookself or table. It is compact but the components are not too crowded for good ventilation. The front panel is handsome and, with the new tuning-indicator tube, the dial is fascinating.

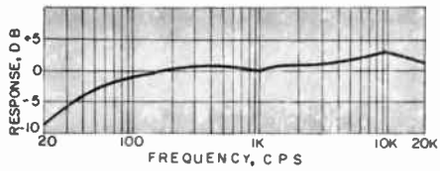

Fig. 3. Response after de-emphasis.

To sum up, we like the HFT-90 very much. It is sensitive enough for nearly

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Continued on next page

OSCILLATOR

Continued from preceding page

The use of a cabinet larger than 5 by 9 by 6 in. will facilitate placement of the board and components. Before any holes are bored, carefully position each part (the circuit board, power transformer, dial assembly and range switch particularly) to make certain that it will fit easily without crowding. Be sure that the cutout for the printed-circuit board is placed far enough away from the front panel to allow the vernier mechanism (if one is used) to properly contact the tuning capacitor. (We didn't do this, and consequently were forced to relinquish the vernier function of the tuning dial.)

Follow the pictorial for general placement of oscillator components. If a cabinet larger than 5 by 9 by 6 is used, the inner chassis base should fit without alteration. Otherwise, two sides of the inner base will have to be shortened to allow it to fit within the case. Alternatively, Mr. Jaski's suggestions for using sheet metal may be followed.

After our oscillator had been built, the size of the feedback resistor was determined by temporarily inserting a 5-K potentiometer in place of the resistor, and setting it for the feedback which produced the best sine wave as viewed on a scope. A value of 3.6 K was found to be very close, but varying line voltage in some areas may necessitate a slightly different value.

After adjusting the feedback for best wave shape at the low end of the middle frequency band, the trimmers on the tuning gang were turned until the output was constant over that whole band. If 1% resistors are used in the range switch (or standard composition resistors are measured with an ohmmeter and values selected which are exact multiples of ten), the output and frequency ratio will be constant from range to range. It was found that care in the selection of range resistors and careful setting of the trimmers resulted in a very close band-to-band coherence. In other words, if the dial was set for 30 cps on one band, it would also produce 300 cps, 3,000 cps, 30 Kc, and 300 Kc on the other bands without readjusting the tuning knob. A single scale can be drawn with assurance that it will be faithful over all ranges.

Ultimately, tests of the oscillator built here in accordance with Mr. Jaski's instructions satisfactorily verified his claims. When properly adjusted, this oscillator will provide excellent sine waves from 15 cps to 50 Kc, and fair sine waves up to 1.5 Mc, with an output variation of no more than 0.5 db from 15 cps to 50 Kc. Although output above that point diminishes, it is accurate in frequency. Square waves are also excellent (see Figs. 8 to 10).

STEREO COMPATIBILITY

Continued from page 19

considerably. At the point when separation was almost gone, I found that 65% of the vertical modulation was missing.

Only new styli were used for the test; all were diamonds. By the time the stereo effect was erased the styli and their armatures were black. Brushing them removed much of this black dust, which was ascertained later to be powdered vinyl.

Some of the best performers, going 200 to 500 plays with no appreciable deterioration of the stereo effect, were, of course, highly compliant high-fidelity cartridges. On the other hand, some of the worst results occurred with the most popular conventional magnetic cartridges.

Some crystal and ceramic cartridges did quite well. Several of them have high vertical compliance, and the records were only slightly damaged by the hundredth play. The older stiff types damaged the record within five plays. In every case, however, the record was still usable as a poor monophonic record, after the stereo information was destroyed.

By and large, the worst cartridges for the reproduction of stereo records monophonically were two of the most popular conventional cartridges. While I will not make a practice of naming specific cartridges that were either good or bad throughout these tests, I believe that the thousands of users of these two cartridges should be warned against using them for stereo records, if they plan to use those records for stereo reproduction later. This should not be interpreted as meaning that they are not good monophonic cartridges; their use and popularity are proof of their quality in that regard. As was expected, the Pickering Fluxvalve cartridge was the worst damager of stereo records. This fine conventional cartridge has always been a paradox in high-fidelity circles. With vertical compliance over only a short distance, it has been noted for its uniform response curve. However, it will destroy all stereo information on a stereo record within five plays. The Pickering Stanton 45-45 stereo cartridge was, however, one of my comparison cartridges and was found to be of superior quality for stereo records. GE RPX model cartridges were also serious offenders. While they are good for conventional records, five plays with one of these cartridges produced notable deterioration of the stereo information. Twenty-five sufficed to bring the record information down to the level of a monophonic record. This does *not* apply to the newer GE VR-II.

Save for the two noted as incompatible, most of the finer high-fidelity cartridges, (magnetic, crystal/ceramic, or FM) can safely be used with stereo records. But simply as a matter of principle, I recommend strongly that only stereo cartridges be used for stereo records.

The results of playing these records with conventional cartridges were not too good, so far as sound alone is concerned. A low-distortion system reproduces all the distortion resulting from the vertical stylus motion of the conventional stylus, a mechanism not designed for vertical excursions. On the other hand, playing a stereo record with a stereo cartridge on a conventional system, by strapping the two channels together, yielded results that were really quite good.

One further check was made. A number of people had commented that the stereo records were not as good as conventional records. I was prepared to believe this, because theoretically the records were about as far advanced as the conventional record was in 1954. Surprisingly (with the exception of exaggerated stereo effects and the like), the technical quality of the recordings seemed as up-to-date as that of our current records. Some deficiencies were discerned in the transients and super highs, but this is to be expected; the art of building stereo cutters is new. The cartridges also are new, and generally not yet quite as good as conventional cartridges. I did not find any cause for complaint, however, and am certain that quality will be improved even further.

EICO KIT REPORT

Continued from page 22

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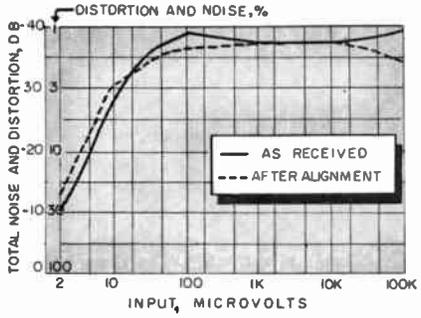

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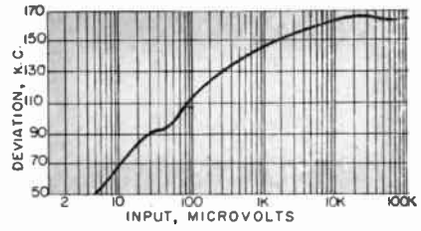

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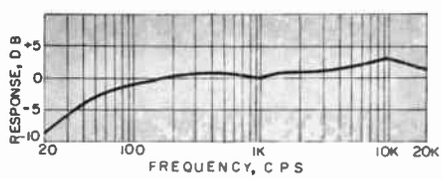

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everyone, it sounds fine without touchy tuning, it stays in tune, it is nearly foolproof in assembly, and it is good-looking. At $39.95 it is one of the best buys you can get in high-fidelity kits.

Manufacturer's Comment: Re the 2½-db rise at 10 Kc, please note that available RETMA capacitance values force a choice between .001 ufd and .0012 ufd for capacitor C12 in the de-emphasis network. The ideal value would be .0011 ufd; paralleling .0001 ufd (100 uufd) across the existing .001-ufd capacitor will do the trick (as AUDIOCRAFT correctly determined) for people who care about it enough. As for the 6½-db drop at 30 cps, we measure only 4 db down on the average at 30 cps and about 2½ db down at 50. This, of course, would not be audible with the average speaker system. But the .01-ufd capacitor C12, in series with the volume control, is indeed the sole cause for the drop in extreme low-frequency response, and we are increasing the value of C12 to .05 ufd in order to extend the flat response down to 20 cps. This change can be made on any existing unit if desired.

AUDIOLAB REPORTS

Continued from page 28

two units have given us a jaundiced viewpoint. In any case, we would recommend that anyone who feels he must have an FM-AM-SW tuner purchase his Globemaster from a reliable and competent dealer who can check it out and be sure it is in proper operating condition before delivery. If possible, the purchaser should listen to the set he intends to purchase, and a home trial period would be helpful.

Manufacturer's Comment: A test to produce absolute figures of measurement should clearly cover the conditions of the undertaking which this report has failed to do. Input, output, and load impedances, frequency of RF signal, etc., not being stated, makes the figures displayed meaningless and, therefore, valueless. It would seem a deliberate attempt to find any possible fault with the equipment, including those which are not there. For example, we fit the Globemaster with a high-level limiter, yet the report uses up much space stating how inefficient this limiter is, which we do not take as a shortcoming, for the report proves that it is performing its function to prevent overload of powerful stations and to provide a measure of AM rejection of impulse noise (in the ratio detector). Normal use of the FM band calls mainly for tuning local stations and thus the report completely missed the point.

Without mention of the frequency of the sensitivity measurement, the aerial impedance, or deviation, the rating quoted is meaningless. Maximum sensitivity is never less than 4 uv at 98 Mc (roughly center of the band). The measurement of IM distortion and the statement concerning excessive second-harmonic distortion stems from the same source, and we must assume that the output was erroneously taken at one volt from the cathode follower, perhaps loaded with 600 ohms or a low-value resistor. With the 600-ohm output fed as intended into a high-impedance input of an amplifier (at least 10,000, or more than likely 100,000 ohms) the distortion is very low indeed, and the acceptance of the Globemaster in world markets, including the U.S., is further proof that the procedure adopted for the tests was grossly inefficient. Since such distortion as quoted would stand out a mile, we are not alone convinced that the tests made were improper, but are considerably surprised at the inefficiency and the lack of basic knowledge evidenced.

The complete production of Globemasters of this type is sold out, and we shall shortly market a version containing many new design features. It is hoped that, upon submission to the organization that made these tests, they will use proper procedure to conduct their tests so that your readers will receive an unbiased and factual report.

Editor's Comment: Hirsch-Houck Laboratories tested the Globemaster in accordance with IRE *Methods of Testing Frequency Modulation Broadcast Receivers*, which has been adopted by the American Standards Association as ASA standard C16.12-1949. This is the method employed almost universally.

If H-H didn't know better than to connect 600 ohms across a cathode follower of this type, they would have been laughed out of business long before this.

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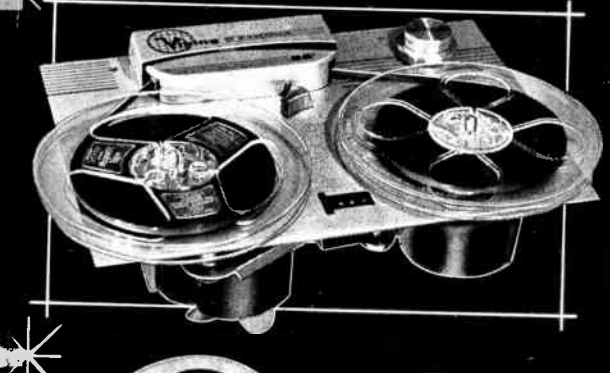

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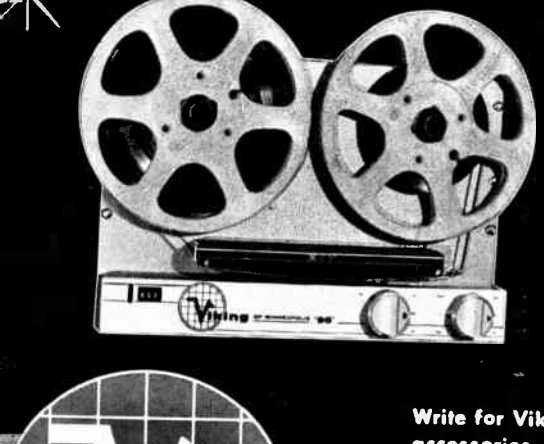
This completely new 85 series tape deck offers fast forward, fast rewind and pause/edit operation. A rotary tape motion control provides spill proof, break proof operation under all conditions. Two motors and Viking's famed "flutter-filter" belt drive are standard. The 85 has room for five heads to meet any monaural or stereophonic requirement.



VIKING 95

Easily the outstanding new tape deck in the professional class. This superb new 95 series gives you dual-speed professional transport, hysteresis "flutter-filter" drive with three motors and a wide choice of head types. Available with 15-7½; 7½-3¾; or 3¾-1⅞ inches per second drive pulleys.

Write for Viking's new 1959 catalog covering decks, recording amplifiers, and tape accessories. Ask your dealer for help with integration of these tape components with your music system, or write direct to Viking's Customer Service Department.

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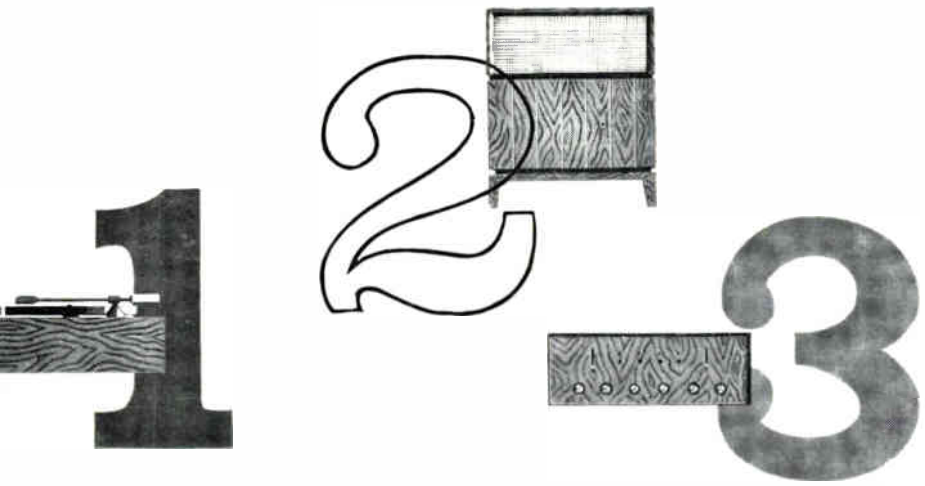

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