Should You Buy a Stereo Recorder?

MARCH 1958 • 35 CENTS

audiocraft

for the HI-FI hobbyist

Kit Report: the Dynaco preamp-control unit

How to make a simple distortion meter

Build a rear-loading corner horn enclosure

First report on the new 16-rpm records

NEW!

MODEL **TPA/10**

THE DISTINGUISHED TRANSCRIPTION TONE ARM BY

Garrard

Some of the significant questions being asked about it ... and their exciting answers

Q	A
How much is the Garrard Tone Arm?	$24.50
Is it built to give me professional-quality performance?	Yes . . . because this precision design, by incorporating the smallest number of pivots, reduces traversing friction to an absolute minimum. This also results in the least amount of wear and tear on records, through the use of spring-loaded, cone-type ball-bearing pivots . . . similar to those you will find in the finest chronometers. The vertical pivot is a specially-designed bearing, combining the features of a ball-bearing journal suspended on a single ball thrust.
What else is "different" about this Tone Arm?	Infinite versatility! It is the only tone arm which is fully adjustable in length and tracking angle. This means that with the Garrard arm, you can make every adjustment you would conceivably wish to make on a tone arm.
Why is it important for me to be able to set it to any length?	For two reasons: (1) You can set it for the longest position permitted by the space you have available now. (2) If you change the installation, you will be able to readjust this arm, keeping the important benefits of using a "longer" arm . . . playing a full 16" record.
Doesn't this require changing tracking angle?	Yes, of course. In fact, there are many opinions regarding optimum tracking angle for any given length.
How do I adjust the tracking angle?	With the protractor which is supplied with the tone arm. In a few seconds, this ingenious accessory lays out the recommended angle on which to align the cartridge for the arm length you are using. Since there are various opinions regarding the optimum tracking angle at various radii, this protractor will also enable you to set the angle at any desired radius.
Will it take any cartridge, and is it easily installed?	Yes, the removable head will take just about any cartridge on the market. This tone arm is designed to be used with any transcription turntable, and adjusts easily for height and stylus pressure. The special templates supplied show you the exact mounting location. Incidentally, the instructions are the clearest and most complete we have ever seen with a tone arm.
Where can I see the Garrard Tone Arm, and how can I recognize it?	It is at your high fidelity dealer, and you will certainly recognize it through its handsome appearance . . . glistening chrome with white enamel. Look for it in a distinctive blue and white box.

DEPT. GC-98, GARRARD SALES CORPORATION • PORT WASHINGTON, N.Y.

THERE'S A **Garrard**
WORLD'S FINEST RECORD PLAYER FOR EVERY HIGH FIDELITY SYSTEM

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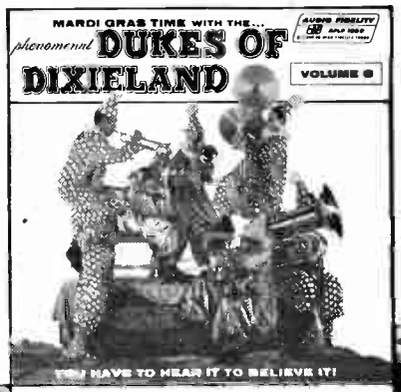
Traditional happy New Orleans Mardi Gras Dixie plus the excitement of Festival Time packed into a great new album! Volume 6 AFLP 1862



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Skirling Bag Pipes, rattling snares and booming bass drums! Well-known melodies, superb hi-fi! 9th Regiment Pipe Band. AFLP 1857

Brilliant new recording star! Witty arrangements plus a high-spirited performance add up to hours of delightful listening pleasure. AFLP 1864

the pause that will keep your records young

an exclusive feature of the new Glaser-Steers GS-77

Your records can be a lasting joy, their original brilliance preserved for many hundreds of performances. This takes special care to guard against undue record wear. The new GS-77 handles records more gently than any other automatic record playing mechanism.

TURNTABLE PAUSE is a dramatic example of this fact. During the record-change cycle, the GS-77 turntable comes to a complete halt, and doesn't resume motion until the stylus has come to rest in the run-in groove of the next record. This completely eliminates the grinding action which occurs where records are dropped onto a moving turntable or disc.

The GS-77 TONE ARM affords further protection. Improved mass distribution and low pivot friction have so minimized arm resonance and tracking error that these flagrant causes of groove and stylus wear are now virtually eliminated. In addition, the arm has been so designed that stylus pressure between the first and top records in a stack does not vary more than 0.9 gram.

SPEEDMINDER goes still further—for by simply setting the appropriate stylus into play position, the GS-77 automatically plays at the correct record speed, and in the microgroove position, intermixes 33⅓ and 45 rpm records regardless of their sequence in the stack.

The GS-77 is the perfect high fidelity record changer. It combines traditional turntable quality with modern automatic conveniences—and it does this with incredible mechanical simplicity. No wonder

...audiophiles are switching to the new

GLASER-STEERS GS-77

See your hi-fi dealer today, or write to:
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THE MAGAZINE FOR THE HI-FI HOBBYIST

MARCH 1958

Volume 3 *Number 3*

THIS MONTH'S COVER: Noting the trend toward slower record speeds, we unveil our brainchild, the AC Minidisc, which revolves at 3¾ rpw (revolutions per week), takes a .000001 stylus, has a guaranteed frequency response of from 1.769 to 1.942 cph (cycles per hour) with RIAB playback, and unmeasurable (above 100%) IM. The Dynakit preamp (shown for size comparison) will not quite match the equalization needs of our Minidisc. Cover by Phil Geraci.

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The Grounded Ear

What's new for your future in sound reproduction?

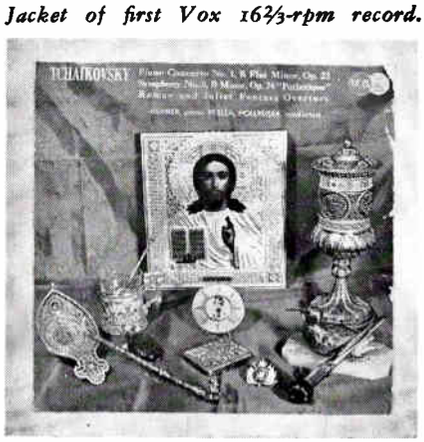
by Joseph Marshall

16⅔-RPM Music Records

It has been nearly two years since the 16⅔-rpm record speed was first introduced and, although most modern changers and some turntables provide for this very slow speed, it has been used almost entirely for the "talking-book" type of recordings. Vox is the first of the major recording companies to produce music recordings which are playable with 1-mil styli for this speed. Now that the ice has been broken I have no doubt that other labels will follow suit, especially since the Vox releases sound a lot better than I expected them to.

These records are dubbed from the tapes used for Vox's standard LP catalogue. Each disc contains roughly an hour of music on each side, or two hours per disc. They are completely compatible with present equipment in the sense that they are recorded with the same groove width as 33⅓-rpm LP's, and can be played with the same stylus, equalizers, etc. However, they will sound better with some equipment than with other. For example, pickups with 0.5-mil or 0.7-mil styli will have less translation loss at the high frequencies,

Jacket of first Vox 16⅔-rpm record.



and these records will sound noticeably brighter with them. The Shure Dynetic, Fairchild XP3, and Pickering cartridges with 0.5-mil styli are particularly suitable.

But they are surprisingly good with the more conventional cartridges too; and with some of the older magnetics, which slope beyond 8,000 cps, and with most crystals and ceramics, they are not much inferior to standard LP's. The bass end is not affected by the slower speed (except as noted later). Nobody with a critical ear would trade the extra playing time for the higher quality of today's high-fidelity LP's; but I think a lot of people with less demanding sonic tastes will be content with them, and they will find obvious applications in "do-it-yourself" substitutes for commercial background-music services.

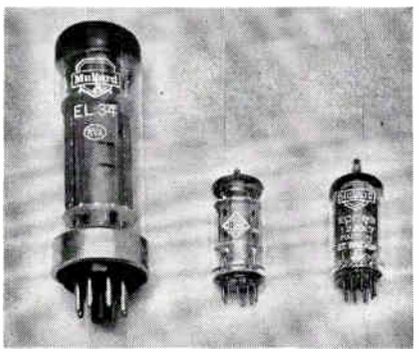
There are going to be some problems, however. I wonder how suitable those changers with the fourth speed will really prove to be. This speed presents even more severe rumble problems than 33⅓ rpm. Moreover, playing these records produces some terrific subsonic surges which are going to get a lot of amplifiers into trouble. I found, for example, that the combination of the Dynakit preamp with my Apartment Amplifier (described in the preceding "Grounded Ear" column), which was perfectly stable with 33⅓-rpm records, would not do for the 16⅔-rpm records unless the preamp was fed from a separate power supply. If my experience is at all typical it suggests that one of these recordings will provide an excellent test for subsonic stability.

Furthermore, wow is going to be a larger problem, and variation in speed is likely to produce a quicker deterioration of quality. Vox recommends that the turntable be permitted to revolve for several minutes before the record is played so that the motor can come up to speed. But this is not easy with some changers, which are designed so that the turntable stops when the arm is not on the record. If the speed is significantly lower than 16⅔ rpm, the treble response will seem much poorer.

However, these are far smaller problems than those accompanying the first LP's; indeed, their challenge may well result in improved equipment for the higher speeds. Meanwhile, assuming that the price will be reasonably comparable to that of 33⅓-rpm LP's of the same disc size, it is a safe bet that these slow-speed records are here to stay.

Imported Audio Tubes

More and more, new hi-fi equipment comes supplied with British, Dutch, or German tubes. There has been some alarm in the American tube industry over this competition from imports. I find it impossible to muster much sympathy. This situation is the result of the indifference of the American tube industry to the needs of high fidelity,



Three representative imported tubes.

and I trust it will serve as a lesson for the future.

For years we have been crying for tubes better suited to hi-fi use. Only one American manufacturer paid any heed; Tung-Sol developed the 5881 and 6550 output tubes. Manufacturers abroad in general have been doing far better. The British KT66 was and still is a superb audio tube. The EL34/6CA7 and the EL84 have, between them, just about taken over the entire hi-fi market for output tubes. The KT88, based on the 6550, appears to be more linear than

Continued on page 42

Electronic Firsts

by MONROE UPTON — Author of "Electronics for Everyone"

TODAY'S dynamic loudspeaker, with its copper or aluminum voice coil attached to a paper diaphragm, was patented in 1898 by Sir Oliver Lodge (British patent 9,712).

Early workers in wireless had borrowed the telephone's earphone, later going to a pair of headphones. Sir Oliver obtained greater efficiency from a large paper diaphragm attached to a coil floating in a magnetic field than could be had from a small iron diaphragm over a pair of pole pieces. However, before the birth of the three-element tube, without which amplification was impractical, the receiver's signal was too feeble to operate a speaker.

When radio broadcasting came along, in the early 20's, the engineers skipped over the Lodge invention to the older headphone for the first speaker, merely adding to it a horn. The horn provided a directional effect, plus some amplification because of better coupling with the air. This "primitive" speaker not only had a very limited frequency range, it overloaded easily to create a rattle that came from the metal diaphragm touching the pole pieces. Its tinny sound contributed to the opinion held by many in those days that radio was only a fad for those too limited to learn how to play mah-jongg.

Very ingenious improvements were made upon the "moving iron" type of speaker, greatly improving both its frequency range and its power-handling capacity. But when Magnavox came out with the first "moving coil" job, the superiority was so obvious that it immediately became the standard transducer for all types of radio receivers. And it probably will be king for a long time to come before it is dethroned by the rival electrostatics and ionics.

THE *paragrele* was invented by the Abbé Martholon, described in his book, *Meteoric Electricity*, published in France in 1787. This ingenious electrical device consists of a number of high, pointed conductors, well grounded, and spaced close together. The metallic points draw from the air quantities of electricity that is about to push raindrops from the clouds. Thus the *paragrele* prevents rain from falling. As George Gobel would put it, "You can't hardly find them no more."

by RICHARD D. KELLER

book reviews

Low Cost Hi-Fi

Donald Carl Hoefler; pub. by Fawcett Publications, Inc., Greenwich, Conn.; 144 pages; 75¢, paper-bound.

A lot of illustrations and good information is packed into this magazinelike book. It is divided into a number of separate articles on the various phases of hi fi, all by the same author, who has done a nice job of injecting his personality and his considered opinions into each of them.

Such titles as "How to Spot a Bargain," "Kits Cut Costs," "Hi-Fi's Best Buys," "Repair Your Own and Save," and "Yours for the Asking" (listing free literature available from manufacturers) are a clue to the value of this book to the audio newcomer working with a slim budget. And the author's fresh style and candid opinions will appeal to all who enjoy digging into the many faceted mysteries of hi fi, and who want to expand their sound systems at minimum expense.

Stereophonic Sound

Norman H. Crowhurst; pub. by John F. Rider Publisher, Inc., New York; 118 pages; $2.25, paper-bound.

This well-illustrated book is evidently the first on the subject of stereo, and it provides a very good introduction and discourse on the subject.

The author goes beyond mere elementary descriptions and into the physiological and psychological aspects of hearing and direction sensing. He discusses the results and limitations of many of the tests which have been conducted to find out how the human hearing mechanism determines the directionality of sound. The importance of loudness versus phase difference, and system frequency range, transient response, and recording- and listening-room environments are covered thoroughly and interestingly.

A great deal is said about the various types of systems — two channel, three channel, Stereosonic, and coded single channel — and the various program mediums such as radio, disc, films, and tape. Various schools of thought on recording procedures are presented, with suggestions about types of equipment — loudspeakers, enclosures, and their placement.

Stereophonic sound is still essentially in its infancy and many of its ramifications and subtleties are as yet little known. This book compiles most of the current thinking on the subject and should stimulate still further thought and research.

Repairing Hi-Fi Systems

David Fidelman; pub. by John F. Rider Publisher, Inc., New York; 204 pages; $3.90, paper-bound.

The growth of the hi-fi kit business in the last few years is right in line with the burgeoning national do-it-yourself trend. Surprisingly enough, a large percentage of the people who build their own amplifier and speaker systems also order oscillator and oscilloscope kits to check their finished products.

To these people, as well as to established radio and TV repairmen, the author addresses this book. At the offset, he carefully segregates high-fidelity equipment from general run-of-the-mill radio-TV and cautions that the quality of servicing skill and care must be much better on the finer sound systems.

He lists the various types of distortion which can corrupt sound and then discusses such audio servicing techniques as signal tracing and square-wave testing, giving complete coverage to the available audio test equipment in both kit and manufactured versions, with specifications and operating procedures.

Most of the book is concerned with fairly comprehensive servicing techniques on amplifiers, pickups, loudspeakers, AM and FM tuners, record players and changers, and tape recorders. Numerous tables are given throughout the book summarizing the material of each chapter in a convenient form.

This book is not, certainly, in the same near-engineering category as Joseph Marshall's *Maintaining Hi-Fi Equipment* (Gernsback), but it does fill a definite need for amateurs and semitechnical people.

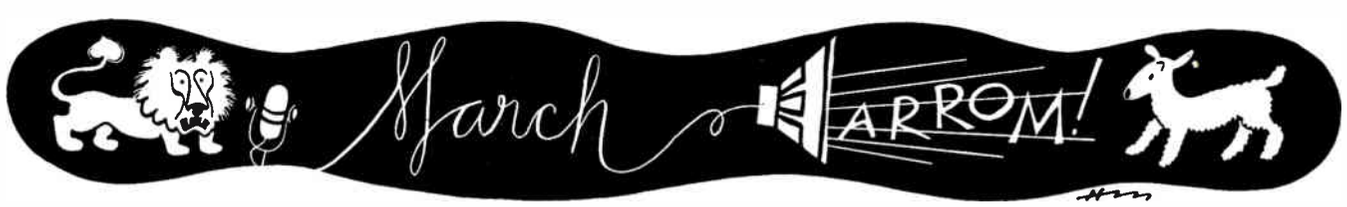
Transistor A. F. Amplifiers

D. D. Jones and R. A. Hilbourne; pub. by Philosophical Library, New York; 152 pages; $6.00.

There has been comparatively little on the book market concerning the application of transistors to audio amplifiers. Now that Shea's book, *Transistor Audio Amplifiers* (Wiley), is more or less outdated, a few pamphlets and booklets and a number of magazine articles are all that is left. So it was that this book, dated July 1957, held promise as a practical, up-to-date guide on how to apply these tiny devices to high fidelity. Unfortunately, that hope has not been fulfilled.

Primarily, the book discusses five transistor audio amplifiers with outputs ranging from 1 to 20 watts. All of them are similar in design, with higher-rated transistors and components used to obtain the higher power outputs. There are also theoretical discussions of complementary symmetry outputs and regulated power supplies (without any circuit values).

The transistors used in all the circuits are British-made and practically unavailable in the United States, and there is not enough information given to ascertain which American units could be substituted for them, although undoubtedly such do exist. There is some worth-while material here, but Americans will evidently have to wait a little longer for any real transistor help, meanwhile utilizing the practical booklets of circuits available from manufacturers such as GE, RCA, Raytheon, and Sylvania as guides.



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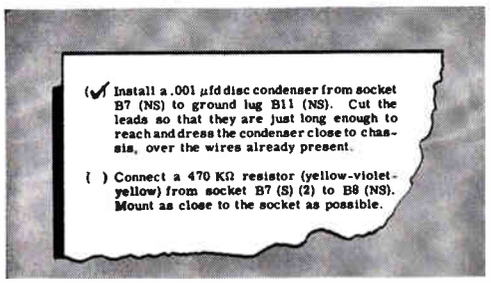
Look . . . how simply you can assemble your very own high fidelity system! Fun-filled hours of shared pleasure, and an everlasting sense of personal accomplishment are just a few of the rewards. Heathkits cost you only HALF as much as ordinary equipment and the quality is unexcelled. Let us show you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



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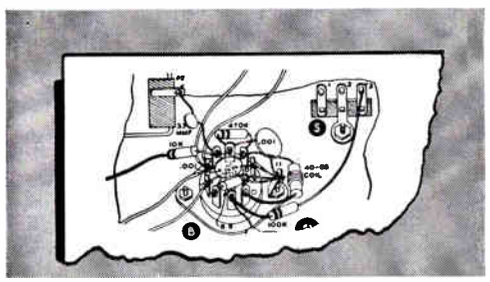
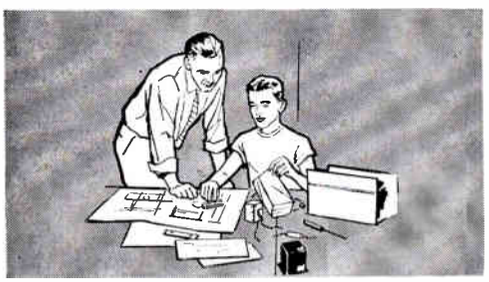
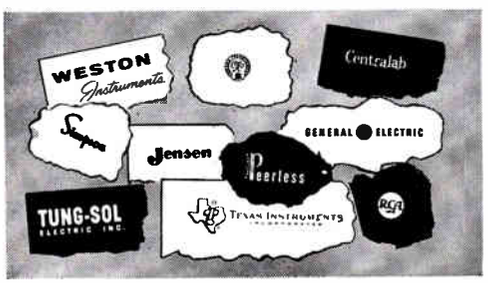
Read the step . . . perform the operation . . . and check it off—it's just that simple! These plainly-worded, easy-to-follow steps cover every assembly operation.



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.

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bookshelf 12-watt amplifier kit

NEW

MODEL EA-2
$25.95

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.

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HEATHKIT

chairside enclosure kit

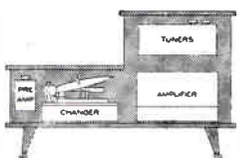
NEW This beautiful equipment enclosure will make your hi-fi system as attractive as any factory-built professionally-finished unit. Smartly designed for maximum flexibility and compactness consistent with attractive appearance, this enclosure is intended to house the AM and FM tuners (BC-1A and FM-3A) 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.

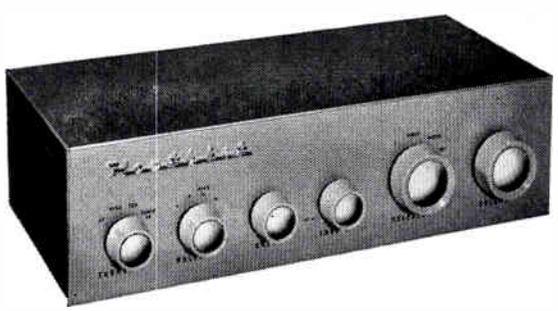
MODEL FM-3A $25.95 (with cabinet)

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

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

MODEL W-5M

$59.75

high fidelity amplifier kits

MODEL W-6M

$109.95

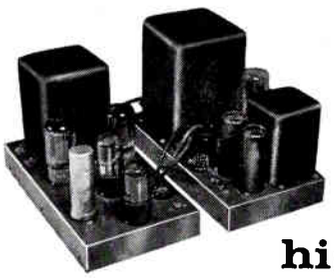
To provide you with an amplifier of top-flight performance, yet at the lowest possible cost, Heath has combined the latest design techniques with the highest quality materials to bring you the W-5M. As a critical listener you will thrill to the near-distortionless reproduction from one of the most outstanding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

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

HEATHKIT DUAL-CHASSIS

MODEL W3-AM

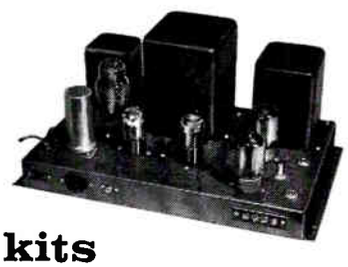
$49.75



HEATHKIT SINGLE-CHASSIS

MODEL W4-AM

$39.75



HEATHKIT

high fidelity amplifier kits

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

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

HEATHKIT

high fidelity amplifier kit

MODEL A-9C **$35.50**

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

HEATHKIT

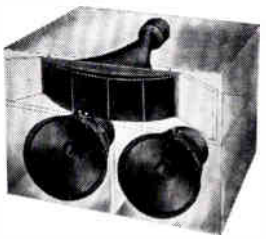
electronic crossover kit

MODEL XO-1 **$18.95**

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

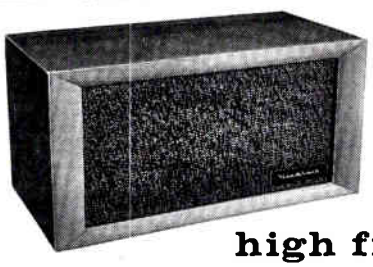
HEATHKIT "LEGATO"

high fidelity speaker system kit



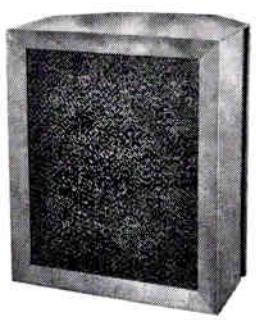
Wrap yourself in a blanket of high fidelity music in its true form. Thrill to sparkling treble tones, rich, resonant bass chords or the spine-tingling clash of percussion instruments in this masterpiece of sound reproduction. In the creation of the Legato no stone has been left unturned to bring you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

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



HEATHKIT
BASIC RANGE

HEATHKIT
RANGE EXTENDING



high fidelity speaker system kits

MODEL SS-1 **$39.95**

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

MODEL SS-1B **$99.95**

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

Free Catalog!

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

HEATH COMPANY • BENTON HARBOR 18, MICHIGAN

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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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address _____

city & state _____

ALSO SEND THE FOLLOWING KITS:

QUANTITY	ITEM	MODEL NO.	PRICE

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

Audionews

GE AMPLIFIER

Production of a new 20-watt amplifier, *Model PA-20*, has been announced by the General Electric Company.

The compact, leather-grain cabinet with gold-brushed escutcheon is compatible with a wide range of component styles. If a custom installation is desired, the power and preamp sections may be separated and mounted individually. All components are factory tested and inspected.

An LC tuned circuit is incorporated in the rumble filter for a sharp cutoff of 12 db per octave below 40 cps, according to the manufacturer. Inputs provided are for HIGH and LOW MAG, RAD-TV, AUX-1, and AUX-2; there are outputs for tape, preamp, and speaker.

General Electric Model PA-20 amplifier.

Controls included are SELECTOR, BASS, TREBLE, LEVEL, LOUDNESS, RUMBLE FILTER, and POWER, as well as 2 screwdriver level controls for Aux-1 and Radio inputs.

Specs state that frequency response is 20 to 20,000 cps, harmonic distortion is below 1%, and hum and noise are 60 db below 20 watts on phono and 75 db below 20 watts on high-level inputs. The suggested price for the PA-20 is $99.95.

ALTEC SPEAKER SYSTEMS

Altec Lansing has announced four new speaker systems in their 1958 line.

The first is the *Laguna 830A* consisting of two 15-inch 803A woofers, the 802 high-frequency driver mounted on the 511B horn, and the 500D 500-cps dividing network. The frequency response is said to be from 30 to 22,000 cps without peaks or other misleading frequency accentuations.

The *Capistrano 831A* uses one 15-inch woofer, an 800E dividing network, and the 802 tweeter with the 811B horn. A range from 35 to 22,000 cps is guaranteed by the manufacturer.

The *Corona 832A* is a corner design with the same components as the Capistrano.

The last model in the series is the *Verde 833A*, a moderate-size enclosure housing a 602B Duplex loudspeaker. Frequency response is said to be 35 to 22,000 cps.

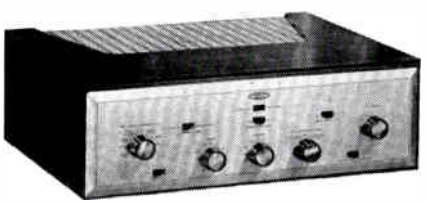
All models are available at Altec dealers.

IRISH DOUBLE-PLAY TAPE

Recently introduced by ORRadio Industries is the *No. 400 Irish* double-play recording tape. The Mylar polyester base enables the tape to withstand a pull of 3 lbs. without distortion (a tape recorder generally exerts a pull of 6 to 16 oz.). The tape also has the advantage of the Irish Ferro-Sheen process which bonds the oxide coating firmly to the base. A 7-inch reel carrying 2,400 ft. of tape is priced at $11.95.

SCOTT AMPLIFIER

H. H. Scott, Incorporated, has recently added several new features to their *Model 99-D 22-watt* amplifier without raising the price; it is still $99.95. Now included are a front-panel SPEAKER SELECTOR switch, a front-panel TAPE MONITOR switch, and redesigned tape-



New feature added; price remains same.

recording jacks accessible on the rear panel. Otherwise, the unit is just as it was before.

Further information on the 99-D may be obtained free from the manufacturer.

STEREO TUNER AND AMPLIFIER

Madison Fielding has recently announced manufacture of a matched stereo tuner and stereo amplifier for the basis of a stereo system.

The *Series 330* FM/AM tuner provides facilities for monaural, stereo, and multiplex reception. Specs for the FM section state that sensitivity is 2 μv for 20 db quieting, frequency response is uniform within 1 db from 20 to 20,000 cps, and that IF bandwidth is 355 Kc at 3-db points and 420 Kc at 6-db points. AFC is provided for drift-free operation. Sensitivity in the AM section is said to be 15 μv per meter loop sensitivity and 3 μv with direct antenna connection. AVC is incorporated in the circuit and there is a separate tuned RF stage for selectivity. Controls included are AM TUNING; FM TUNING; selector for AM, FM, STEREO, ON, and OFF. The tuner is available for $129.95; price of matching cabinet is $19.95.

The *Series 320* 40-watt stereo amplifier has one low-level and two high-level inputs for each channel and 4-, 8-

Matching stereo tuner and amplifier.

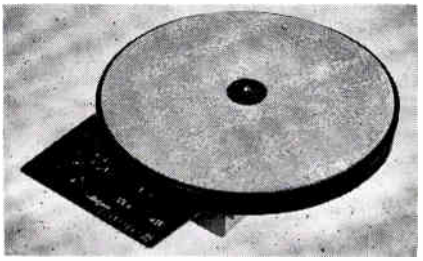
and 16-ohm speaker outputs and tape-monitor output. Controls on each channel are provided for EQUALIZATION, BASS, TREBLE, VOLUME, LOUDNESS, POWER, and CALIBRATE. Controls for both channels are POWER, MASTER VOLUME, and SELECTOR. The frequency response, according to the manufacturer, is within 0.5 db from 20 to 20,000 cps: power response is said to be constant at 20 watts per section from 20 to 20,000 cps, ± 1 db; hum and noise are stated as being down 55 db at full output in phono position and better than 75 db in high-level positions. The price of the amplifier is $169.95, and of the matching cabinet is $19.95.

Both models are available in walnut, mahogany, or korina finishes.

NEW STARLIGHT TURNTABLE

Metzner Engineering Corporation has announced the *Starlight Model 80* turntable, styled in coffee and gold and selling for $49.50, audiophile net. Continuously variable speed control from 16 to 84 rpm is provided by a built-in illuminated stroboscope, and a filter eliminates speaker pops when the power switch is operated. The 3½-pound turntable has an automatically retracting 45-rpm center hub and is center-driven by the motor shaft; metal-to-metal contact is avoided in the drive system to keep

Turntable has built-in stroboscope.



rumble at a minimum. Wow and flutter are said to be less than 0.25% with rumble stated as 40 db below NAB standard level.

KNIGHT TAPE RECORDER

A two-speed (3¾ and 7½) tape recorder, the Knight *Model KN-4010*, is being offered by Allied Radio Corporation.

Included in the recorder are two built-in speakers and a roving speaker, an

Interlock prevents accidental erasure.

8-watt push-pull amplifier, a transistorized preamp, and high-frequency AC erase. An automatic shut-off stops the machine the instant a tape is finished and a special safety interlock prevents accidental erasure. Dual neon-bulb indicators show when volume is at correct level for recording. Inputs are provided for recording from mike, radio, or TV, and output from the recorder's preamp may be fed directly into a hi-fi system.

The KN-4010 is supplied with microphone, 5-inch reel of tape, and take-up reel. It is listed under Allied Stock No. 91 RZ 750 and is priced at $129.95.

BIDIRECTIONAL MICROPHONE

The Fen-Tone Corporation's *Trix Sixty Special* is a miniature bidirectional ribbon-velocity microphone comprised of a triple horse-shoe magnet supporting a relatively long corrugated limp aluminum ribbon, encircled with four breath shields. This method of assembly is said to prevent gaging and spurious vibrational nodes. Although designed as a studio microphone, the Trix Sixty Special can be used for PA work as well.

Frequency response is said to be flat from 50 cps to 12 Kc, ±2 db; output at 50 ohms referred to hi-Z is rated at —58 db. The microphone measures 4 in. by 1⅜ in. and costs $96.50 including 18 ft. of balanced shielded cable.

Bidirectional ribbon-velocity mike.

SHERWOOD AMPLIFIER

Sherwood's new 36-watt amplifier, the *Model S-1000 II*, features eleven front panel controls: SELECTOR for five inputs, EQUALIZATION, BASS, TREBLE, LOUDNESS, LOUDNESS compensation switch, TAPE MONITOR switch, PRESENCE, SCRATCH FILTER, RUMBLE FILTER, and PHONO LEVEL. Outputs are provided for 16, 8, and 4 ohms. The output-tube balance control is adjustable with meters, and the phono preamp and tone-control amplifier are operated from a quick-warm-up DC filament supply.

Power output is stated as 36 watts (72 watts peak) at 1½% IM distortion. Other manufacturer's specs are: inverse feedback, 21 db; frequency response at 36 watts, 20 to 20,000 cps ±1½ db; preamp sensitivity, 2½ mv; preamp noise level, 60 db below rated output.

Size of the S-1000 II is 14 by 10½ by 4 in. and its shipping weight is 24

Amplifier includes preamp section.

lbs; price is $109.50 for the chassis only. Cabinets are available in brown or black Flextone, and gold-tooled mahogany, black, tan, or white leatherette.

For more information about any of the products mentioned in Audio-news, 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.

DOUBLE-PLAY RECORDING TAPE

Minnesota Mining and Manufacturing Company has recently added *Scotch No. 200* double-play magnetic recording tape to its line. It is made from durable polyester film and is said to withstand a pull of 3.6 lbs. before stretching. The 7-inch reel, which retails for $11.95, contains 2,400 ft. of tape and is capable of recording for four full hours at 3¾ ips or two hours at 7½ ips. The 10½-inch reel holds 4,800 ft. of tape and will record for 16 hours at 1⅞ ips; it retails for $26.90.

DYNAMIC ELECTRONICS PREAMP

The latest product off the line from Dynamic Electronics is the *Model PA-110* preamp. This simple and inexpensive unit is designed for use with a variable-reluctance pickup or tape recorder, and it uses the controls on the existing amplifier in the sound system. According to the manufacturer, frequency response is 11 to 25,000 cps, ±1.5 db; noise-and-hum level is 60

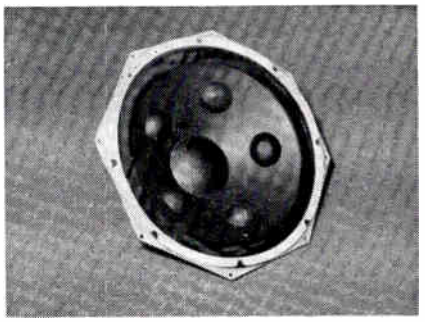
Preamplifier is very small and compact.

db below 10 mv; and the over-all gain is 34 db. The PA-110 is housed in a black and copper shielded cabinet and measures 6 by 3¼ by 3½ inches; weight is 2½ lbs. $12.95 is the list price.

AUDIOLAB WOOFER

The Audiolab *Custom 16* woofer can be used in any type of enclosure and is said to have excellent transient response because of dynamic braking. 15 to 30 watts can be handled depending on the frequency and type of enclosure; frequency response is 26 to 1,000 cps, according to the manufacturer. Harmonic distortion varies from 2 to 5% at 40 cps and 4 to 7% at 30 cps depending on the enclosure. Price of the speaker is $89. Further information is available from Audiospeaker Laboratories.

May be used in any type of enclosure.



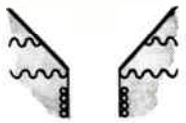
Indisputably the Finest!

UNIVERSITY'S NEW 315-C 3-WAY 15" DIFFAXIAL

This speaker protected by U. S. Patent nos. 2,641,329; 2,690,231; 2,751,996 and other patents pending.

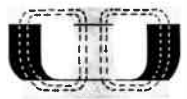
THESE ARE THE REASONS WHY

Exclusive self-stabilized woofer cone structure and dual spider construction ensure lifetime centering of moving system, for all extreme excursions.

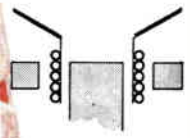


University-controlled processing of imported cone pulps results in consistently uniform, distortion-free response.

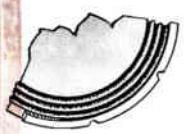
Exclusive, massive flux-contoured 6 pound Gold Dot Alnico 5 magnet provides efficient power drive for deepest low frequencies, free of transient distortion.



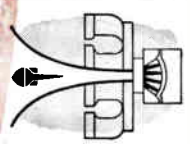
Extra-long voice coil ensures purity of maximum low frequency energy conversion during periods of extreme cone excursion.



Exclusive University-formulated long polymer lattice permeates rim suspension for effective acousto-mechanical rim damping.



True through-axial construction permits balanced tweeter, mid-range and woofer acoustic integration without design compromise.



Exclusive hypersonic tweeter incorporating radial phasing equalizer automatically balances all high frequencies for smooth, realistic reproduction.

Exclusive "reciprocating-flare" horn now has wave front equalizer for more uniform wide-angle treble coverage.

Exclusive multi-sectional Diffusicone provides controlled diffraction for linear mid-range response and dispersion.

Continuously variable dual control network integrates and blends mid-range and tweeter for concert realism regardless of room acoustics.

Response: 25 cps to inaudibility; Power capacity: 50 watts, integrated program; Total magnet wt.: 6½ lbs. Alnico 5; Impedance: 8-16 ohms; Depth: 12"; User net: $156.00.

UNIVERSITY LOUDSPEAKERS, INC., 80 SO. KENSICO AVENUE, WHITE PLAINS, N. Y.

LISTEN *University® sounds better*

Gentlemen:
I noticed in the December *Radio & TV News* that you have an FM station list available for $.50. Do you also have a list of United States and Canadian AM stations? I am in desperate need of such a list since I am an AM listener. I get many western U.S. and Canadian stations I have never heard of before but have no list for positive identification. Please let me know where I can get such a list. Thank you.

F. S. Dombrowski
Okauchee, Wis.

We do not have available a list of AM stations similar to our FM station list. You can obtain information on AM stations, however, in the Broadcasting Yearbook, *obtainable from Broadcasting, Broadcasting-Telecasting Bldg.. 1735 DeSales Street, N.W., Washington 6, D.C. The price is $3.00.*
— ED.

Gentlemen:
I am a charter subscriber to your publication, and will continue to subscribe. AUDIOCRAFT is a truly fine semitechnical journal, as well as being good reading. Like many others, my only wish is that there should be more of it! I have been pleased to note the gradual increase in the number of articles and features, and hope that you will continue to increase the depth of your coverage.

I was very interested in "Two-Track, Three-Channel Stereo" by Paul Klipsch. There are probably a great many persons, like myself, who have heard just enough stereo to be interested, but who would like to know more about it. Might I suggest, or request, a comprehensive series of articles on stereo reproduction?

Donald K. McKay
Hamden, Conn.

A series, almost exactly of the sort you describe, was begun in our February issue.
— ED.

Next month -- Audiolab Reports

WITH the next issue AUDIOCRAFT Magazine will begin publication of laboratory test reports on commercial high-fidelity components.

This will represent another in our long list of "firsts." It may well be the most important of all, however, for these reports will differ from the usual consumer-magazine equipment reports in three significant ways:

1) They will be prepared from completely objective laboratory tests, with comment limited to remarks that will provide information for interpretation of the results. There will be no vague generalities and no omission of embarrassing facts. Tests will be standardized, so that similar units will be tested under identical circumstances. Thus, the results will be truly comparative.

Further, these objective tests will be chosen so as to obtain instrumental results that will reflect, as accurately as present-day knowledge permits, the quality of performance which the equipment will yield in practical use. In this way the advantages of subjective evaluation will be combined to a maximum degree with the far more sensitive and accurate indications of instrumental tests. We believe this to be an extremely important consideration; it explains why we have decided *not* to include microphones, loudspeakers, and speaker enclosures among those products to be tested. Although it may be possible to judge a mike or a speaker system on the basis of objective tests alone, the tests would have to be so elaborate — and the results would take so much space in the magazine — that they would be impractical for us to undertake at this time. All other hi-fi components will, however, be covered.

2) The tests and report preparation will be done by Hirsch-Houck Laboratories, Mount Vernon, New York — an entirely independent company, not connected with us in any way. This company is managed by Julian Hirsch and Gladden Houck. Messrs. Hirsch and Houck carried out tests and wrote all reports for the former Audio League, which many readers will remember as the originator of objective reports on hi-fi equipment. The Audio League had an enviable reputation among manufacturers and subscribers alike for competence, fairness, and absolute integrity. This tradition is maintained by Hirsch-Houck Laboratories; it is undoubtedly the finest and most capable organization in the world for the work we have assigned them.

3) It is explicit in our arrangement with Hirsch-Houck that we will not be permitted to modify, cancel, or withhold a report once it has been undertaken. A manufacturer may request that we not begin a report on his equipment for any good reason, such as impending obsolescence, but we are not bound to comply even with this. After a report is prepared a copy will be sent to the manufacturer; if he feels that his product has been treated unfairly he may correspond with the laboratory directly. Should the laboratory find that his objections have validity they may revise the report accordingly — but we cannot do so ourselves, nor can a manufacturer "kill" an unfavorable report. He may, if he desires, append a short comment.

We believe that this will constitute an equipment reporting service of unparalleled value to high-fidelity equipment consumers. Our Audiolab Test Reports will be impartial, reliable, and of maximum utility, because of the integrity and competence of the testing organization. They will separate the good equipment from the not-so-good because punches will not be pulled when they are deserved. They will be free of personal prejudice, because the basis of judgment will be objective instrument tests. They will be free of any taint of pressure from advertisers, because we have bound ourselves to publish the reports exactly as written by Hirsch-Houck Laboratories — and they owe allegiance to no manufacturer.

Several reports are already in progress for the April issue. They include the McIntosh MC-60 amplifier and C-8 preamp combination, and the EICO HF-52 amplifier.

AND with *this* issue we launch another new department: "Electronic Firsts," by Monroe Upton, author of the popular *Electronics for Everyone*. We hope you'll find his anecdotes of "pre-electronic" history as amusing and fascinating as we did. — R.A.

A preamp with unmeasurable distortion? Once only a fantastic dream, the idea's here to stay, in

The Dynakit Preamplifier

An **audiocraft** *kit report* *by Joseph Marshall*

THE quality of a superb amplifier is to a large extent wasted if it is preceded by a preamplifier-control unit whose performance is much poorer than that of the amplifier. Until a short time ago, the design of control units did not keep step with the improvements in power amplifiers, particularly in respect to transient response and low distortion, with the result that most of the electrical distortion in hi-fi systems originated *before* the amplifier.

Recently, however, preamp-control units have been receiving more attention from designers. The Dynakit preamplifier comes astonishingly close to the ideal of hi-fi performance — that is, to control the signal without leaving any degrading evidence, either measurable or audible, of its work. Distortion of all types is so low that for any practical purpose, even for laboratory service, the Dynakit preamp can be called distortionless. This performance is all the more astonishing in view of the price: $35.

The Circuit

A quick and nonanalytical glance may give the impression that the Dynakit circuit, Fig. 1, is a fairly conventional one. Analysis will reveal several differences from standard circuitry far more important in effect than they might seem on paper. For one thing, every stage has at least two feedback circuits; the first two actually benefit from three.

The first 12AX7 supplies amplification and equalization for the phono and tape-head or mike channels. Equalizing networks are in the feedback loop from the plate of the second tube to the cathode of the first. But there is one very significant difference from the usual feedback-pair equalizer. Note the 100-K resistor that joins the two cathodes. This provides *positive* feedback which increases the gain of the pair very markedly. The increased gain yields two benefits: 1) it permits complete boost at the bass end for the phono equalizers, and yet 2) leaves enough additional gain to provide an appreciable amount of feedback even at the bass frequencies which, in other circuits, receive little benefit from feedback. In addition to the positive and negative voltage feedback, each tube has an unbypassed cathode resistor to supply current feedback. This combination provides an unusually high feedback factor which is reflected in the extraordinarily low distortion.

Three equalization curves are provided for the phono channel: RIAA, LP, and 78. The 78-rpm curve provides a 6-db-per-octave boost below 500 cps, and a 6-db rolloff at 10,000 cps. The input resistance of the phono channel is 50,000 ohms — a good compromise value that will work well with most pickups. Lower values can be obtained simply by inserting a resistor across the output of the pickup at the turntable. For example, a 56-K resistor will give a total resistance of 27,000 ohms, for Pickering cartridges.

There are two phono inputs, one for low-level and another for high-level cartridges (only one can be used at a time). There is another input marked SPECIAL which can be wired to provide still another switched phono input with RIAA equalization, a mike input, or an NARTB-equalized input for a tape head. Instructions are provided for all three possibilities; the extra parts required (a 12-$\mu\mu$fd capacitor and an 18-K resistor) are now supplied with the kit. There is a low-pass RF filter provided by the 10-K series resistor and the input capacitance of the input tube, to bypass strong local radio signals picked up by the cartridge, which might otherwise overload the circuit and might be rectified to produce audible interference.

The LOUDNESS control is a very simple tapped-control type, with compensation furnished only when the VOLUME control is below half rotation. It provides both bass and treble compensation, quite satisfactorily. It can be completely disabled, however, by a front-panel switch.

High-level inputs are provided for RADIO, TAPE and TV sources (Fig. 2). There are no input level controls because they aren't needed; no amplification is supplied before the main VOLUME control. All inputs not in use are grounded to eliminate crosstalk.

The tone-control circuits are new, although they have superficial resemblance to the Baxendall type. Another 12AX7 is used, with the tone-shaping network in the two-stage feedback loop. More than 20 db of cut or boost at 20 cps is furnished by the BASS channel; the TREBLE channel provides some 14 db of boost and (in our specimen) 20 db of cut at 20,000 cps (only 14 db is specified). Most of the bass boost is applied below 100 cps where it is most needed by good speaker systems and doesn't muddy up the lower middle range. The high-frequency boost also

is most effective at the extreme end where tweeters begin to falter.

It will be noted that, as in the Baxendall, the bass crossover moves downward as the boost is reduced. The result is a very smooth and inconspicuous tone control which (as the curves show) gives far more boost than one might think when twirling the knob. The two tube sections have gain enough for wide tone-control operating ranges and enough to spare for reduction of distortion by feedback.

Provision of a self-contained rectifier to convert 6-v AC from the companion amplifier to 12-v DC for the filaments of the tubes is a welcome novelty. The hum-balancing pot is unusual in a DC filament supply, but it does produce additional reduction of hum. The capacitor in the center of the filament chain is an RF filter to clear up line hash which can be quite a problem in sensitive preamps. Decoupling is elaborate and, for extra safety, a long-life electrolytic unit is used. Operating voltages of 6 v AC and 200 to 350 v DC must be obtained from an outside source—such as the power amplifier.

No cathode-follower output circuit is provided, but the output impedance is very low because of the feedback loop from the final stage. There is one disadvantage to this: the input impedance of the following amplifier affects the feedback loop and, therefore, the frequency response. The Dynakit preamp is designed to feed a 470-K input. Higher input resistances will not be any problem; lower ones will require snipping off (or leaving out) a 510-K output resistor.

Construction Notes

In the Dynakit amplifier, a new standard for simplicity of kit construction was established. This is continued in the Dynaco preamplifier, although it will take considerably longer to do the job (six to eight hours) than building the amplifier. The most critical portion of the work is eliminated because the tube circuits are already wired on a printed-circuit board. But there are still 100 different steps in assembling and wiring.

The steps have been figured out very thoughtfully in four stages. Wiring and assembly are done in layers, as it were, so that even at the end, when almost everything is done, the wiring is straightforward and there is no necessity for trying to reach into a corner already too full, and little danger of burning one part while soldering another.

In the first stage, Fig. 3, the power supply and tone-control components are mounted and partially wired. Then the printed-circuit board is added and connected to the work done previously. The equalizer switch is assembled and wired before mounting in the chassis, for the third stage. Finally, when the switch

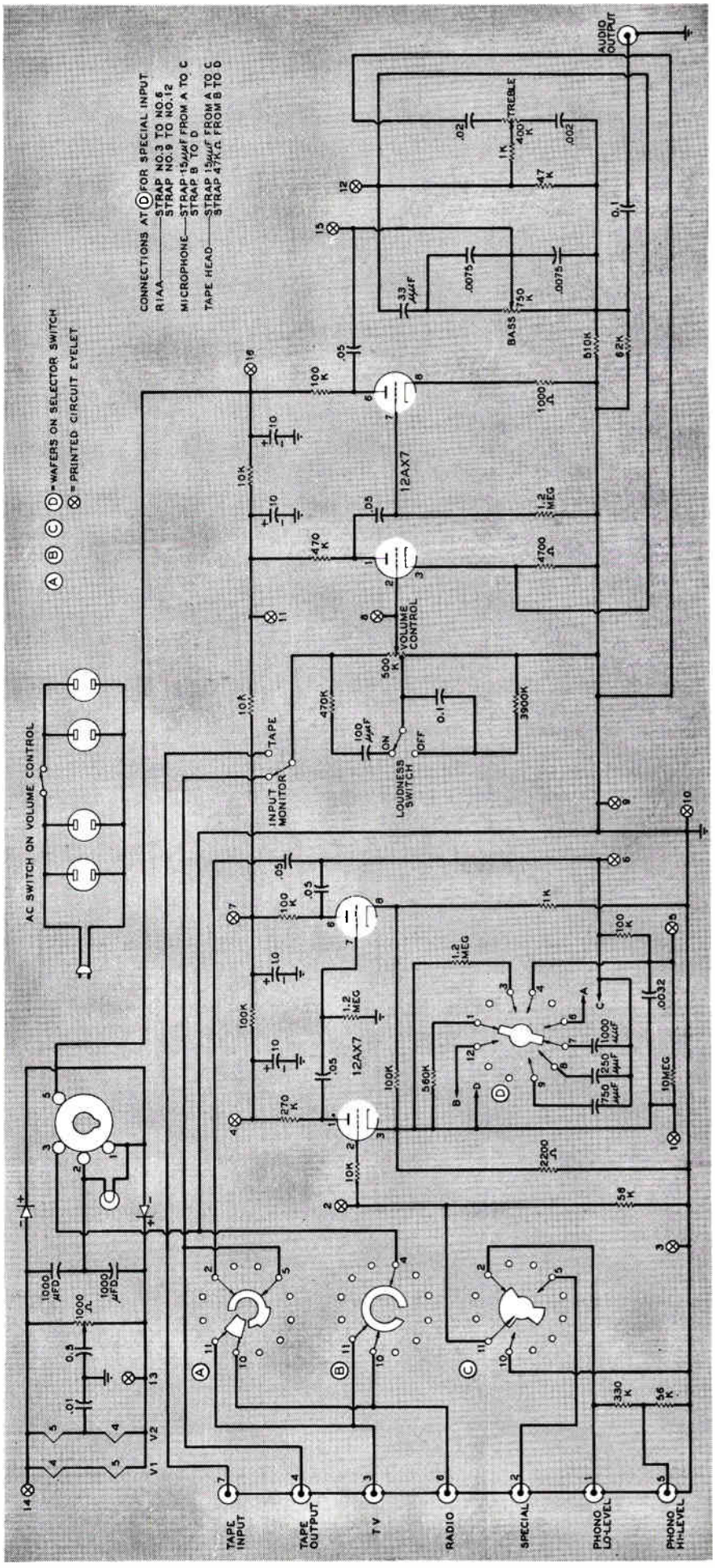


Fig. 1. Schematic diagram of the Dynakit Preamplifier. Note the multiple feedback loops, and unique rectifying circuit which provides DC voltage to the tube filaments.

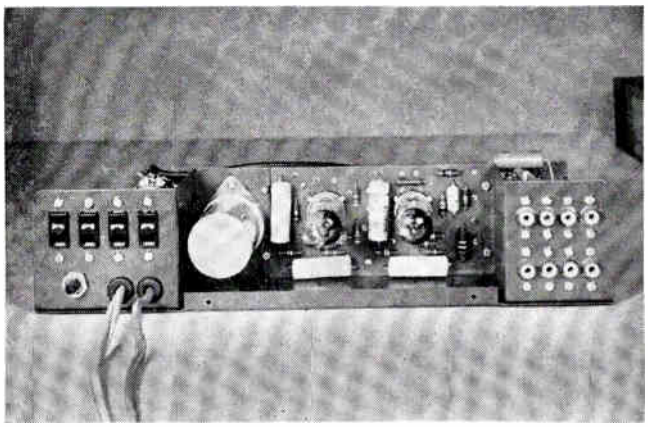


Fig. 2. Rear view of the chassis shows inputs and AC outlets.

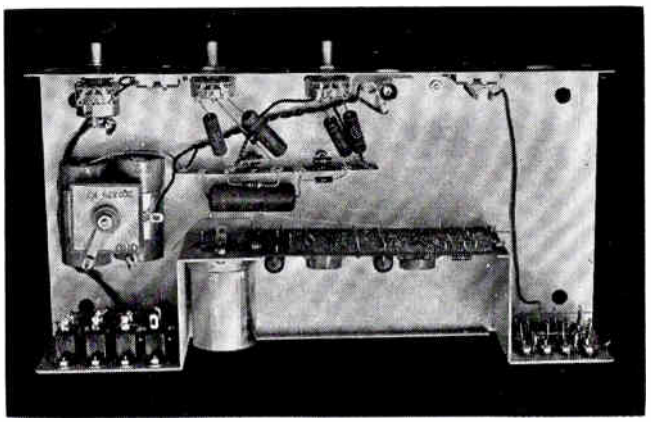


Fig. 3. Power supply and tone controls are partially wired.

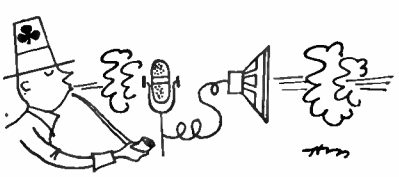
is mounted, the remaining interconnections are made.

It is a good idea to use the scale marked on the pictorial diagrams to cut the leads to the size specified. And, if you like to make strong mechanical joints at terminals, allow an extra quarter inch in length for each piece. Also, as you do each step, check it against the big pictorial diagram.

The steps in construction have been especially well worked out to make wiring to the printed-circuit board as simple and orderly as possible (Fig. 4). To minimize any possibility of damage to the etched foil, the board has tinned eyelets where the wires are to be soldered. We suggest that the soldering iron be applied from the front (the side on which the components and tubes are mounted) while the wire is pushed in from the back. In this way you are far less likely to damage the printed circuit. The completely wired chassis is shown in Fig. 5.

Adjustments are very minor and simply made. We found that the tone controls centered in the flat spot within less than 1/16 inch when we simply set the knobs as suggested at the 7-o'clock position. Setting the hum balance is also not critical. It can be done perfectly well by ear. Instructions for connecting the power cable are based on the idea that the preamp will be used with a Dynakit or Heathkit amplifier, and an octal plug is provided so that after wiring it can be plugged directly into such amplifiers. The voltages can be supplied by any amplifier or other gadget which will yield between 200 and 350 v DC and 6 v AC. But note below that 350 v B+ yields the optimum performance; lower voltages result in somewhat higher distortion. (The red wire in the cable is for the positive high voltage; the black is for the ground. Green and white leads are for the 6 v AC.)

The source of 6 v AC must be "floating" — that is, not grounded at any



point. In some amplifiers, the filament chain is grounded at the center point of the filament winding on the transformer or through a built-in hum control. This can be made to work by simply disconnecting the ground from the center tap on the hum balance control entirely. Then the balance pot in the preamp will provide an AC ground for both amplifier and preamp.

AUDIOCRAFT Test Results

It is seldom that a piece of equipment amazes us, but the Dynakit preamp certainly did. Fig. 6 shows the frequency response at various levels of output with and without the LOUDNESS-control compensation. Note that our measured response with the VOLUME control at maximum is absolutely flat from 10 to 40,000 cps, and slopes to only 3 db down at 100,000 cps. Note also that the response below 10 cps is within ½ db to 6 cps, down 1½ db at 5 cps, and 4 db down at 4 cps. The low-end response remains absolutely flat whatever the position of the VOLUME control (with LOUDNESS off). The high end slopes as the VOLUME control is moved down, but the slope always begins beyond 20,000 cps.

The LOUDNESS-control compensation comes in at half rotation. We liked its effect because the largest part of the boost was below 100 cps, just as with the BASS control, so that it did not result in the boomy, muddy sound some loudness controls produce. It also provided some boost at the high end: 5 db maximum at 20,000 cps. All these curves were taken with a constant 0.25-volt input, which produced an output of about 2.5 v with the VOLUME control at maximum.

Because the high-level inputs go di-

Fig. 4. Rear of PC board shows how connections are made.

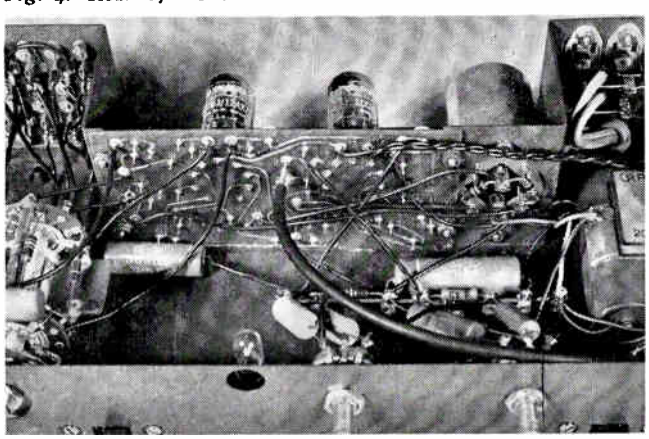
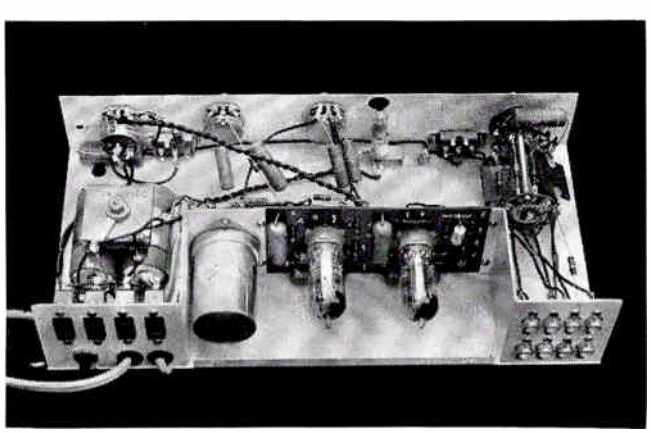


Fig. 5. Completed preamp testifies to simplicity of wiring.



rectly into the VOLUME control it is virtually impossible to overload the Dynakit preamp, although the loudness contour will vary with the input voltage. It is suggested that the volume controls on radio and TV be adjusted with the preamp VOLUME control just past the middle point (where the LOUDNESS control is inoperative) to produce a rather loud "concert-hall" loudness which requires no compensation. Then, as the volume is reduced to a more comfortable level, loudness compensation will come in.

Fig. 7 shows the tone-control contours, and Fig. 8 the phono equalization curves. Because precision capacitors are used, these curves follow the specs very closely. The RIAA and LP curves depart from the theoretical by less than ½ db. The 78 curve is similarly close to that

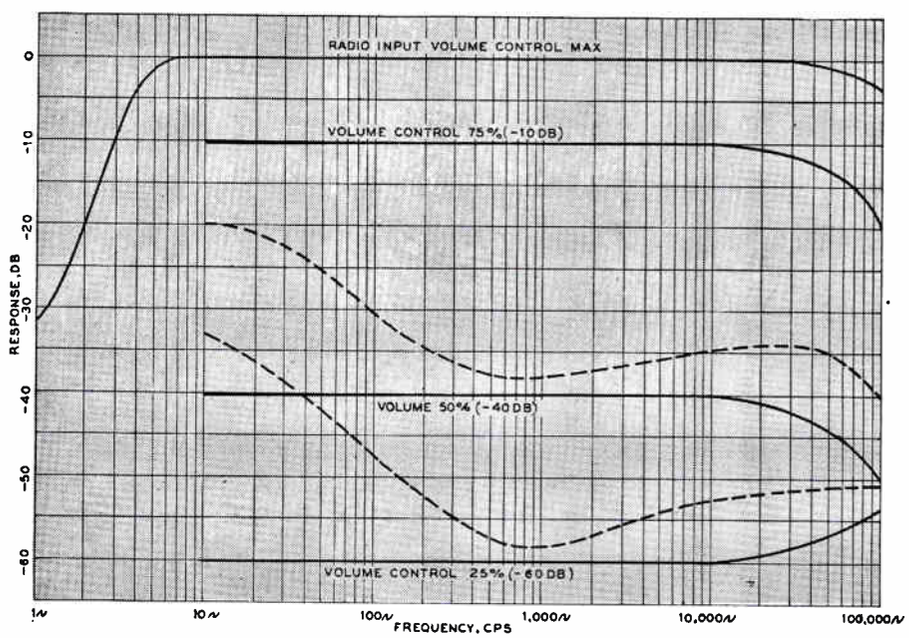


Fig. 6. Frequency response of the Dynakit preamplifier at several settings of the volume control. The dotted line shows response with loudness compensation added.

specified and, you will note, delivers some 27 db of boost as 20 cps.

Distortion curves in Figs. 9 and 10 are really extraordinary. We must note to begin with that, although the kit will operate with any B+ voltage between 150 and 350 v, and with very little difference in gain as the voltage is changed, the distortion *will* vary with applied voltage. The curves shown were taken with 350 v. Whereas with 350 v B+ the IM at 2 volts (equivalent sine-wave voltage) was less than 0.1%, with 200 v B+ the IM went up to 0.3% at 2 volts output. Harmonic distortion also increases at the bass end with lower voltages, as the following brief table shows:

Harmonic Distortion

	200 v	250 v	350 v
50 cps	0.5%	0.1%	.05%
500 cps	.01%	0	0
5,000 cps	0	0	0

This is presumably a result of the fact that feedback is reduced as the B+ voltage is reduced.

We do not claim the figures and curves to be absolutely accurate. It is extremely difficult even with the finest laboratory equipment to measure such low levels of distortion accurately. Wherever we indicate zero distortion, we recorded no reading whatever; it is quite possible that there may nevertheless be distortion on the order of one hundredth of one percent. Incidentally, the distortion does not increase as the VOLUME control is turned down, so long as the output voltage is kept below 2 or 3 volts.

Even more extraordinary and satisfying is the harmonic distortion curve which includes the *entire* preamp — from the phono input (with RIAA equalization) to the output. Input voltage was adjusted at various frequencies to produce an output of 1½ v — enough to drive most modern amplifiers to full output. Obviously, it took a great deal less input at 20 cps than at 20,000 but the method approximates an absolutely flat recording without recorded distortion. It will be noted that the distortion is 0.2% or less throughout the audio range. Actually, the distortion itself is considerably lower than the curves indicate because the readings include hum and tube noise which of course are much higher in the phono channel. This noise may well account for as much as 50% of the total reading.

It is difficult to do the same sort of test for IM distortion. The regular 4-to-1 ratio of 60 to 6,000 cps gave a figure too low to read — well below 0.1%. To come closer to the real situation

Continued on page 42

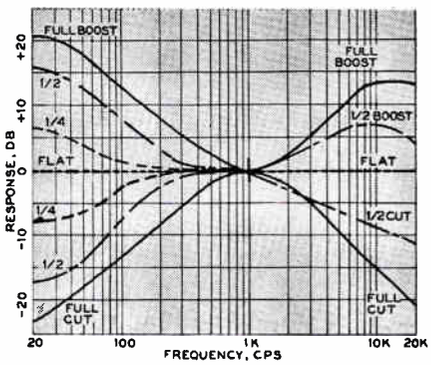


Fig. 7. Contours of the tone controls.

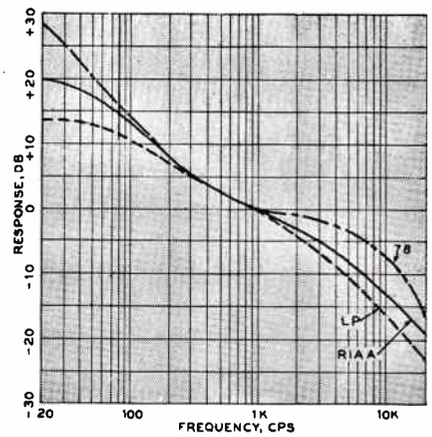


Fig. 8. Equalization of phono channel.

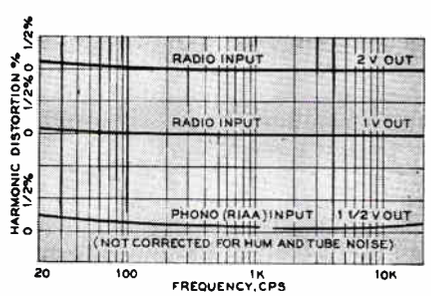


Fig. 9. Harmonic-distortion percentage.

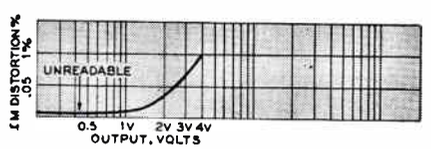


Fig. 10. Curve indicates IM distortion.

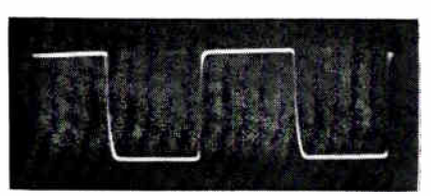
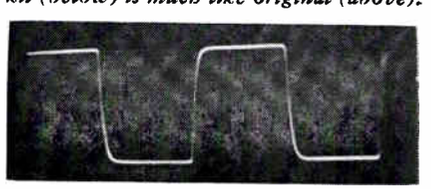


Fig. 11. 10 KC square wave from Dynakit (below) is much like original (above).



by JOEL EHRLICH

STEREO and your tape recorder

Just because stereo discs are on the way, don't put your recorder in moth balls. It may be more useful than ever.

IN view of the current discussion about stereo disc reproduction, it might be supposed that all the manufacturers of recorded tapes are preparing to fold their tents and fade into obscurity.

Happily, this is not the case. People with tape players will continue to buy recorded tapes, although it is logical to expect sales to fall off a bit once the new stereo disc gets moving. But stereo discs have no greater chance of eliminating the home use of tape than tape had of eliminating conventional discs. Many a pessimist had predicted that tape would put an end to the use of discs. It hasn't happened so far, and there is no indication that it will. The same should hold true for stereo discs and stereo tape. The reasons are obvious: tape is admittedly the more flexible medium, and is the *only* medium easily used in the home for recording with fidelity.

Let's look at it another way. In addition to playing commercial tape records, the tape recorder functions as the "memory" of a high-fidelity system. Any especially good concert or other program can be saved indefinitely by means of the recorder. FM, TV, and AM broadcasts, disc-recorded material, and live sources are all available to the recorder through the control unit of the hi-fi system. With a good recorder, the entire system is used to play back the home-made tape, thus yielding maximum sound quality.

More than anything else, the recorder has the facility of being able to put you in two places at once. You can, with at most a slight modification, record one program source and listen to another at the same time — or watch a television show, or attend to company. Aside from its many other functions, the recorder preserves that which you cannot listen to as it is broadcast.

This is probably the best place to mention my feeling about tape players. The primary virtue of tape, it seems to me, is the fact that it can be recorded upon at home. Of course it has other important virtues too, such as fidelity, long life, resistance to mechanical wear, and continued high-fidelity response. But now that stereo is available on discs as well as recorded tapes, the most important advantage of a tape recorder is the fact that tape, alone of all home media, can be used to *record* sound with little or no trouble (depending upon your aptitude and moment of inertia). So why buy a player when, for so little more, you can have a recorder?

The major expense in any tape system is the transport mechanism, and one is involved in both player and recorder. The parts missing in the player that are needed for recording are the erase head, the bias/erase oscillator, the level indicator, some means of mixing the bias with the signal, and some switching to go from record to playback mode and vice versa. At the very most, another tube and a few resistors and capacitors — not much in terms of money. Let us not think in terms of a tape player; let us think (and talk) of a tape recorder, a much more practical device.

Now, back to the question of the future of stereo tape. For several years we've had single-channel recorded tapes on the market. Even though recorded stereo tapes are predominant at the moment, sales of these monophonic (monaural) tapes have held up suffi-

The Law

Although there is nothing in the annals of legal history which *specifically* prohibits off-the-air recording for purely personal enjoyment in one's own home, we cannot take the stand to advocate the widespread and indiscriminate practice of radio recording — either stereo or monaural — without tempering Mr. Ehrlich's suggestions with a warning. Don't, under any cricumstances, try to sell your pirated treasures, and never place any fee upon your Saturday night living room listening sessions. Home recording is strictly for fun, and for fun it must remain.

ciently to indicate that at least a portion of the public prefers tape even for non-stereo listening. Note that we have had records of the identical works, at a far lower cost. Thus, the argument for the death of recorded stereo tapes — the fact that there'll be stereo records available of the same works for less money — is proven to hold little water.

There are good reasons for this lack of co-operation on the part of tape (it won't fall down and die as it is supposed to): it sounds better than anything else; it is less likely to suffer damage at the hands of the inexperienced; it can never be scratched; and if it is broken, it can be spliced.

Suppose we look again at tape with emphasis on the recording part of the tape recorder. Fully 50% of record wear occurs during the first three to five months we own the record. This is because while the record is new, it gets more playing than all the other records in a collection. As we get to know the music and the particular performance better, we play it less, concentrating on new favorites. Here too is an ideal spot for a tape recorder. Many people now tape-record their disc records when they are new. Until they stop playing the number regularly, they listen to the tape. Then they simply erase the tape, return the record to the rack, and put something else on the tape. Others never use the records at all: the tape is always played, and the record is kept locked away so that, should something happen to the tape, a new tape recording can be made. Records preserved this way never wear out; and the tapes don't either. As much as this applies to conventional records, it applies with even more force to stereo discs, for which the surface wear will be somewhat greater. The use of tape here makes obvious sense.

With stereo discs here it is easy to visualize a not-too-distant day when all FM and TV broadcasting will be stereo by the multiplex method. There is already quite a bit of simulcasting (AM and FM each carrying one channel) and even some early multiplexing. Disc jockeys, surprisingly, will be a potent force in bringing this about on a large scale; they will have stereo records, and the forces of competition will prompt them to demand stereo broadcast facilities.

Of course, we'll probably have a lot of AM/FM simulcasting at first, but FM multiplexing will grow and grow and grow. Again, the advantages of a superior source will force the issue. It might well be noted here that any stereocasting will have to be compatible, but let's not get into a discussion of that just now — it makes a good article by itself. In any event, we are sure to have some form of stereocasting quite soon, and this will be a fine source of material for

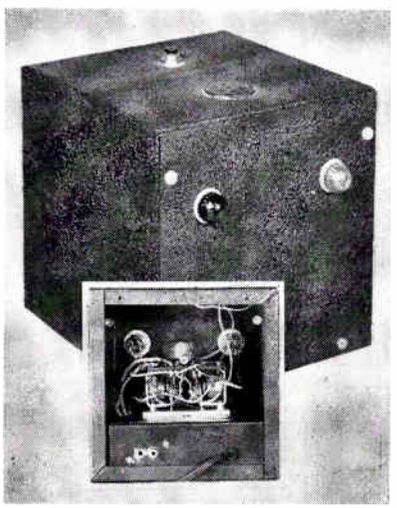
Continued on page 36

An automatic recorder switching box

This easy-to-build device removes two stereo sources from your hi-fi system's control input circuits when you want to record them while listening to something else, to prevent the selector switch shorting them out. They are reconnected automatically when you're through recording.

The AC line cord is connected to a switched power socket on your tuner, thus being turned on and off with it. When the tuner is turned on, the thermal delay relay (Ry2) immediately applies power to the release coil (a) of the latching relay (Ry1). After the built-in delay of the thermal relay, the power is removed (note the arrow signifying the normally closed condition of Ry2); but relay Ry1 remains latched in the released position. This connects the output of the tuner(s) or other high-level stereo sources to the control units, for normal listening. When it is desired to record while listening to another source (i.e., to separate the system), the button (S1) is depressed, applying power to the latching coil (b) of Ry1, opening the circuit between the tuner(s) and the control unit(s). At the same time, the red neon lamp, which is lighted whenever the unit is in "normal" (relay released) condition, is extinguished and the green neon "recording" (relay latched) lamp is lighted. After recording, the tuner(s) is turned off. Then, upon cooling, the thermal relay (Ry2) makes contact again. Since no power is being applied to the circuit (it was removed when the tuner was turned off), no change takes place. The next time the tuner is turned on, however, power is immediately applied to the release coil (a) of Ry1, until Ry2 opens again due to its thermal action. The circuit is returned to its "normal" condition.

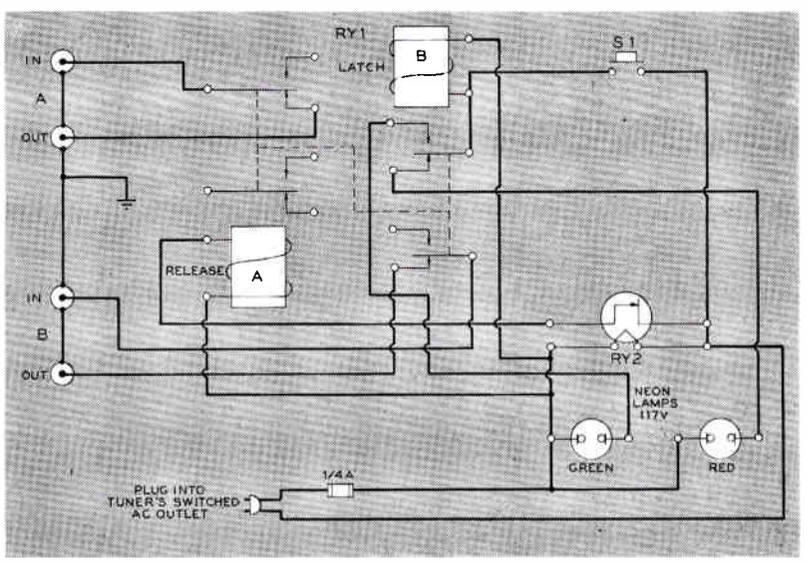
Parts for the circuit are few, and the entire device is quite inexpensive and simple to construct. Parts layout is noncritical except that AC leads should be kept away from audio leads, and all shielded wire should be used for the audio leads. The parts needed



Two views of recorder switching box.

are: an Amperite No. 115C5 thermal relay, an octal socket, a fuse and fuse post, four phono jacks, one normally open momentary-contact single-pole push-button switch, two neon lamps and sockets, and a four-pole double-throw latching relay (117 v AC).

Schematic of switching box. Any electrically equivalent relay may be used.



How to Make a Distortion Meter

by RUFUS P. TURNER

Essentially a rejection filter, this device can be used with an audio oscillator and VTVM to measure harmonic distortion

IN high-quality sound work, *fidelity* refers to the faithfulness with which a signal is amplified and reproduced. This faithfulness disappears when distortion enters the picture. Hi-fi signifies low distortion in its broadest meaning.

Distortion is an inevitable by-product of amplifier and loudspeaker operation. Actually, we would like to amplify a signal without introducing any distortion whatever, but this is not possible with practical components and circuits. Modern design has reduced distortion to small amounts but a little of it still is present in the highest-quality equipment.

There are several kinds of distortion. One kind that is particularly important to hi-fiers is nonlinear distortion, which is a general term for both harmonic and intermodulation distortion. A circuit producing harmonic distortion generates extraneous frequencies which are multiples (harmonics) of the signal frequency. Thus, if a 400-cps signal is passed through a distorting amplifier, the output will contain not only the amplified 400 cps but also weaker signals of 800, 1,200, 1,600, and 2,000 cps and perhaps higher harmonics as well. These frequencies mix together to produce a sound that is not the same as the original. In some instances, the result is displeasing to the ear.

Harmonic distortion can be measured in amount. It is expressed as a percentage of the signal voltage represented by the total RMS harmonic voltage. Thus, a 1-volt, 1,000-cps fundamental with .05 v of 2,000-cps energy, .02 v at 3,000 cps, and .009 v at 4,000 cps would have a total RMS harmonic voltage of $\sqrt{.05^2 + .02^2 + .009^2}$, or .055 v. This being 5.5% of 1 volt, the total distortion in this instance is 5.5%.

A rule of thumb, which is not necessarily accurate and which varies with listeners, says that harmonic distortion of a single tone becomes noticeable to the ear when it reaches the level of 5%. In music reproduction, 1% is often audible. For a high-quality modern amplifier, harmonic distortion should always be less than 1%.

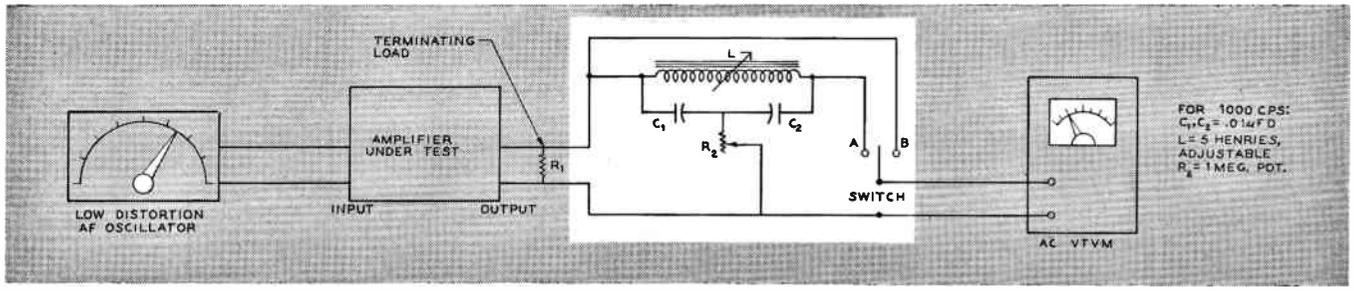
Distortion in a particular system is apt to vary with frequency and with power output. An amplifier may have low harmonic distortion at one frequency but high distortion elsewhere in the spectrum. It is common for many simple amplifiers to exhibit high fidelity at low power levels but to become quite poor when delivering appreciable power output. Distortion measurements accordingly are very important in checking amplifier performance.

Measuring Distortion

It might seem that a good way to measure distortion would be to apply a pure sine-wave signal to an amplifier and then to look at the output signal with an oscilloscope, noting how much the output wave form differs from that of the original. This can be done, but the accuracy of this method is not very good because the variations in wave shape (as seen on a 5-inch scope screen) are so small, for the distortion percentages usually encountered in practice, that the variance is hard to measure on the screen. Furthermore, this process is too slow if you have to make measurements at a number of frequencies.

A different method has been standard practice for a number of years. In this scheme, the fundamental frequency is removed from the output signal by means of a rejection filter. Any voltage left is that due to all the harmonics. If this voltage value then is divided by the full output voltage before the filter, and the result multiplied by 100, the

Fig. 1. Equipment setup for measuring harmonic distortion with filter (shown here in white block) described on these pages.



answer is very nearly the harmonic distortion in percent. Thus: where E_1 is the voltage before the filter, and E_2 the voltage after the filter, % distortion = $(E_2/E_1) \times 100$.

A simple circuit employing this principle of measurement is shown in Fig. 1. Here, the test signal is supplied to the amplifier under test by a low-distortion audio oscillator or signal generator. The amplifier is terminated by a loudspeaker (if you don't mind the noise) or by a load resistor R_1, equal to the output impedance of the amplifier. The rejection filter (a bridged-T network) consists of choke L, capacitors C_1 and C_2, and potentiometer R_2. When switch S is thrown to position A, the voltmeter indicates the voltage after the filter (that is, after the fundamental frequency has been removed.). When S is at B, the meter indicates the voltage before the filter. In operation, S is thrown first to B and the voltage read as E_1. S then is thrown to A, and potentiometer R_2 and the slug of choke L are adjusted for deepest dip (null) in the deflection of the meter. This voltage is read as E_2. The distortion percentage then is calculated as 100 (E_2/E_1). The meter can be made to indicate distortion percentage directly, and all calculations avoided, simply by adjusting the amplifier output for a deflection of exactly 1 volt when S is at B.

The values given in Fig. 1 for C_1, C_2, L, and R_2 are for 1,000-cps rejection. C_1, C_2, and R may be changed for other frequencies. In order for this method of measurement to be accurate, choke L must have high Q; otherwise it will reduce the harmonic voltages, as well as the fundamental, and will give a false reading of harmonic content. A suitable adjustable component is the UTC Type VIC-15.

Some resistance-capacitance circuits also are rejection filters. RC networks are appealing because they are compact and simple. One such circuit is the Wien bridge, (consisting of two capacitors and two resistors) which has appeared in many instrument circuits. But the Wien bridge cannot be used in place of the LCR network in Fig. 1 because it tunes too broadly for this application. However, it can be used in a feedback amplifier to provide sharp tuning. A commercial distortion meter consists of such a tuned feedback amplifier with a self-contained AC vacuum-tube voltmeter.

An instrument incorporating the components indicated by the white block in Fig. 1 can be fashioned for handy use with any low-distortion audio oscillator and VTVM. Using the materials listed below, assemble the instrument as shown in Fig. 2. Parts placement is not critical, and a smaller — or larger — chassis base may readily be used. Although the unit pictured contains banana jacks, any other type of input connector may be used to adapt it to your own system. A photograph showing inner construction details appears in Fig. 3, and a curve indicating rejection of the filter at the fundamental frequency (1,000 cps) is given in Fig. 4.

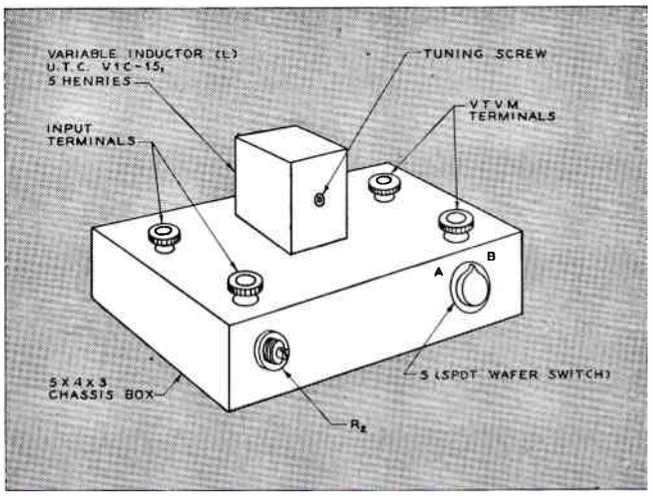


Fig. 2. The rejection filter can be built into a 5×4×3-inch Minibox as shown above. The choke is mounted on top of the chassis so that the tuning screw will be easily accessible.

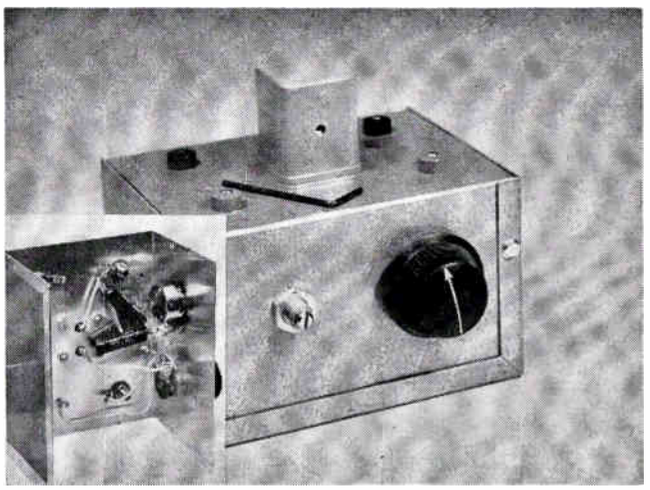
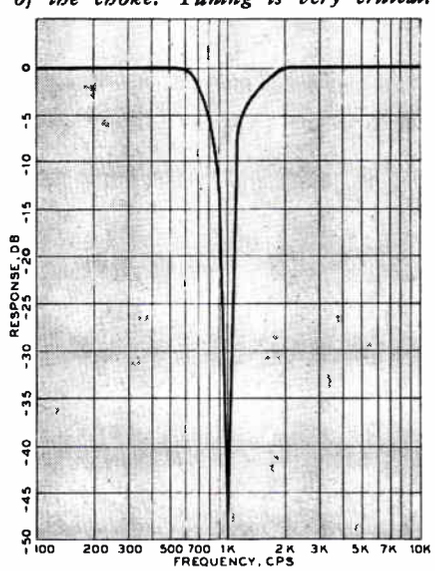


Fig. 3. Two views of the completed unit. The "L" shaped object in the larger photograph is an Allen wrench used to tune the choke. Parts arrangement inside box is optional.

Parts List

1	UTC VIC-15 5.4-henry variable inductor	$ 7.35
2	red banana jacks	.26
2	black banana jacks	.26
1	SPDT switch	.50
1	Minibox, 5 × 4 × 3 in.	1.24
1	potentiometer, 1 meg, linear	1.32
2	capacitors, .01 μfd	.36
	Total	$11.29

Fig. 4. Filter rejection at the resonant frequency. Steep drop is due to high Q of the choke. Tuning is very critical.



BUILD A FOLDED-HORN ENCLOSURE

Here are complete plans for a folded-horn enclosure designed by Jensen

by HARVEY P. JONES

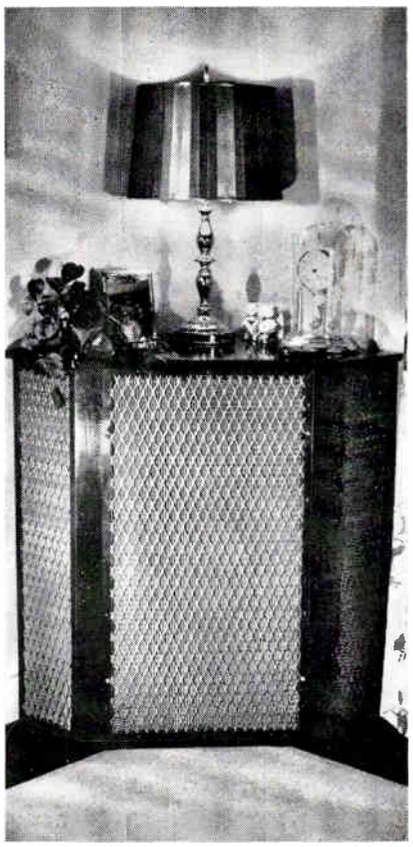
THE JENSEN Manufacturing Company makes available plans for "Construction of Compact Back-Loading Folded Horn Cabinets for 12-inch and 15-inch Loudspeakers."* Dimensions of the two cabinets are indentical except for height. This design is not available commercially, but the principle involved deserves greater recognition; its simplicity makes it easy to build, and it produces excellent sonic results. In size and proportions it "lives" well in a medium-size listening room where some of the larger folded-horn enclosures are overpowering in mass.

Considerable latitude is possible in the exterior treatment of this enclosure. My own modification is shown in Fig. 1. I have mounted within the enclosure a Jensen H-530 15-inch coaxial speaker.

While this design is said to sound well when located on a side wall, it looks much better in a corner and undoubtedly produces a much superior response in such a location. So placed, this enclosure gives a very satisfying "big" and clean sound with no apparent peaks and with a complete lack of boominess and boxiness. Lows seem to go down into the 40- or 50-cps region with little loss.

The back-loading feature of these designs is achieved by providing a relatively small enclosure back of the loudspeaker diaphragm with the horn throat at the front of this chamber. For frequencies above approximately 300 cps the design provides acoustic crossover, so that radiation above this frequency is suppressed in the horn. Interference with the radiation directly from the front of the diaphragm is thereby prevented.

Complete plans for building this folded-horn enclosure appear on the opposite page. The construction notes call for adequate bracing against vibration and resonance. In addition, I provided for full-length glued and screwed cleats where the vertical members join the base, as well as in other places where there seemed any reason (or excuse) for their inclusion. Glubond, made by Swift and Company, was found a highly satisfactory adhesive. It is probably related to other white water-soluble liquid adhesives now readily available.



The completed folded-horn enclosure.

It is imperative that ¾-inch plywood be used throughout. Ordinary fir plywood "good one side" is sufficient for all except exposed surfaces. In my own case these are walnut veneer on lumber core. The top and bottom are finished with thin veneer strips glued to the edges by means of liquid Glubond. This is an easier process than it may sound, because the adhesive sets in a very short time once it comes in contact with wood.

The drawing shows panel sizes and cutting angles. Carefully follow these figures and recheck them before cutting to prevent wastage. In assembling the horn all joints must be airtight, particularly near the loudspeaker where the pressure is rather high. Air leaks will decrease efficiency substantially in the low-frequency range because of pressure loss. Use wood screws and glue to insure tight joints. Construction must also be quite rigid. You can test the panels with a mallet or with your fist; a solid rather than a drummy sound will indicate solid construction.

The front baffle is removable for loudspeaker installation. Bracing cleats stiffen this baffle and do not touch the side cleats or the front edges of the V-shaped sound chamber. Use felt strips around the mounting cleats to insure an airtight seal for the baffle. The baffle can be held by decorative wood screws around the edges.

The top is held on by cleats glued at the top edge of the sides, and screws, up through these cleats, pull down the overhanging top. Any irregularity in the sawing of the vertical units is nicely taken care of by a 29-cent roll of Mortite calking compound which, when laid along the edges of the vertical units, fills all voids completely as the screws are turned to draw down the top of the cabinet; yet this calking compound permits later removal of the top without difficulty.

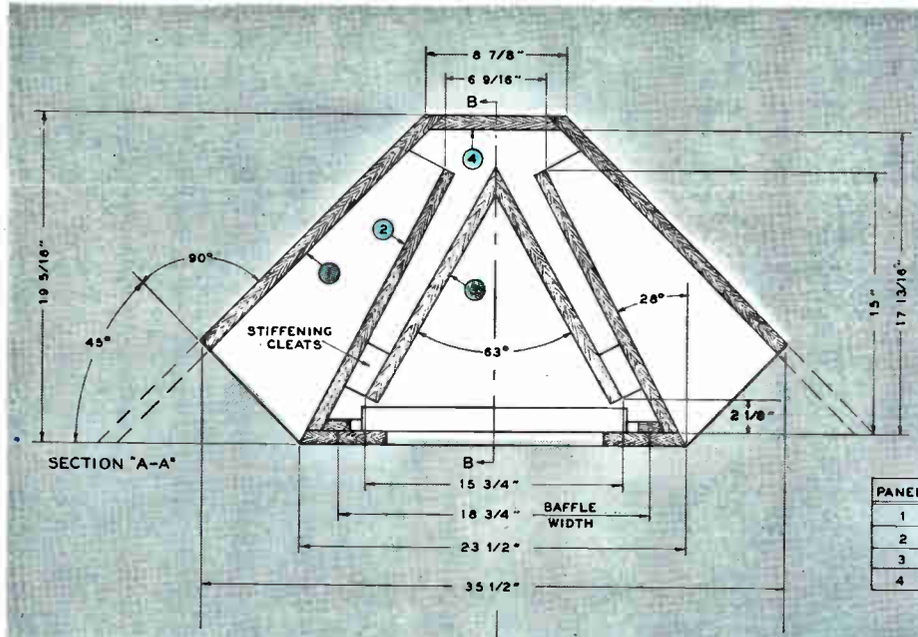
As shown in the illustration, both plastic and metal grille coverings are used. The metal is for appearance as well as for protection of the speaker cone from possible damage by one member of our family who still belongs to the lollipop set.

The exposed walnut areas of the enclosure were stained with Glidden's water stain, which was followed by several coats of rubbing varnish. Minnesota Mining's Wet-or-Dry abrasive paper in a fine grade was used (wet) between each varnish coat. The final coat was rubbed with rottenstone and oil.

So that the base of the enclosure would clear the corner of the rug on which it is placed, short ¼-inch strips of wood were tacked and glued at B, C, and D. Through these were driven large diameter Domes of Silence — the rubber-backed type. This three-point suspension insures a wobble-free cabinet. In addition, sash handles were screwed into the centers of the No. 1 panels to aid in moving the unit around on

Continued on page 48

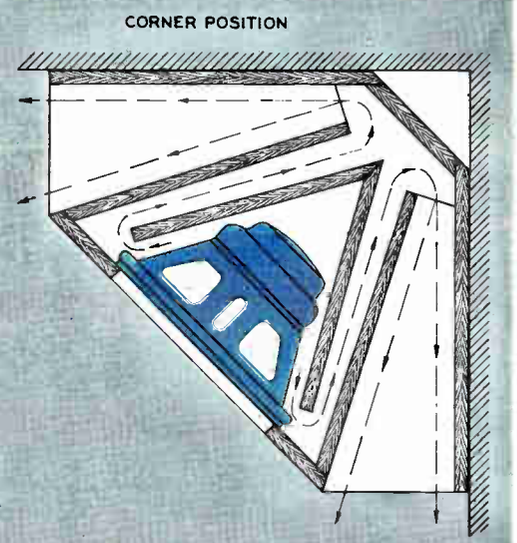
*Technical Bulletin No. 3A, The Jensen Manufacturing Company, Technical Service Department, 6601 South Laramie Avenue, Chicago 38, Illinois.



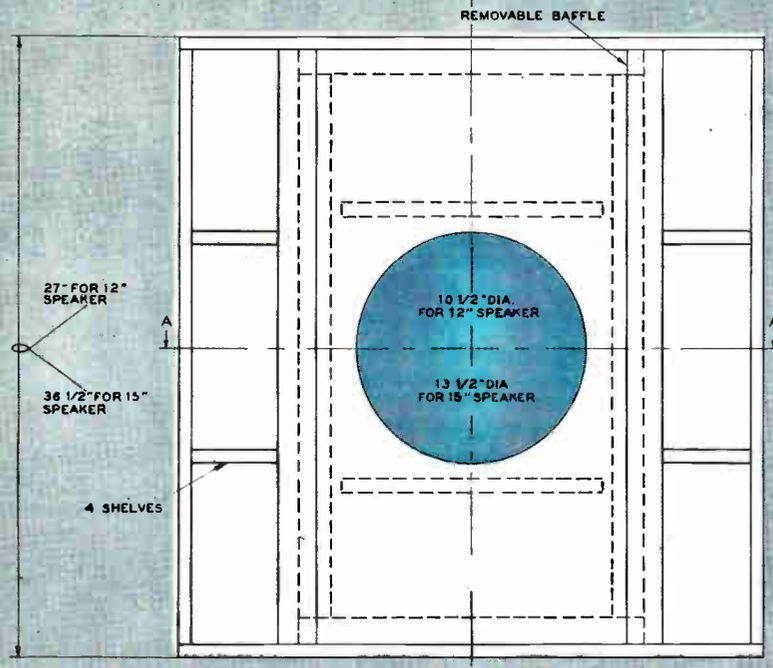
Follow these

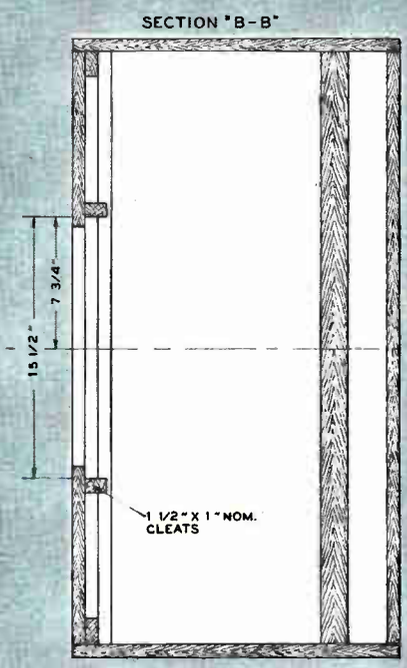
BLUE PRINTS

to build your own folded-horn enclosure



PANEL	REQ	LENGTH	ANGLE
1	2	19 9/16"	45°
2	2	17"	62°
3	2	15 1/16"	58 1/2°
4	1	8 1/4"	45°





Construction Notes

1. *Cut vertical panels from ¾ inch plywood to sizes indicated in the block near the center of this page.*
2. *Cut top, bottom and front panels to sizes shown on drawings.*
3. *Assemble the enclosure, using screws and glue on all but the top and front baffle.*
4. *Prepare exterior with finish desired, and place grille cloth on front baffle.*
5. *Install speakers, and attach front baffle.*

(See text for comprehensive directions)

TRANSISTORS

in audio circuits

by PAUL PENFIELD, Jr.

Part IX: Medium and high-power transistors

Tips and techniques for output-stage designers

POWER transistors are sufficiently different from low-power models that it is necessary to describe them separately. The emphasis is on high-current operation and high-power dissipation, giving the transistors somewhat different characteristics.

In addition, output circuits are designed to operate the transistor close to the limits of the device, where distortion is quite a problem. Thus it seems appropriate to discuss those characteristics which contribute to distortion in power transistors.

Temperature Effects

The reader who has followed this series from the beginning knows that transistors are affected much more by high temperatures than are other electronic parts. There are two main reasons for keeping the temperature down. First, at high temperatures the transistor will not operate well in the circuit, because of large cutoff current and changes in parameters. And second, at high enough temperature the transistor will be damaged.

The first effect will not harm the transistor, but nevertheless it is a real temperature limitation. The second effect is caused by one or more of the following: (1) unwanted impurities on the surface of the germanium or silicon may wander inward at high temperatures, destroying the very delicate donor and acceptor impurity balances; or (2) the indium alloy used in making the emitter and collector regions may melt; or (3) the donor or acceptor impurities themselves may wander about because of increased vibration from the higher temperatures, destroying the sharp junctions necessary for transistor action.

Fig. 1. Examples of two typical high-power transistors for output-stage use.

For these reasons, do not operate or store a power transistor (or any other transistor, for that matter) above its maximum rated temperature, which is around 80° to 100° C. for germanium transistors and 150° C. or higher for silicon models. If the temperature limit imposed by the increased cutoff current is lower than the storage temperature limit, you can't operate the transistor even as high as the latter figures.

Removing the Heat

Design of power transistors involves not only the electrical properties but the thermal properties as well. All the power dissipated in a transistor appears as heat, and unless you get rid of this heat efficiently, the transistor will heat up and, possibly, be destroyed.

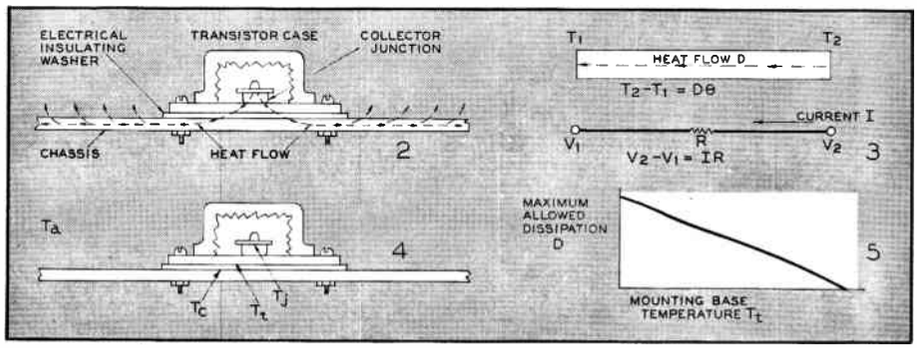
Typical modern high-power transistors are shown in Fig. 1. The transistors are made to bolt securely on a radiating fin or chassis, and the collector junction, which generates most of the heat, is located close to the copper mounting.

Fig. 2 shows a cutaway view of a power transistor. As the dotted lines representing heat flow indicate, the heat comes out of the collector junction where it is generated, through the transistor mounting base, through the insulating washer, and through the chassis to the surrounding air. The collector junction — which is the hottest point in the transistor — will obviously be hotter than the ambient air, and it is important to know just how much hotter it is.

The formulas governing heat flow are very much like the formulas governing simple electrical circuits, so it is not difficult to compute how hot the collector junction is.

Heat flows through a material only because one end is hotter than the other. As Fig. 3 indicates, the difference in temperature between end 2 and end 1 of a rod of material, $(T_1 - T_2)$, is equal

Fig. 2 shows a cutaway view of a power transistor, and Fig. 3 diagrams the heat flow. Fig. 4 illustrates the thermal circuit, and Fig. 5 is a "derating" curve.



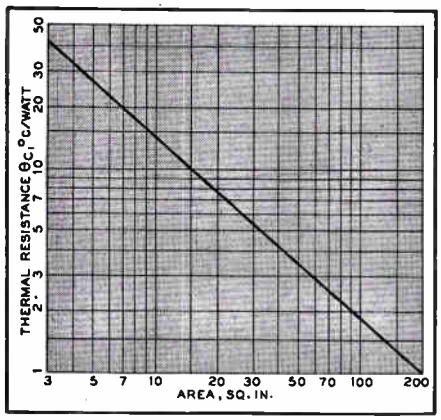


Fig. 6. Curve indicates the thermal resistance of chassis to heat flow.

to a constant θ times the heat flow D. θ is known as the thermal resistance, by analogy with the similar electrical quantity. In the bottom half of Fig. 3, the voltage across a resistor, $(V_2 - V_1)$, is just equal to a constant R (the resistance) times the current I flowing through the resistor. If you think of the two situations you will find much in common. Thermal resistances combine together in series and in parallel the same way electrical resistances do.

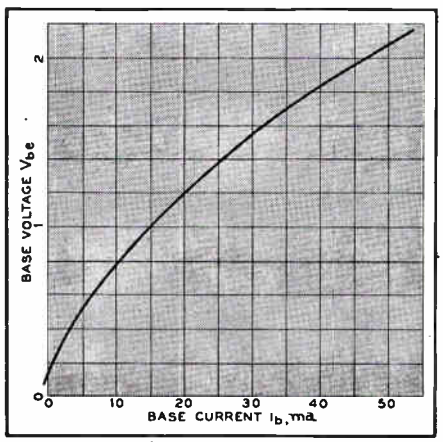
Because of this analogy, you can use your knowledge of electrical circuits to advantage in analyzing the heat flow problem. Fig. 4 shows a little more clearly the thermal circuit: it is the temperature drop across the transistor proper, $(T_j - T_t)$, the temperature drop across the insulating washer, $(T_t - T_c)$, and the temperature drop from the chassis to the surrounding air, $(T_c - T_a)$. If we call the three corresponding thermal resistances θ_t, θ_w, and θ_c, then the junction temperature T_j is

$$T_j = (\theta_t + \theta_w + \theta_c) D + T_a \ldots (1)$$

where, as in Fig. 4, T_a is the temperature of the air.

Each of the three thermal resistances is easy to calculate. The transistor manufacturer usually gives the value of θ_t in his specification sheet, or else supplies a "derating curve" like Fig. 5, from which the thermal resistance θ_t is just

Fig. 9. "Input-characteristic" curve reflects important cause of distortion.



the difference in temperature over which 1 watt more or less dissipation is allowed.

Do not be misled by a plot such as Fig. 5, incidentally, into thinking that you can actually safely dissipate the power indicated. The scale on the bottom reads "Transistor mounting-base temperature," which is of course considerably higher than the ambient temperature!

The thermal resistance of the insulating washer depends on its thickness. Mica washers usually run about 0.3° C/watt thermal resistance, for each mil of thickness,* meaning the usual 1- or 2-mil washers would run about 0.5° C/watt.

Anodized aluminum washers are also available with roughly the same thermal resistance.

The insulating washer is used only, of course, when the mounting base of the

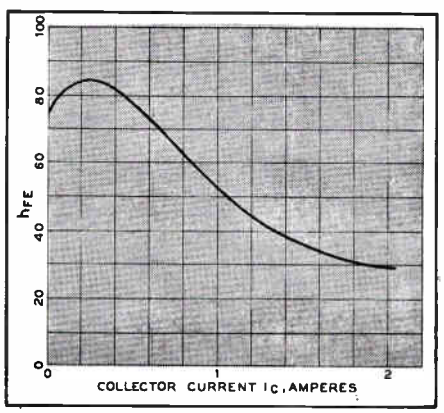


Fig. 8. The "beta-fall-off" curve.

transistor cannot be electrically tied to the chassis. When no washer is used, call θ_t zero.

It is supposed that the insulator is making good thermal contact to the surfaces it touches. If the transistor is mounted "dry" there will inevitably be air gaps interrupting the heat flow. To keep these out, some material must be put between the surfaces to fill up these holes. Silicone grease is sometimes used, but ordinary nonconducting automobile grease is just as good. Apply it to both sides of the washer before mounting the transistor.

The thermal resistance of the chassis-to-air heat flow, θ_c, can be read from Fig. 6. The curve shown is for the case in which both sides of the chassis are exposed to free air. If the chassis surface is horizontal and only the air on top is free, multiply the thermal resistance from Fig. 6 by 1.5; if only the bottom air is free, multiply by 3. If the chassis surface is vertical and only one side has free air on it, multiply by 2.

The curve shown in Fig. 6 applies to pieces whose longest dimension is less than 25 in. Aluminum chassis are better

*A mil is .001 in.

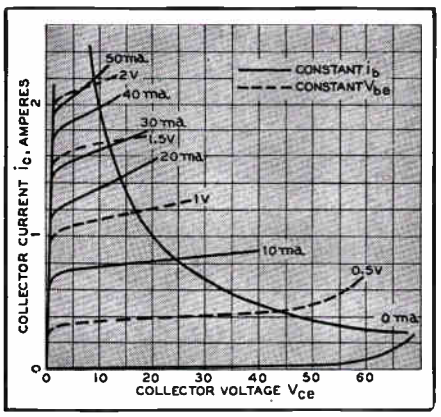


Fig. 7. Typical set of characteristic curves for a modern power transistor.

than steel ones for heat-removing purposes.

It should be mentioned that the free-air method of removing heat, described above, is the most common but not the only method. Some transistors come equipped with fins which help to get rid of the heat by acting as so much more surface exposed to air. Sometimes transistors are cooled by forced air; that is, air is blown against the transistor or chassis by a fan.

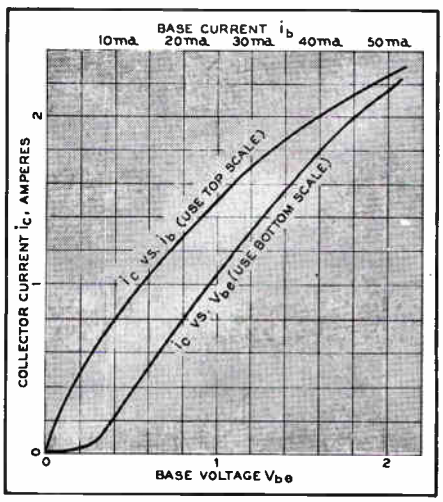
Water-cooling transistors is also possible but not too practical, since the expense and bulk of water-cooling (or refrigerating) equipment would be more than the expense and bulk of equivalent vacuum tubes which could run at higher temperatures.

Power-Transistor Electrical Features

Power transistors have roughly the same type of volt-ampere curves as were shown for transistors in general in Part 3 of this series. A typical set of characteristic curves is shown in Fig. 7. Note that both the base-to-emitter voltage v_{be} and the base current i_b are used as running parameters. Although really all the information we need for circuit design is contained in this graph, it helps to look

Continued on page 43

Fig. 10. Nonlinearities as shown here create most of transistor distortion.



Are you troubled by speed irregularities, dropouts, or fading highs? Maybe your transport mechanism is due for an overhaul. Here's how to go about it.

A WEEK or so ago I became involved in a heated discussion with an indignant young man who wanted to know why tape manufacturers couldn't be a little more careful about their quality control. He was firmly convinced that all makers of recording tape were taking the gullible buying public[1] for a ride by selling shoddy products, and then blaming their poor performance on the tape recorders with which they were used.

Bit by bit the story came out. He had just bought a highly touted nonprofessional tape recorder for several hundred dollars, and every time he recorded something with it, dead spots and uneven high-frequency response were apparent when the tape was played back. He had observed that when he re-recorded some of his defective tapes using different program material, the same defects appeared at the same spots on the tape, so of course the trouble had to be with the tape.

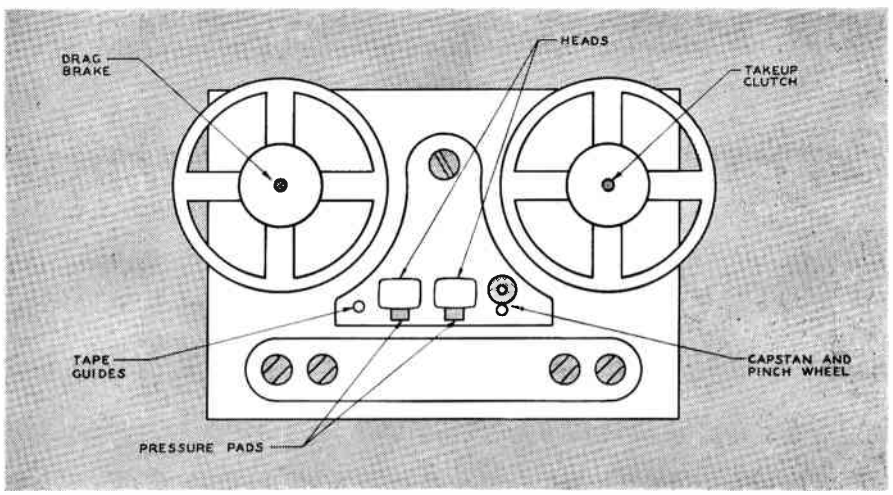
He had penned insulting letters to a few of the tape companies, and two of them had seen fit to answer with the thoroughly untenable intimation that his *tape recorder* was at fault. This did not sit well with the young man, and he nearly became violent when I told him that his recorder did in fact have a reputation for being susceptible to dropouts and varying high-frequency response. He laid aside his brass knuckles when I added that there *was* something he could do about it. I'm glad to be able to report that he licked his troubles with nothing more than a screw driver and a standard alignment tape.

Unfortunately, all such problems are not so easily eliminated as his were, but most of them can be ironed out to the point where they will constitute nothing more than a minor annoyance.

The most common complaint is, of course, speed variation — wow, flutter, and irregular changes in speed that may occur once a week or several times a minute. If the recorder has never had particularly good speed regulation, there probably isn't much that can be done about it unless the factory is willing to tackle it. Speed variation that develops in a previously satisfactory machine, however, is usually traceable to dirt or misadjustment of the drive system, the drag brakes, or the take-up clutch. The first thing to do is to open up the mechanism and carefully clean all pulleys, belts, idlers, and brake drums with gasoline or with the cleaning fluid sold under the name of Long Life. Nonlubricated friction-drag devices such as clutches and brakes should be wiped with cleaning solvent; very few tape recorders use lubricated brakes, and, if the service manual does not plainly specify oiling one or more of these pads, the presence of oil on them is an unmistakable sign of trouble.

A dirty or oily brake or clutch pad may be cleaned by dropping the entire pad assembly into a container of solvent, kneading the pad with the fingers to work the oil out of it. Then dry it by pressing it against a piece of blotting

Fig. 1. The arrows point to potential trouble spots in a typical tape recorder.



[1] I understand that it is customary in such discussions about "the consumer" to picture him as a dim-witted boob with one hand over his eyes and the other digging for his wallet.

paper, and let it stand overnight before reinstalling it.

If the recorder is new, it should not need lubricating unless any pulleys are obviously bone dry. One that has been used for some time will probably need oiling; follow the instructions in the service manual, being careful *not* to overoil anything. Next, clean the heads, tape guides, capstan, and pinch wheel, and if the recorder uses head pressure pads, clean these too.

Put the whole thing back together again and listen to the 3,000-cps flutter-test section of a standard test tape.[2] The cleaning procedure outlined above should have cleared up most cases of speed variation, but if wow or flutter is still excessive, note the rate at which the variations occur and then look for that part of the drive system which is revolving at the same rate. This part will probably be the source of the trouble, and should be checked for eccentricity, binding bearings, dents, and burrs on its contact surface, and for excessive bearing play.

Flutter, wow, and noncyclic variations in speed are often caused by slippage of the tape on the capstan or by incorrect take-up or drag-brake tensions. If the capstan system is gripping the tape properly, it should be possible to break a 1-mil (extra-play) acetate tape or to stall the capstan drive by holding the tape while the recorder is running. This is not true of all recorders, but if slippage does occur when the tape is held back, see what the service manual has to say about it before overlooking this as a possible source of trouble.

Take-up and holdback tensions are often fairly critical, and if these are badly out of whack they can accelerate head wear and permanently damage tapes by stretching them out of shape. Spillage or stretching when switching out of high-speed modes may be the result of poor synchronization between the feed and tape-up-reel braking systems. Check these against the recommendations in the service manual.

[2]A flutter test tape may be made by recording a 3,000-cps signal from an audio oscillator, although the "doubling" of speed variation that takes place when playing this will make it more difficult to recognize its repetition rate.

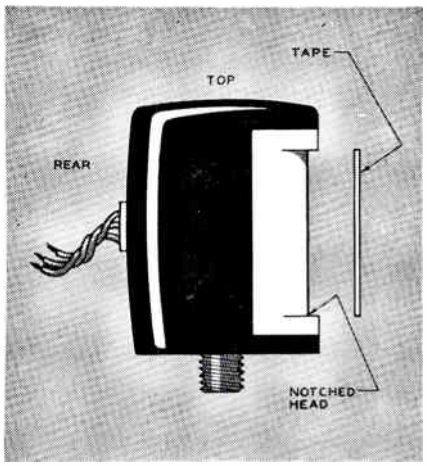


Fig. 2. Abrasive action of tape passage can wear sharp notches in head surface.

Tape burbles are random interruptions of tape travel, caused by a sticky splice or by a burr on the edge of the feed reel catching on the tape. Burbles cannot always be entirely avoided, but they can be minimized simply by not using sticky tapes or defective reels.

Some current-model recorders depend entirely upon holdback braking tension to maintain intimate tape-to-head contact, and anything that causes a burble on such a recorder will break this contact and create a dropout as well. Dropouts — random losses of signal — are generally induced by interruptions of tape travel or by imperfect head alignment. Clumps of unhomogenized oxide on the tape may cause dropouts, but these nodules are rarely encountered on high-quality recording tapes.

A recorder which uses head pressure pads will not be susceptible to dropouts, or to varying high-frequency response due to fluctuating contact, as long as the pads are kept clean and are replaced as soon as they wear to about half the original thickness. When holdback tension is the sole source of head contact, head wear will be slower and more even, but susceptibility to dropouts may be quite a bit more pronounced, particularly if the heads are not properly aligned or have become notched from tape abrasion.

Fig. 2 shows how these wear notches can form a "channel" virtually the same width as the tape across the pole pieces. As long as the tape is perfectly straight the notch shoulders will not interfere with its motion in any way. If, however, the tape has developed any longitudinal bends, it will occasionally ride up over the shoulders and cause loss of highs or a mild dropout. If notching becomes bad enough to be troublesome, the head(s) should be replaced or returned to the manufacturer for honing.

On non-pressure-pad recorders, a much more serious (and common) cause of dropouts is backward or forward leaning of the heads. A head that is canted forward, for instance, will bear more heavily on the upper part of the tape, so that as soon as there is a momentary letup in tension, contact may be lost at the bottom of the head. A canted head will also wear out fairly rapidly and unevenly.

Head canting is best spotted by exposing the heads and then bouncing a light off the surface of the tape where it folds over the head. With the drag brake partially released and the recorder running, perfect contact with a new head will create a light reflection of uniform width (Fig. 3). Figs. 4 and 5 show a couple of the patterns obtained when tape contact is *not* all that it might be, or when heads are badly or unevenly worn.

Head canting can usually be remedied by simply juggling the head fastening screws back and forth or by shimming up the head with thin pieces of celluloid until the light pattern looks as close to ideal as possible. Then use an alignment tape to trim up the azimuth alignment.

Actually, a recording head is not likely to become canted in normal use, and so does not have to be checked for it very often. Occasionally, however, a new recorder will have somewhat canted heads — as was true of the one bought by the indignant young man. It is wise to check this before coming to trust implicitly the ability of a new machine to turn out top-fi tapes with the consistency of a professional studio recorder.

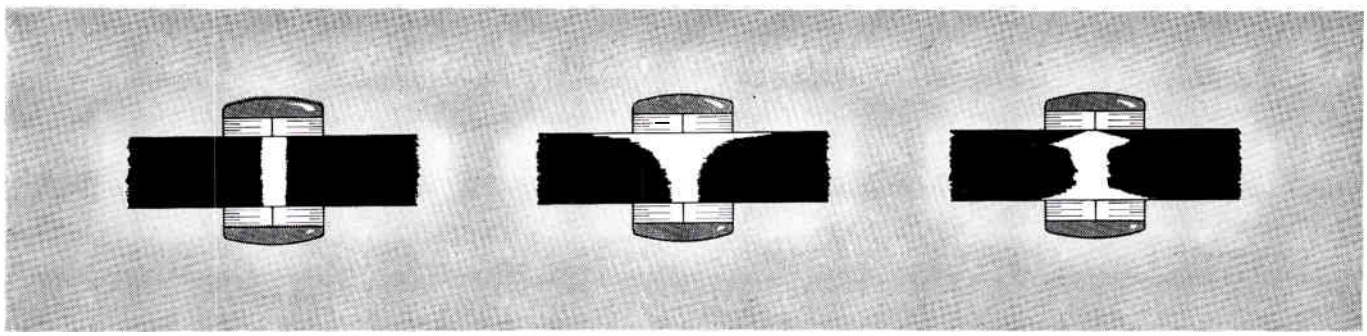
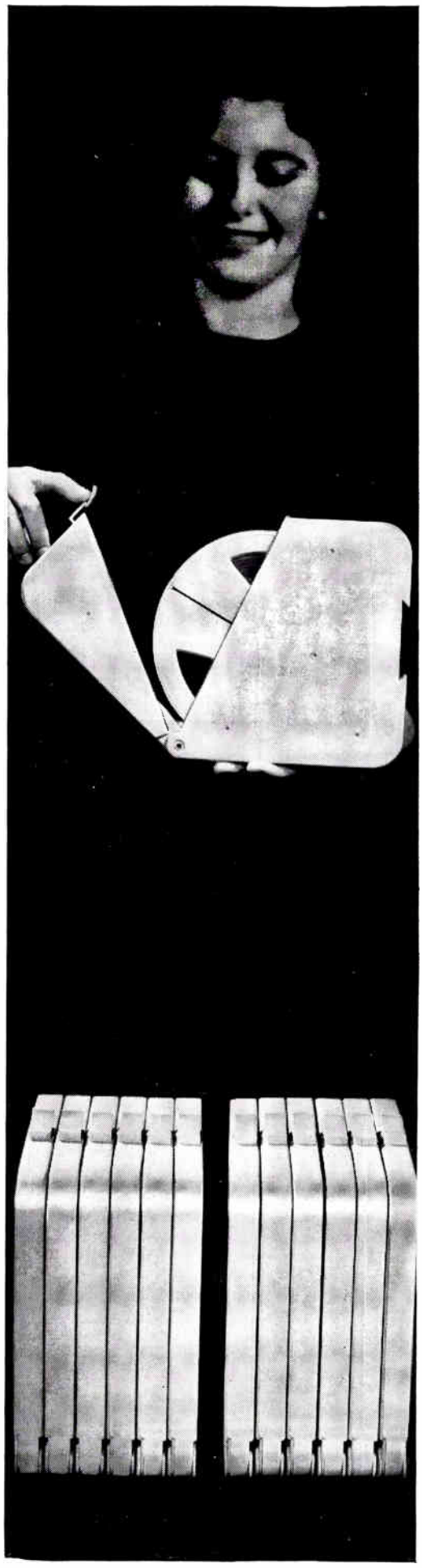


Fig. 3. Perfect head contact creates a light-reflection pattern of equal width.

Fig. 4. Spreading pattern indicates extreme head wear or poor tape contact.

Fig. 5. Broad reflections at edges of tape show presence of wear notches.



SONORAMIC

THE QUALITY RECORDING TAPE IN THE NEW PERMANENT PLASTIC CONTAINER

Sure, Sonoramic might cost a few pennies more. *But*—it buys you the unique protection and convenience of Sonoramic's new permanent plastic container.

This exclusive product is a high impact, shatterproof, polystyrene box styled in a handsome slote gray. The container protects tape against dust and dirt; opens at the flick of a finger; stacks neatly side by side on shelf, bookcase, table or can be mounted on a wall. It also comes with a handy indexing system on pressure-sensitive labels which is keyed to the unique Ferrodynamics *Selection Finder* reel.

More important—the box holds Sonoramic's new wide latitude recording tape.

This tape is a giant step forward in recording tape engineering. It guarantees the user distortion-free recording and maximum performance regardless of make of recorder, line voltage fluctuations and tube age and head condition. Lubricated-for-a-lifetime too, to eliminate squeal, layer-to-layer adhesion and deposits on heads.

Feature of the new Sonoramic line is the Tensilized Double-Play Mylar*—2400 feet on a 7″ reel—which is twice as strong as ordinary magnetic tapes with the same playing time. Whatever your tape needs—for the home or for professional use—you'll find a Sonoramic tape to fit your needs.

For extra convenience, and at no extra cost, the tape comes in the exclusive Ferrodynamics easy-to-thread V-slot *Selection Finder* reel.

*A Du Pont trademark.

To the first 50 people who respond to this advertisement—we'll be happy to send out a free Sonoramic tape container. (And if you're not in the first 50, we've a pleasant surprise for you anyhow.)
Write to Dept. D-103, Ferrodynamics Corporation, Lodi, New Jersey.

SONORAMIC IS A PRODUCT OF THE

Ferrodynamics CORPORATION
LODI, NEW JERSEY

Detachable Speaker Rings

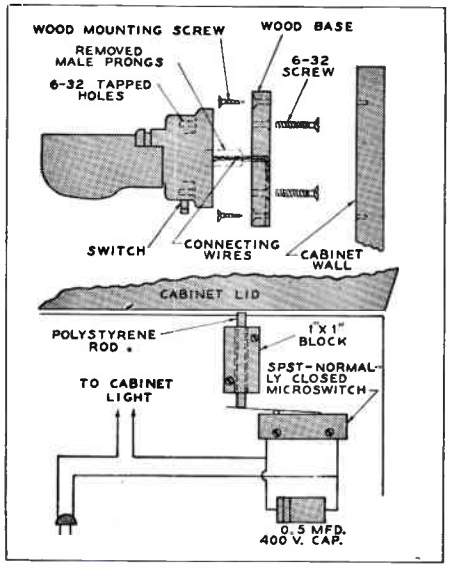
In reference to Mr. Wynn's suggestion [see Oct. 57 issue, p. 31] for preventing the cardboard speaker ring from sticking to the mounting board, I would suggest simply rubbing the contact surface with a wax candle or block of paraffin.

Lt. Cmdr. F. W. Ewald
Oahu, Hawaii

Light For Equipment Cabinet

When the average music listener with a components music system finally gets around to putting these into a cabinet the problem of a light for the inside of the cabinet usually arises. In looking for a suitable unit for such a purpose, two requirements must be kept in mind: a bulb large enough to do the job and a unit small enough to fit conveniently into the cabinet.

While radio supply houses list panel lights of various sorts, a commercially available night light found in a hardware store fits the bill very nicely. The unit I used was a Snapit light with prongs designed to fit directly into a wall outlet. These were covered with a friction-fit fiber insulator to cover the base of the unit which housed the socket and the switch. This insulation was easily removable and, since I did not want the additional bulk of a female socket for the



light, I removed the fibre cover around the male prongs and bent these out so that they could be clipped off (or sawed with a small hack saw). Two No. 20 hookup wires were then soldered to the stubs of the male prongs, which were now cut short enough to allow the unit to be mounted flush with its base. There were two convenient holes already in the plastic of the switch housing which were tapped to take a 6-32 screw. A small square of ¼-inch-thick wood was cut slightly larger than the diameter of the light base to serve as a new base for the lamp. Two holes were drilled to match the tapped holes and two for mounting screws. The base was sanded and stained to match the interior of the cabinet and a hole cut for the wires with a groove for them in the back of the new base.

The bulb is a 7-watt type that has relatively long life and is readily available for replacement. The Snapit light comes with an ON-OFF switch on the side which can be used to operate the light.

Since the light was used in a cabinet with a lift-up top it was decided to make the light switch automatic, so that it would go on when the top was opened. A small microswitch was secured from a surplus counter in a radio supply house. This was mounted, out of sight under other equipment, on the wall of the cabinet. It was of the normally closed type with a long extension wafer to actuate the switch. Above this wafer a 1-by-1-inch piece some 3 in. long was mounted, through which a hole slightly larger than ¼ in. had been drilled. The hole acted as a guide for a ¼-inch piece of polystyrene rod. The position of the switch was adjusted so that when the top of the cabinet was closed the rod pressed the switch open, turning off the light (See diagram). A 0.5-μfd 400-volt paper capacitor across the switch terminals completed the installation.

Edward T. Dell, Jr.
Millis, Mass.

Hardware Sorter

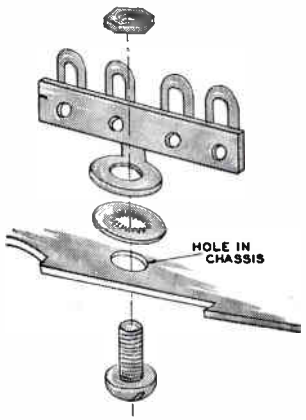
When building a kit, it's a nuisance to have to look through a pile of assorted hardware for just the right nut, washer, solder lug, spacer, or what-have-you. To keep the little beggars sorted and within easy reach, I tried driving several 2-inch nails all the way through a 4-by-8-inch piece of ⅛-inch wood (the top of a cigar box or even a piece of heavy corrugated cardboard would do very well) about 1½ in. apart. Then I strung each kind of hardware on a separate nail. Make sure that you have at least one nail that is skinny enough for 3-48 nuts.

Eleanore B. Wright
Sheffield, Mass.

Restless Tie Points

Anyone who has tried to cinch down the nut and bolt holding a tie point to a chassis knows what a squirmy little cuss it can be. Inevitably, the last twist of the screw driver will turn the whole works out of line; then, to get it straight, you must loosen the screw and start all over.

Try placing the lock washer between the tie-point foot and the chassis, rather



than directly under the nut. The little teeth on the lock washer grip the two metal parts and everything stays put without the usual juggling and fussing.

L. E. Johnston
Madison, Wis.

Radioactive Dust Brush

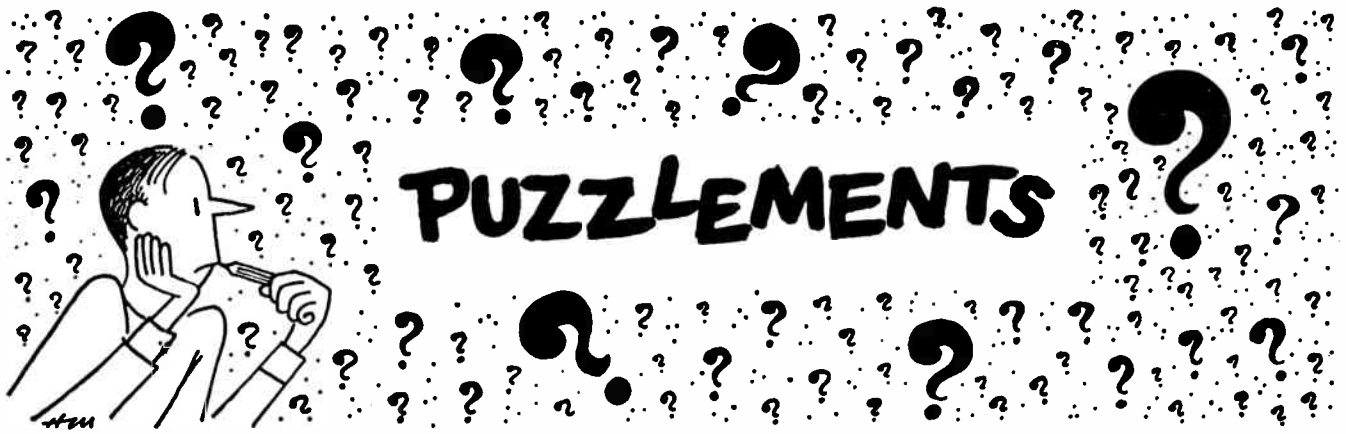
A radioactive record brush can be made very simply. Place the pickup with the needle resting on a piece of cardboard. A ten-cent camel's-hair brush, cut through the ferrule, is leaned at an angle of about 45° against the pickup shell directly in front of the needle and cemented there.

An ordinary commercial radioactive capsule can then be cemented between the brush and the needle.

The brush sweeps each record clean of dust as it is being played. No static charge is built up because the surrounding air is ionized by the action of the radioactive capsule. The weight of the brush and capsule is not great enough to affect the action of the pickup arm.

L. M. Garrett, M.D.
Corpus Christi, Tex.

What is the best setting of volume controls and input levels to guarantee least distortion and noise?



by NORMAN H. CROWHURST

WHY should a pickup cause distortion on my preamplifier at home, when it did not on the demonstration preamplifier at the store where I bought it? Could the input impedance of my preamplifier be wrong, or something?" When this question was asked, I thought at first that perhaps the distortion of which my questioner spoke was disturbed frequency response brought about by working the pickup into too low an input resistance, for example.

This will cause loss of high frequencies in many magnetic or moving-coil cartridges. In the case of a crystal or ceramic, working into too low an input resistance will cause loss of low frequencies. But this was not the explanation in this case. He really meant *distortion.* He went on to explain that when he played the pickup at home it "broke up" on loud passages, which it did not do when it was played at the store.

Well, one possible explanation of this could be that his previous pickup had ruined his record but did not show the distortion it produced. This is noticed quite frequently in changing to an improved pickup. For example, a pickup that has an inferior high-frequency response may damage or destroy the high-frequency component in the recording. Because it does not respond to these frequencies the reproduction from it may sound quite good in spite of this damage. But when an improved pickup is used to play the same disc it does respond to the higher frequencies; and the fact that the previous pickup has caused damage makes the reproduction now sound distorted.

If this is the explanation, of course it can always be discovered by playing some new discs that have not been played with the older pickup. In this particular case, this check had been made and still the distortion was present when louder passages were played.

Next I asked him whether he had noticed a difference in the setting of his volume control with this pickup compared with the old one. Was it possible that the volume did not need to be turned up so far to get the same loudness with this pickup? He had not particularly noticed, but he thought it was possible that the same loudness might be reached when the control was a whisker lower down.

As he wasn't too sure about this, the next step was to pull out the schematic for his particular preamplifier. It proved to follow the general arrangement depicted in Fig. 1. The volume or gain control was immediately before the output stage. This means that a pickup giving a higher-level output may cause some stage before the gain control to run into distortion, although the gain control may be turned down so that the level fed to the power amplifier is still well within distortion limits. Of course, this makes it exhibit the same symptoms as if the pickup itself were distorting: turning the gain down does not eliminate the distortion *before* the control; it only turns down the volume it produces.

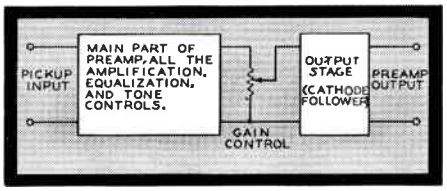


Fig. 1. Basic arrangement of the preamp discussed in this month's puzzlement.

The input resistance for the preamplifier was 47 K and that specified for the particular pickup was also 47 K — nothing wrong here. But probably the output from the pickup was about 6 db higher than that which the preamplifier had been designed to handle.

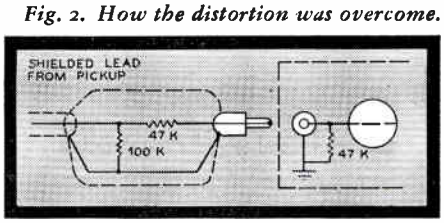
Since the gain control has a logarithmic taper designed to accommodate at least 40 db change in gain from one end to the other, a matter of 6 db would be only about one number difference on the marked scale — about the kind of difference one might expect between one recording and another. Consequently it would not be surprising that the user did not notice the fact it was operating at a slightly lower position.

The quickest way to check this would be to insert some attenuation at the input and see whether or not it removes the distortion. To achieve 6 db attenuation, a 47-K resistor in series with the input will halve the voltage, while a 100-K resistor in shunt will result in the correct loading resistance for the pickup, as shown in Fig. 2.

This, of course, should be connected close up to the input socket and carefully shielded. Making up a small attenuator of this sort and temporarily shielding it with aluminum foil, we attached it to the preamplifier. The pickup now behaved perfectly without producing any distortion on the loud passages. Since then my friend has put the attenuator in a neat little box mounted on the back of his preamplifier, and is very happy with his new pickup.

This is just one of the troubles that high-fidelity equipment users can get into by incorrect use of volume or gain controls. In this case it would appear to be poor design on the part of the pre-

Fig. 2. How the distortion was overcome.



amplifier. After all, one is entitled to expect that a preamplifier should handle any of the usual group of magnetic pickups at the low-level input, and any of the crystal or ceramic group at the high-level input.

For this purpose, the gain control — or at least part of it, if a ganged dual arrangement is used — should be nearer the front end of the preamplifier, to insure that operation with a pickup giving more output than average does not cause distortion of some later stage.

Logically, equalization and gain control should both come quite early in a preamplifier. Tone controls can come a little later, and a loudness control may be immediately before the output, because this serves a different function from the gain control. The purpose of a loudness control is to alter the level at which the program is played. Consequently, turning down the loudness control is not likely to result in any distortion, because the gain control should take care of the maximum level that a given record will deliver.

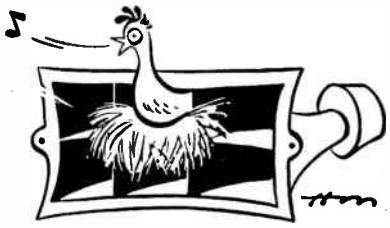
But another wrong use of volume controls that can result in poor performance concerns the relative adjustment of the control on the preamplifier and the one on the basic amplifier, which is usually intended to be preset. The confusion can of course be complicated if one has a basic amplifier with a gain control and a preamplifier with both a gain control and a loudness control.

Whatever the combination of controls, the system should be operated so the output from the preamplifier at the maximum loudness level you will ever want to hear is about the maximum output level the preamplifier will give before beginning to run into distortion. This will probably be a position with both the gain controls at an intermediate setting; that is, with neither of them turned all the way up.

There seems to be a strong temptation to arrange the system so that one or the other of the controls is wide open to give the maximum desirable loudness. Suppose the basic amplifier is capable of 50 watts for 0.5 v input, and the maximum loudness you need in your living room requires only about 0.1 v input to the amplifier. If the basic amplifier has its gain control turned all the way up, then the gain control on the preamplifier must be turned pretty well down so that at maximum loudness the preamplifier gives only a peak audio output of 0.1 v. This means the background noise and hum from the preamp-control stages beyond the gain control can be larger than necessary, possibly by 20 db or more, and can result in more hum and noise from the system. This will be worse if the preamplifier gain control is used to operate the system at even lower levels: the audio will turn down

Continued on page 40

Reviews of highest-fi disc



Sound-Fanciers'

THE Big News at the moment I write (likely to be even bigger by the time these lines appear in print) is of course that onetime wild dream of hi-fi pie in the sky: the *stereo disc*. Contrary to my skeptical expectations, developments have been fantastically speeded up and it already appears that the vital question of a standard processing system has been settled — in favor of the Westrex 45/45 groove-cutting technique. At least it is this system which has been employed both for the first stereo disc to be produced for within-the-industry circulation and the first American experimental pickup models.

I haven't yet gotten my itching fingers on (or even been able to hear the latest preview demonstrations of) either the Fairchild or Pickering stereo-cartridge prototypes, and so haven't yet been able to play stereophonically the most exciting disc in my bulging Christmas stocking: Audio Fidelity's pioneering "Compatible Demonstration Record for Test and Laboratory Purposes," AFLP 1872. It isn't available to the public, but is accompanied by the welcome news that, when stereo AFLP's are produced for general release, the price tag will be no higher than that for this company's conventional LP's — $5.95.

Preliminary Compatibility Report

Now, one swallow of course isn't adequate proof that summer is actually here, but at least the first one is a sure harbinger of its imminent approach. It won't be long now. Meanwhile, it behooves all of us to keep our enthusiasm within reasonable bounds and to remember that so revolutionary a new era can't possibly usher in — immediately — an audio millennium. Until I can check for myself the stereo reproduction of the present disc and the other companies' prototypes which should soon follow it, I can only provide, at this time, a none too enthusiastic and quite tentative evaluation of the claim to compatibility as judged by a single-channel performance with a standard LP pickup equipped with a one-mil stylus rather than the half-mil one utilized in the new stereo-cartridge designs.

Being luckier (or more insistent) than Mr. Darrell, we were able to get our hands on a Fairchild prototype stereo pickup and so could hear AFLP 1872 in 3-D. It is very, very good — nearly as good as the equivalent stereo tape played on a professional-quality machine. The technical quality is so close to that of present monophonic discs that any differences are of negligible importance, compared to the marked improvement in realism conveyed by stereo. The pickup played monophonic discs in excellent fashion also.

We know that Mr. Darrell's standard pickup is of a type that has high vertical compliance over a limited excursion range. This is no disadvantage for standard records, but it is for stereo records which have considerable vertical groove motion. His dissatisfaction is undoubtedly caused by this cartridge limitation. Playing AFLP 1872 with a standard cartridge having greater vertical excursion capability, we found the resulting monophonic sound to be of quite good technical quality; whether continued playing with such a cartridge would damage the record for later stereo use remains to be seen. — ED.

The present stereo disc is indeed playable monaurally in this way and both channels seem reasonably well represented and blended, but the quality is (as probably must be expected) far below that of the regular LP processings of the same recorded materials. Aurally,

Guide

by R. D. DARRELL

the single-channel playback of the disc is perhaps passable (not unlike that of the earliest LP's as reproduced with the then available microgroove pickups), but tonally rather bodiless and certainly not free from distortion. I'm sure this might sound acceptable enough to an indiscriminating audio novice, but when it is compared with the standard LP versions, it gives only a hint of the wide frequency range, dynamic impact, and crispness of transient response for which Audio Fidelity is deservedly celebrated.

Just to make sure of this, I immediately went back to the original LP's (AFLP 1851 and 1843) of the Dukes of Dixieland *Marching Along* selections and the excerpts from *Railway Sounds: Steam and Diesel* which are represented in the stereodisc prototype. The former, which I reviewed so enthusiastically last October, still strikes me as a sonic masterpiece; and the latter, which I had heard before only in show demonstrations last fall, proved to be equally impressive technically, although perhaps lacking a bit in drama, since, for all its superb documentation of clanks, chuffs, bells, and horns, it fails to include any of the high-speed, roaring-past express trains which were so electrifying in the memorable *Rail Dynamics* disc with which Emory Cook first achieved fame away back in 1951. But of course the real test still remains to be made in direct stereo comparisons of the new disc versions with those released earlier on tape. I still haven't received the railway reel (AFST 1843), but my unqualified delight in the Dukes' Vol. 3 (AFST 1851) was expressed here in last January's column — and if the stereo disc, in true stereo reproduction, can come even close to that, the success of the new two-channel groove medium will certainly be assured.

The New Approach to New Music

One thing is sure: no one is more likely to welcome the opening of a second stereo front than the contemporary composer, who got his first real break in years when LP's came along to bring his works to infinitely more listeners

Continued on page 44

STEREO

Continued from page 21

off-the-air recordings. It will make a stereo recorder virtually indispensable.

We have been talking about stereo tapes and stereo taping. Let's look at monaural tape and taping for a while. One virtue of tape, monophonic *or* stereo, is that it can be used to record something broadcast at an inconvenient time. Assume that you live in New York and like to listen to the New York Philharmonic Symphony every Sunday (3:05 through 4:30 P.M.). To listen means that you'll miss Wide Wide World, Omnibus, or any of the many fine television programs that seem to be confined to Sunday afternoons. These conflict with the Philharmonic. If you must decide between them, you are being cheated — there is no need to miss either. With a tape recorder in the house, you can record the Philharmonic while you watch television. In its most simple (and probably most costly) form, you need another television set not connected to your sound system, and a tape recorder connected to your tuner (or whatever you wish to record). The recorder preserves the concert while you do something else.

Another, less costly method would be to connect the recorder to the "recorder output" (if you have such) of your tuner, while you set the main selector switch of your system to TV. There is one catch here: most good audio equipment has a selector switch that shorts out all the inputs not in use at the time, to prevent crosstalk. This would prevent the use of your tuner and TV simultaneously, because the output from the tuner would be automatically shorted by the selector. Thus, you would have to unplug the tuner from the control unit. Since the small phono plugs and jacks will not take too much plugging and unplugging, a switch will have to be inserted.

Such a switch need only be an SPST (single-pole, single-throw) toggle switch mounted in a small aluminum box with two phono jacks mounted thereon. The unit is so wired that, with the switch on, there is a through connection between the tuner and the control; with the switch off, this connection is broken. In use, the switch is normally left on. When you wish to record from the tuner while listening to something else, merely set the switch to the OFF position and proceed. Use shielded wire throughout to prevent hum pickup, and keep all leads as short as possible. One such switch can be made for each input so that you can record from any of them. For stereo, use a double-pole, single-throw switch (DPST) and four phono jacks.

There is one minor fault with this device: you can forget to throw the

Continued on page 38

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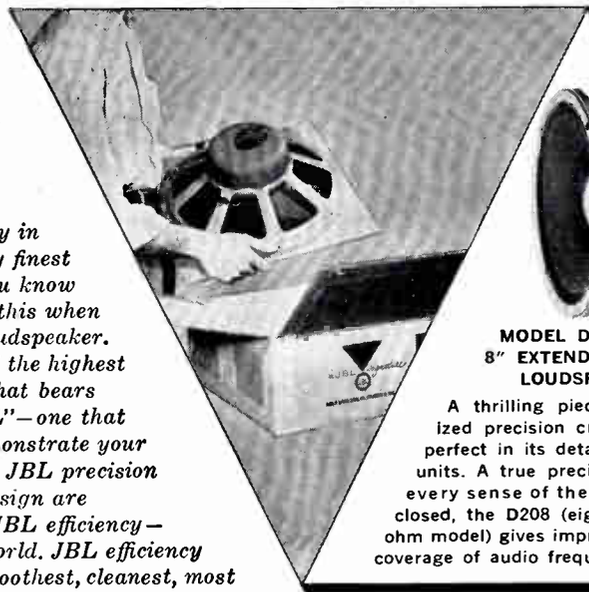

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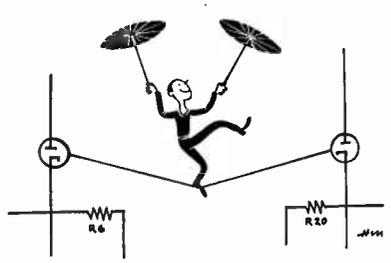
STEREO

Continued from page 36

switch to the ON position after use. The gadget described in the box on page 21 remembers for you.

Having been sidetracked by the technical for a moment, let us study how recording off the air applies to stereo. It has already been mentioned that stereocasting is bound to increase as we get more stereo discs. This, in turn, means that stations and networks will have to build stereocasting facilities. Is it not then logical to assume that there will be stereocasting of live events on a routine basis? Once this becomes the case, we will be able to record live stereo off the air extensively. Don't forget that far too many good concerts and the like are not recorded for release to the public, but are broadcast only. There are just too many good things for record companies to record them all. They wisely prefer to remain with the standards, which are good commercial ventures, and which they can sell a lot of. Again, let us not get sidetracked here. Back to the main track: with a stereo recorder you will be able to record and save these



memorable events. It is clear that a stereo recorder will be a handy thing to have around. We can assume, from the above, that there will be a lot of these machines sold. And if there are many recorders in use, there will certainly be a market for recorded stereo tapes.

It should be pointed out that throughout this article I have been talking about a quality tape recorder. I do not mean to imply that package tape recorders are worthless, or anything of the sort. I do say that they do not fit into the scheme of a high-fidelity system. For a tape recorder to be a part of such a system, it should not be a packaged unit. It should have no built-in power amplifier or speaker; they duplicate those in the hi-fi system, without their quality.

By now, it should be apparent that I don't think much of what the skeptics are saying about the future of tape. Tape will become more and more important to the home listener; and it will be a smart man who early recognizes its potential, and uses every bit of it. See your audio dealer today. Talk tape with him — he'll be happy to help you.

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FM specifications include grounded-grid triode law naise front end with triode mixer, double-tuned dual limiters with Foster-Seeley discriminator, less than 1% harmanic distartian, frequency respanse 20-20,000 cps ± ½ db, full 200 kc bandwidth and sensitivity of 2 microvolts for 30 db quieting with full limiting at one microvalt. AM specifications include 3 stages af AVC, 10 kc whistle filter, built-in ferrite laap antenna, less than 1% harmonic distartian, sensitivity of 5 microvalts, 8 kc bandwidth and frequency response 20-5000 cps ± 3 db.

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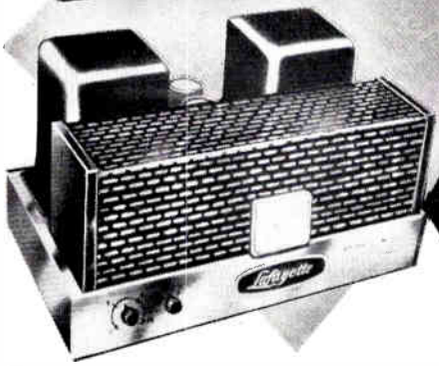

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PUZZLEMENTS

Continued from page 33

with the volume control, but the hum and noise level will stay at the same level as that produced at maximum power.

At the other extreme, some like to have their preamplifier gain control wide open at the maximum desirable loudness in their living room. To achieve this they turn the gain control on the basic amplifier down to the desired setting. This method minimizes hum and noise admirably but can sometimes produce distortion troubles similar to the one with which we started off this discussion. Most preamplifiers are provided with more gain than they are ever likely to need, except perhaps if the most insensitive of pickups happens to be used. But with an average pickup, working the preamplifier wide open will produce a greater output than is needed, with resultant distortion from preamplifier stages *beyond* the volume control. True, the gain control on the input to the basic amplifier will reduce this output to the level proper to give the desired loudness. But it will not eliminate the distortion already produced, this time in the output stages of the preamplifier.

Best results are obtained from a compromise setting in which neither control is operated wide open. The volume control should be adjusted to produce the maximum working voltage for which it is designed, usually in the region of 1 or 2 volts. This is then attenuated by the input control of the basic amplifier so as to give the maximum loudness that will ever be desired in the living room.

Now, to get the best operation throughout one can use the control on the preamplifier to work the system at lower loudness levels. Alternatively, equally good results can usually be obtained, if so desired, by using the input level control on the basic amplifier as a volume control, unless the preamp has a loudness control just for this purpose. There is no trouble provided you don't turn the volume down on one amplifier and then later on turn it up on the other, so as to disturb the correct balance of the settings for maximum loudness.

Sometimes this may happen by one member of the household turning up the volume, on one control, while another member alternately turns it down, using the other one. Either way, you will end up either with an excessive background and hum level, or else with some distortion you didn't begin with. Make sure everyone knows which control you decide upon as the proper one to use.

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GROUNDED EAR

Continued from page 4

its prototype, and is finding rapid acceptance. Only the production of tubes markedly superior to these is likely to recapture the market for American output tubes.

More dismaying to American manufacturers has been the growing use of imported versions of the various hi-fi twin triodes and rectifiers. Again, the initial penetration was due to better performance. My experience is typical. I replaced American 12AX7's and 12AU7's in two preamplifiers with random and unselected British Mullards. In both instances the noise and hum were reduced by more than 6 db. Replacing a 5AW4 with a GZ34, I obtained 25 volts additional plate voltage and higher output on peaks; and the presence of a cathode provided better protection for my four output tubes during warm-up.

Manufacturers tell me that they find the imported double triodes and output tubes far more uniform in characteristics also, and thus they insure closer conformity of production amplifiers to specifications. I understand that the imported tubes are also cheaper to the manufacturers in large lots and this, no doubt, helps them not a little. But basically their popularity is due to their superiority of performance. It is notable that this is the only aspect of high fidelity today in which imported products are superior to the domestic.

I note in a financial journal that some elements of the tube industry are considering asking for greater tariff protection. I trust they will consider instead a solution which would please all and give them far greater future protection: that of rolling up their sleeves and producing better audio tubes.

DYNAKIT

Continued from page 19

existing in an RIAA-equalized record, the proportion was varied to ratios of 1 to 2 and 1 to 4, but the reading was still under 0.1%.

Square-wave response in the flat tone-control positions, with the VOLUME control at maximum, is so good in our model that the preamp can be used to increase the sensitivity of a scope at audio frequencies. Even the 10,000 (Fig. 11) and 20-cps square waves were very close to the original; there was no sign of ringing. The transient response of the preamp alone, with an independent power supply, was better than any test we could devise to try it. Transient performance of a combination of the preamp and a power amplifier sharing the same power supply would depend a great deal on the stability of the power amplifier. With the Dynakit amplifiers for which, presumably, the preamp was tailored, it remains excellent indeed.

Hum and noise are completely insignificant and will be inaudible even with low-level cartridges at any level anybody could possibly tolerate in the home. The gain is sufficient to operate a Fairchild pickup without a transformer, for example, although the loudness compensation is then not of much use.

The preamp's heavy-gauge cabinet provides very good shielding against stray magnetic fields. Since there is little heat to dissipate, the unit can safely be installed in closed spaces such as a turntable base or cabinet.

There can be differences of opinion on such matters as whether three phono equalization curves are sufficient, whether there ought to be input level controls or more and different main controls, and so on. It seems to us that Dynaco has worked out a preamp-control combination that will suit the great majority of people: simple and inexpensive, yet flexible enough to take care of most contingencies and tastes.

But even the most demanding of hi-fi perfectionists could not ask for more performance in terms of the high-fidelity essentials — wide-band response, almost complete freedom from distortion, faithful equalization of modern recordings, and superb transient response.

TRANSISTORS

Continued from page 27

at this same information in different ways to show more clearly the distortion-producing elements.

Fig. 8 shows the common "beta-fall-off" curve, showing the value of h_{FE} for every value of collector current. This quantity h_{FE} is defined as the ratio of collector current i_c to base current i_b, so it is not quite equal to β, or h_{fe}, which is the increase of collector current i_c divided by the small increase of base current which causes it. However, the two curves look very similar.

The theoretical reasons for the rise at low current followed by the dropoff at higher currents are complicated, but the people who design power transistors understand them, and it is quite possible that future transistors will have a more nearly constant value of h_{fe}.

Fig. 9 shows the so-called "input characteristic" which is a chart of how the base current i_b is related to the base-to-emitter voltage v_{be}. Unfortunately, it is decidedly nonlinear — another important cause of distortion. Notice the direction of the nonlinearity: as the voltage is increased, the current at first is very small but soon increases rapidly. This curve was drawn for a particular collector voltage but, as mentioned in Part 3 of this series, the lines for various voltages all fall very close together.

The two nonlinearities shown by these two graphs are the most important ones in a transistor, and account for the majority of the distortion found in power-transistor stages.

One other way of presenting essentially the same information may be even more informative. Fig. 10 shows two plots: one of the collector current (at a constant voltage) as a function of input current, or base current i_b; the other of the same collector current as a function of the input voltage, or the base-to-emitter voltage v_{be}, again at a constant collector voltage.

The gradual curving of the first curve reflects the dropoff in h_{FE}, as we saw in Fig. 8. The second curve has a sharp bend at low collector currents caused by the nonlinear input characteristic, Fig. 9, and it also has a relatively straight portion beyond the point at which the two nonlinearities cancel, being in opposite directions.

The curving of these graphs is important in desgning power transistor stages with low distortion.

Present Uses

Present-day power transistors are not useful at frequencies much above the audio range, with the exception of certain experimental high-frequency types.

It is difficult but not by any means impossible to design a high-fidelity audio

Continued on next page

TRANSISTORS

Continued from preceding page

power stage. But the design is quite a bit easier when response beyond 7,500 cps is not required. For this reason the first applications for power transistors seem to be in auto radios, portable phonographs and other low-fidelity instruments.

There are also a number of nonaudio applications that are interesting. The power oscillator can convert direct current into AC in quantities large enough to be useful. Power transistors will also be found useful in converting AC to DC when used with certain types of rotating generators. And power transistors are used in place of vibrators in many applications, including auto radios. But the major field of application is still audio amplification.

Next month we will take up circuits for power transistors.

SOUND FANCIER

Continued from page 35

than ever could have heard them in isolated concert performances, but who has still been handicapped by the single-channel medium's inadequacy in reproducing spaciously the full variety and richness of sonic colorations characteristic of so much present-day composition. For the sound fancier in particular the ideal approach to new music is via stereo, where, however strange or unintelligible the melodic and harmonic idioms may seem, there never is any lack of sheerly sonic fascinations.

Moreover, stereo has a unique power of restoring genuine freshness to novelties which have made a sensation when they first appeared on LP, but whose edge and impact are quickly lost on repetition. An apt instance is Carl Orff's *Carmina burana*, which achieved so remarkable a triumph in its 1953 debut on Decca DL 9706, but which had become almost passé when it was reissued as part of the complete *Trionfi* trilogy (see Nov. 1956 SFG) and later alone in a superior recorded performance in last year's Angel 35415. Now it reappears again on the Vanguard LP, VRS 1007, where it is likely to galvanize only listeners who have never heard the work before, since the recording, fine as it is, doesn't markedly surpass Angel's, and the performance by the Hartford Chorus and Symphony under Fritz Mahler is less polished even though it is enlivened by uncommon gusto. But it also appears simultaneously in a stereo taping (VRT 3011-2, two 7-inch reels) and here it is a brand-new and more-electrifying-than-ever revelation.

Now, I'm not one of those taken in by Orff's pretense that he is re-creating

authentically medieval and renaissance music making or that he has anything really profound, old or new, to say. But so what? He has (I think deliberately and perhaps somewhat cynically) contrived a sure-fire, sensational best seller, and when one hears his catchy tunes and even catchier rhythms clothed in the genuinely intoxicating sonics and big-auditorium acoustics they are given here, all aesthetic considerations can be forgotten as one is caught up willingly in the whirlwind of aural titillations. The floor-shaking bass drum here, the sizzling rattle of percussion, and irresistible lilt of quasi-cowboy and nursery-tune fragments, the overwhelming blasts of full choral and orchestral sonorities are all unqualified audiophile delights. If you want to bowl your friends over with an ultradynamic display of stereo's full powers, you can't go wrong with these tapes!

Easy Impressionism — Hard Expressionism

In less brutally obvious, more impressionistic music, two further proofs of stereo's reinvigorating ability are to be found in the tapes of Ibert's nose-thumbing *Divertissement* and Debussian *Escales* (RCA Victor ACS 54 and ACS 57, by the Boston Pops and Symphony Orchestras under Fiedler and Munch respectively). The corresponding LP versions (in LM 2084 and 2111) are fine examples of current single-channel technology all right, but to depict the rollicking ribaldries of the suite or the Mediterranean atmosphere of the *Ports of Call* triptych, it takes the glowing pigments and widespread canvas of the best stereo sound. I have never been too impressed with *Escales* before, but I am

AUDIOLAB TEST REPORTS
Coming next month — see page 15

here, although perhaps more so by the Bostonians' ultrasensuous tone coloring than by Ibert's somewhat posterish designs. For me, the composer is infinitely more imaginative in his saucy suite of circus pieces, one of Fiedler's earliest triumphs in the days of 78's, but one which never could be captured with all its razzle-dazzle intact until auditorium-authentic sonic vibrancy and acoustical expansiveness could be brought back truly alive into our living rooms.

And even with the most difficult of all modern music, that utilizing the twelve-tone technique as first explored by Arnold Schoenberg, stereo miraculously eases the burden on one's ears and so at least prepares the way to a better intellectual comprehension of the implacably severe logic involved. His Suite, Op. 29, for a chamber ensemble led by Gunther Schuller is what I think of as "looks-and-glances" music: nervously

Continued on next page

SOUND FANCIER

Continued from preceding page

scrambling or languishing episodes which impertinently unearth from my mind's disorderly catchall attic Robert Burns's apostrophe to a mouse:

Wee, sleekit, cow'rin', tim'rous beastie,
Oh what a panic's in thy breastie!
Thou need na start awa' sae hasty,
Wi' bickering brattle!

I doubt that this is what Schoenberg had in mind, but even though what he did have may remain a mystery to most listeners, no true audiophile can fail to be intrigued by the deftly dovetailed sonic spots and splashes (especially those contributed by three different varieties of clarinet) here. I would hesitate to recommend the original LP version (Period SPL 705 of 1955) except to twelve-tone specialists, but in the stereo taping (Period PST 7) the suite is immensely easier — and more provocatively stimulating — to take; and this despite the fact that the recording here (obviously made in the days of early two-channel experimentation) lacks the full expansiveness and warmth of more recent stereo technology.

Contemporary (Nonstereo) Parade

It is unfortunate that the inestimable advantages of stereo are as yet seldom available to the less celebrated contemporary composers. The advent of the stereo disc probably will give them a better break before long, but meanwhile they are at least getting (both quantitatively and qualitatively) far more adequate representation on LP's than they ever dared hope for in earlier years. Most effective technically is Mercury's series of Eastman-Rochester Symphony performances under Howard Hanson, the latest of which (MG 50147) presents Kent Kennan's skillfully scored, brief *Three Pieces* and Bernard Roger's decidedly childish, inconsequential, and imitative five fairy tales, *Once Upon a Time*, plus a much more imaginative and expressive ballet, *Gold and the Señor Commandante*, by William Bergsma. All of them are superbly recorded, but it is the nervously vital Bergsma score which most dramatically exploits the extremely wide dynamic range and crisp transient response here.

Neither the Composers' Recordings nor the Louisville commissioned-works (available on subscription only) series is distinguished by such brilliant recording, but both of these continue to give a hearing to many less familiar composers and to a wide range of musical styles. The outstanding new release in the former series is the coupling (CRI 114) of Henry Cowell's *Persian Set* and Lou Harrison's Suite for Violin, Piano, and Small Orchestra, both of which are

rather too closely miked for my taste, but exceptionally well performed by no less a conductor than Stokowski. Both pieces are notable for unusually piquant and ingratiating tonal coloring: Cowell's with biting reeds and vibrant guitar-strumming "Tar" evocations of mid-eastern idiom ingeniously translated into vivacious western rhapsodic tunes and rhythms; Harrison's with more distinctively original and poetic adaptations of Balinese-gamelan sonorities, exploited here with the same skill and expressiveness which distinguished this composer's exciting *Canticle No. 3* in the recent *Breaking the Sound Barrier* stereo tape (and LP) from Urania.

I was much less impressed by the uninspired, slapdash, pretentious Piano Concerto by Antonio Lora, and the excessively lugubrious, meandering Variations by Adolph Weiss, in unpleasantly thin recorded performances by F. Charles Adler (CRI 113). And I was frankly bored throughout Robert Whitney's Louisville LOU 57-1 and 57-6 programs of (in the former) Paul Nordoff's querulously ineffectual *Winter* Symphony and the Swiss composer's (Paul Müller-Zürich) skillfully assured Cello Concerto (a long way behind Virgil Thomson's magnificent one, on Columbia ML 4468 of some years ago); and in the latter the Britisher Edmund Rubbra's languishing Violin Improvisations, Irving Fine's lush *Serious Song*, a lament for string orchestra, and Harold Morris's pretentious *Passacaglia, Adagio, and Finale.*

Opéra comique devotees may relish the lively and colloquial *School for Wives* by another Swiss contemporary, Rolf Liebermann (LOU 57-3) despite the somewhat amateurish performance under Maurice Bomhard's direction. But for me the finest Louisville achievements of the past year (ranking with the Vincent and Jolivet disc LOU 57-2, praised in this column for Aug. 1957) are to be found in the 57-5 and 57-4 releases. The former couples Ned Rorem's introspective but richly lyrical and moving *Design for Orchestra* with a neoromantic, almost Brahmsian *Suite symphonique* by still a third Swiss contemporary, Bernard Reichel. The latter (57-4) is perhaps the hardest of all on non-modern-tempered ears, for it is a formidably long and intense solo for soprano (mostly in the high register) with orchestra. Nevertheless, this *Idyl of Theocritus* by Roger Sessions is unmistakably one of the most powerfully evocative and dramatic grand-scaled works ever essayed by an American composer. And once one surrenders to its dark magic, both the occasional shrillness of Audrey Nossman's voice and the consistent harshness of Sessions's grating dissonances become inevitably right for the passion, fury, and final bitter resignation of this setting of what has been not unjustly termed the greatest love poem in all literature.

FOLDED HORN

Continued from page 24

housecleaning days. This baby is heavy!

There is very little clearance within the unit for the back end of the speaker. The H-530 just makes it, but the G-610 Triaxial requires the removal of its dust cover. According to Mr. Karl Kramer, Manager of Technical Services for the Jensen Company, this procedure has no undesirable effect on the tone or performance of the speaker.

The discussion thus far assumes the use of a coaxial or triaxial speaker, and these will mount with the least effort. However, in separated two- or three-way systems the woofer may be mounted as shown for unitary systems. Long middle-range units may be mounted behind a suitable opening at the top of the front baffle and an airtight box mounted in an opening in the V to accommodate the driver end of the component. Be sure the joints around such a box are well calked. A tweeter may be mounted in the front baffle without complications, but, again, be sure there are no leaks where it joins the baffle.

An interesting variation to this enclosure would be to omit the two No. 1 panels and allow the walls in the corner of the room to act in their stead. Such a departure has Mr. Kramer's blessing and would save on cost and weight. In such a case I should be inclined to make the top and bottom as before, and to install a two-by-two brace between them at the outer extremities for support of the outer edge of the grille work.

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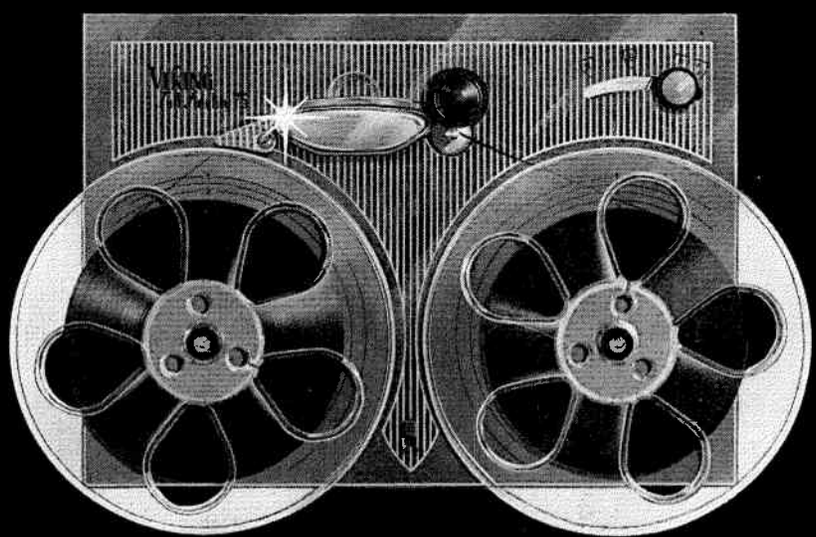

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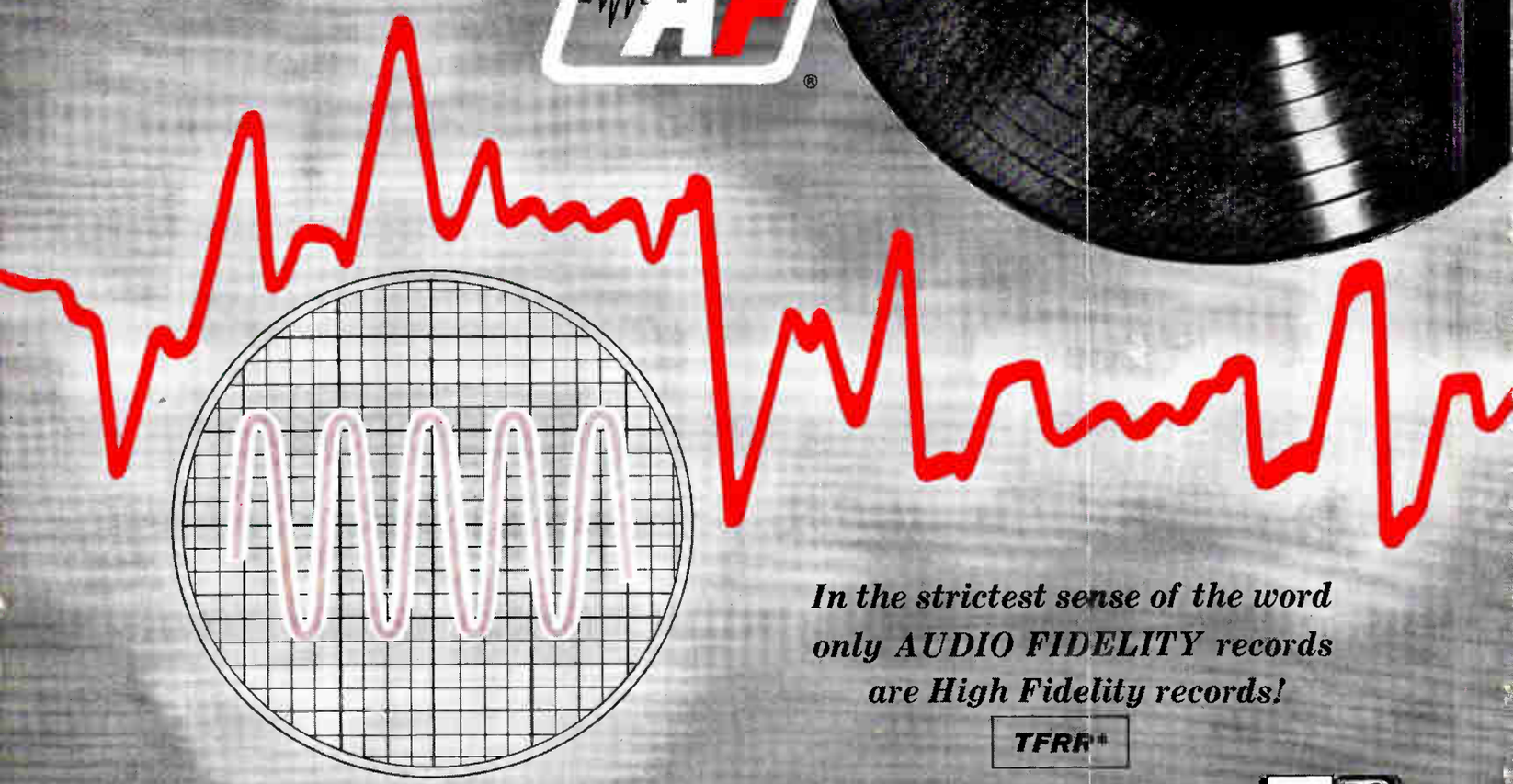

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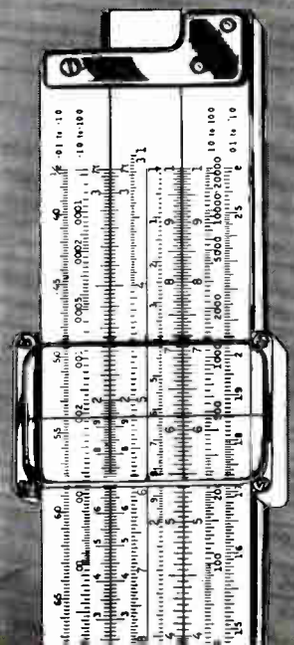

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