AUDIO

MARCH, 1958
50¢

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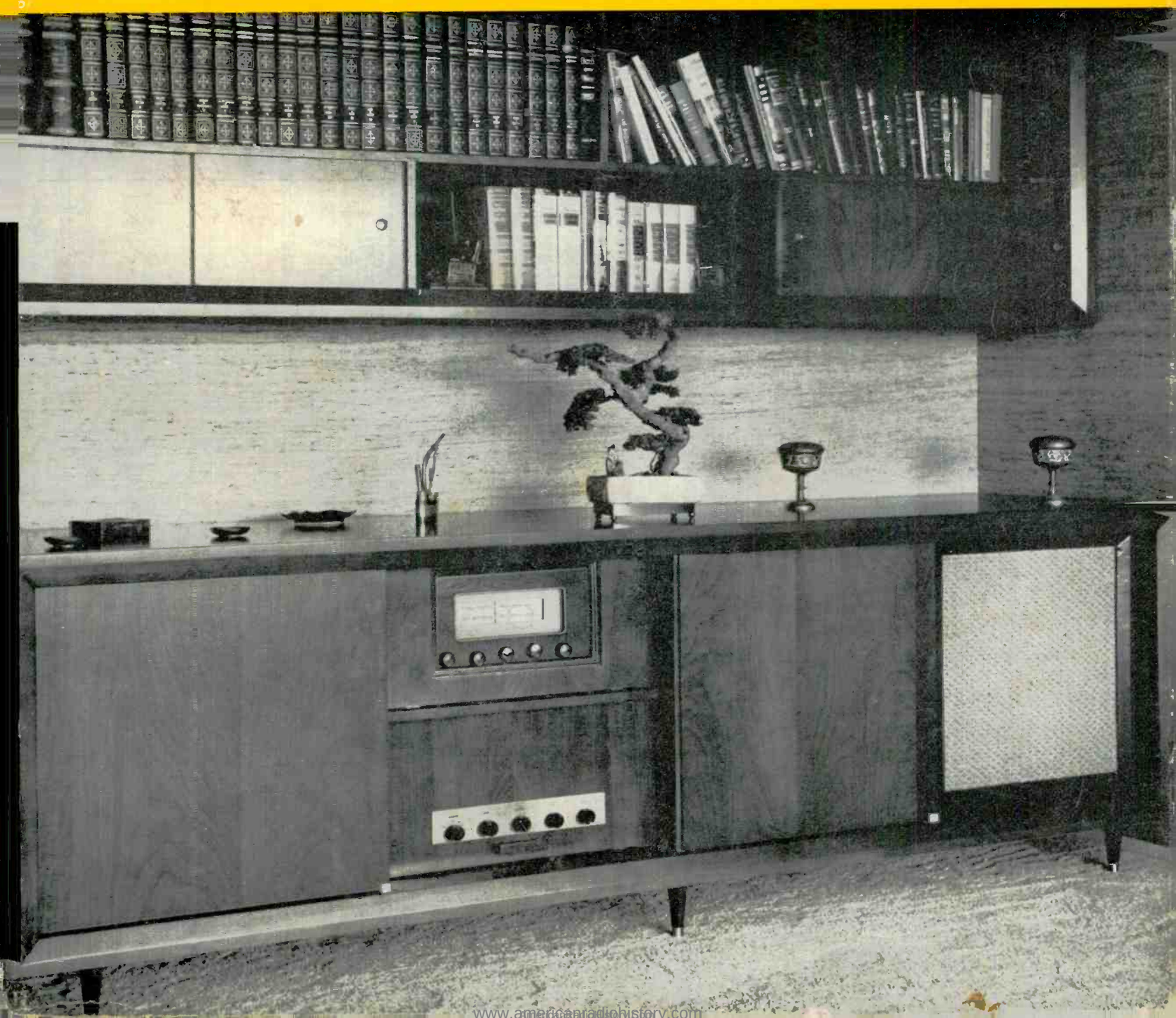

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You are looking at an instrument so flawless and versatile that it is far ahead of its time. It incorporates every feature you will ever need . . . now or in the future. For instance, the PR100A has *eight* inputs and *two* cathode-follower outputs. Ganged volume controls simultaneously regulate two channels so that you can add "stereo" whenever you wish. Push-button switches permit the instantaneous selection and level adjustment of all program sources. Distortion? *Virtually unmeasurable.* Frequency response? Beyond anything you could ever use. Chassis: $119.50. Blonde or mahogany-finished enclosure: $7.50.

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The Sounding Board

UTMOST PROTECTION FOR VALUABLE RECORDS!

The exclusive Garrard Pusher Platform is foolproof. It was one of the key Garrard developments 20 years ago, a development which revolutionized the record changer and reaffirmed the Garrard reputation throughout the world. Today . . . it is still the only device which insures positive, gentle handling of records regardless of diameter or condition of the center hole. The *new* pawl guide is *extra-thick* and *extra-long* to handle all records . . . new or old . . . thicker or thinner than standard. One of the key advantages of the Garrard Pusher Platform is that it operates with the Garrard exclusive *single-piece* precision bent spindle. Thus there are no moving parts to damage center holes and no overarm to accidentally dislodge records.

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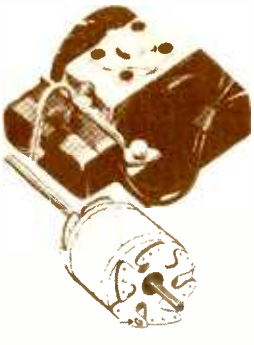
OPERATION IS SILENT, SAFE, AND SURE!



Garrard designs and builds its own motors, unlike many manufacturers of record changers and transcription turntables. The heavy-duty 4-pole "Induction Surge" motor in the RC98 was specifically engineered for this machine . . . and it is the most modern, quietest, and smoothest power plant available in record changers. It induces no hum, even when used with the most sensitive magnetic pickups. Garrard devised an exclusive method for balancing armatures dynamically, and they are individually weighted to guarantee perfect speed regardless of record load or "hot" or "cold" operation. Equally important with low tracking pressures of present day cartridges, is the exclusive Garrard *sensi-matic* trip mechanism incorporated in the RC98, which allow tracking pressures as low as recommended by *any* cartridge manufacturer. Absolutely no need to compromise. The heavy steel precision turntable of the RC98 is a full inch high and it adds its own shielding to that of the motor, helping to eliminate stray magnetic fields. Unusually heavy, it imparts flywheel action eliminating one major source of "wow" and "flutter".

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Convenient service and replacement parts is of course, the guarantee of continued satisfaction with any fine mechanism. Garrard record players hold their pre-eminent position in the American market through the finest service, and "spare parts" stock in the industry . . . the facilities of BIC.

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Sounding Board

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RC-98

4 SPEED SUPER-CHANGER
AND
MANUAL PLAYER

THE WORLD'S FINEST
By

Garrard

Universally regarded by audio experts and serious record collectors as "the greatest record changer of them all", the Model RC98 culminates 35 years of Garrard experience in the engineering and production of fine record playing equipment. This excellent unit provides a galaxy of high fidelity innovations, yet without gadgetry. Actually, the RC98 retains some of the earliest Garrard features, which after more than three decades, are still the best mechanisms of their kind . . . best for the preservation and best for performance of records.

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The RC98 is far more than the very finest of automatic record changers. It is equally an outstanding single play turntable, and its performance should be measured against *only* the very finest transcription turntables. A touch of a finger, and the RC98 responds to the exact function desired. The AUTO-MANUAL switch permits instant choice of either operation. Interchangeable spindles (a complete set of four furnished as standard equipment) permit playing any record at any of the four speeds, manually or automatically, with the greatest possible convenience.

VARIABLE CONTROL OF EACH SPEED!

A vital high fidelity feature . . . the RC98 provides a continuously variable adjustment of each turntable speed . . . a feature all too often not found in many of the much more expensive transcription turntables, despite its extreme importance. With this feature, it is possible to "tune" the RC98 to the exact pitch or key of a musical instrument to satisfy the most critical music listener, even those with *perfect pitch*. Moreover, it is capable of completely correcting the inadequacies of a large number of records. Fully electric, the RC98 speed control operates without friction or loss of efficiency, and adjustment is visually controlled by means of any stroboscope (one is supplied with each unit).

— cut along dotted line and save —

The Sounding Board

MARCH, 1958 VOL. 42 No. 3

Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

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COVER PHOTO—Reader Ben Barron, 940 Larrabee Street, West Hollywood 46, California, designed this unit to fit a specific alcove, then designed the matching shelf unit above to hold books and records. To facilitate cleaning and servicing of parts, all units slide out on rollers for easy access.

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AUDIOCLINIC??

JOSEPH GIOVANELLI*

High Fidelity

Q. *I am a new subscriber to* AUDIO, *and wanted immediately to avail myself of your offer to answer any and all questions, regardless of their suitability for use in the column. Since I am just beginning my hobby, I should like to know just what we are striving for. What is high fidelity? Harvey Bond, Hayes City, Iowa*

A. Fidelity indicates faithfulness to something. In this instance, we are interested in the degree of faithfulness with which reproduced sound (primarily in the home living room) resembles the original performance of that music or other material. What we wish to do is to make that resemblance as close as possible. High fidelity does not mean high volume of sound, and it does not connote an exaggerated emphasis of either the bass or the treble end of the audio spectrum. High sound volume is appropriate only when the original performance contained loud sounds. As has already been said, we want to make the reproduced sounds as nearly like those heard at their original performance as possible. This implies that we have not yet arrived at a perfect result; probably we shall never do so. We can improve our results, however, and that is why we work to get that last cycle in the bass or treble, that fraction of a per cent less distortion, or that extra db or two increase in signal-to-noise ratio.

One problem which confronts us, therefore, in defining high fidelity is this: Just how close to the ideal must our reproducer perform before we term it high fidelity? No one has as yet set the standard for this, and for that reason many packaged units are sold with letters emblazoned on their labels "HIFI"; to those of us who have heard truly good sound reproduction, it is hard to accept the sound produced by a single 4-inch speaker as really high fidelity sound.

Tape Recorder Bass Response

Q. *I have made many tests with tape recorders, and I have noticed that none of those I tried have much bass below 30–40 cps. Is this because the tape is unable to accept frequencies below these values? James C. Bryson, Redwood City, California*

A. The tape can accept frequencies as low as necessary, provided we take proper care in designing our associated recording and reproducing amplifiers. Characteristically, tape rolls off at the rate of 6 db per octave of frequency decrease. To correct for this we must design our reproducing equipment so that it possesses a boost of 6 db per octave of frequency decrease. This will balance the rolloff and we will have a flat response. Most amplifiers, however, are designed to boost 6 db per octave but only down to a certain point, say 50 cps, after which point the amplifier behaves as though it were flat, providing no further boost. This means that from there on, the bass rolls off at 6 db per octave.

There is no reason why the tape cannot accept tones lower than 30 cps. To illustrate this, let us assume a tape recorder running at a speed of 30 ips. We feed a test signal into the recorder at 100 cps. When the tape is played back at the same speed, we obviously have a tape whose program content is 100 cps. If the tape were slowed down to 15 ips, a 50-cps tone would be noted. If again the tape is played back at 7.5 ips, a 25-cps signal will be picked up, but you'll have to turn up your gain to get it, because your playback amplifier is no longer boosting complementarily to the tape's rolloff characteristic. 3.75 ips will give us a 12.5 cps tone, while a tape speed of 1.875 ips yields a tone whose frequency is 6.25 cps. This speed reduction versus frequency could be carried further till a speed of 0.0000001 *inch per minute* is reached, but I think it should be clear that we can, if we want to, arrive at any low-frequency limit we wish, so long as we design an amplifier with sufficient correction.

Turntable Speed

Q. *I have heard much discussion about how the size of the intermediate idler of a phonograph turntable will affect the turntable's speed. Is this so? I have seen tables which slow down as the idler is pressed more firmly against the motor shaft, thereby making the idler smaller. Mark W. Tennberg, Albany, New York*

A. The size of the idler has no effect upon turntable speed. The reason a table slows down when more pressure is created between the idler and the motor shaft is not that of the idler's possible reduction in size, but simply because the motor is loaded more heavily under those conditions, with this loading, in turn, causing the motor shaft to turn more slowly.

In order that I may give reasons for my position, picture a motor shaft whose diameter is one inch. This, in turn, drives an idler whose diameter is one inch, which, in turn, drives a turntable whose rim at the area of contact with the idler is also one inch. Because the ratios of the motor shaft, idler, and turntable are 1:1:1, all wheels will rotate at the same speed. Assume now, that the idler has worn down to a half inch in diameter. The ratios are now 1:½:1. This means that, for every revolution of the motor shaft, the idler to which it is friction coupled must revolve twice. It would seem that the turntable must rotate faster under this condition. This is not true. The turntable is twice the diameter of the idler, which means that the idler must revolve twice in order that the table may complete one revolution. In order for the table to make one revolution the motor shaft makes one revolution, the idler now makes two revolutions, while the table makes one.

Should it still be hard to picture the foregoing, think of the parts in terms of their linear distances, which are their circumferences. Assuming no slippage, the number of linear inches traveled by a given point on the motor shaft must equal the number of linear inches traveled by points on each other part of the chain. Work out the ratios in terms of linear inches which must be covered by each part, and you will see that the turntable has covered the same number of inches, regardless of idler speed.

Do not, as so many people try to do,

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

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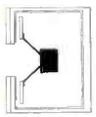

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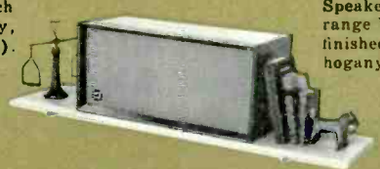

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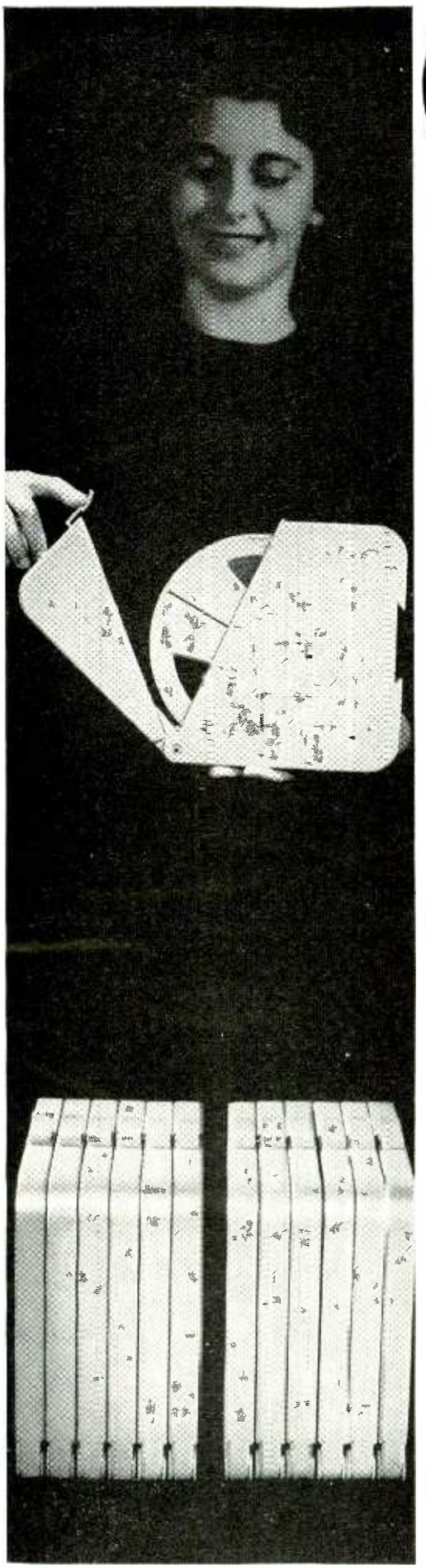
apply this explanation to belt-drive systems in which the motor drives a pulley which is belt-driven to another pulley, on the same shaft with which is located a third pulley belt-driven to a fourth, and so on. Each belt must be considered a closed, separate loop. In order for the above discussion to be applied to belt drives, it would be necessary for the intermediate pulleys to be common to two belts. This also applies to stepped idlers—those that have two or more different diameters.

Feedback Cutter-Head

Q. *I have an inexpensive disc recorder which I should like to improve. I've read* AUDIO*'s article on the application of the hot stylus for LP recording, and wondered if further improvements are possible through the use of negative feedback around the amplifier and cutter. In my particular case, the cutter, Astatic M418, is too small to insert a separate feedback coil; hence I thought it might be possible to employ a capacitor pickup to derive the feedback voltage. This might be done by the addition of an external plate next to the stylus, and perhaps a movable one upon the stylus itself. Do you think this is feasible? Jack L. S. Bellin, Providence, R. I.*

A. The means you propose for the translation of stylus motion into feedback voltage seems feasible. However, when constructing the pickup plates, their self-resonance must be taken into account. The plates must be sufficiently rigid so that resonance will occur in the supersonic region. Their mass must be sufficiently small so as not to interfere with the high-frequency performance of the cutting head. I regret that the design of the circuitry is outside the scope of this column. Basically, I can say that the plates spoken of form part of the capacitance needed to make up the tank circuit for an oscillator. The variations in the capacitance caused by the moving stylus provide a means for frequency modulating the oscillator. The oscillator should be of the electron-coupled type, so that anything done to the plate circuit of the tube will not affect the stability, or at least will have a minimum effect on it. The plate circuit should incorporate an additional tank circuit whose resonance frequency is made slightly lower or higher than that of the oscillator. The exact deviation from the oscillator frequency depends upon the frequency chosen for the oscillator, plus the Q of the plate tank circuit. Best results will be obtained by trial and error. This plate circuit is coupled to a diode detector. In other words, the tank circuit and the diode detector form what is known as a slope detector. To ensure that this detector works properly, deviation of the oscillator must be held within the linear portion of the slope of the circuit. The output of the detector should be coupled to a suitable audio amplifier which can build the signal to a voltage sufficient to provide the proper opposition to the normal signal being fed to the cutter. Should you perfect this circuit, readers of my other column, AUDIO TECHNIQUES, which appears from time to time in this magazine, would be interested in the results of your work, and the means by which those results were achieved. (*A complete FM calibrator of this type, which could be used for a source of feedback signal, was described by Ralph A. Schlegel in* AUDIO ENGINEERING *in May, June, and July, 1947.* ED.) Æ



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. A-104, Ferrodynamics Corporation, Lodi, New Jersey.

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(*Don't start your own—we'll sell you this one.* ED.)

"Arena" Repercussion

SIR:

I do not have access to Albert Forman's *Electronic Technician,* but your skimpy rehash of his attempts to verify recent tuner tests leaves several questions. Did Mr. Forman select his test samples anonymously on the open market? Who owns the lab in which the tests were conducted? Who pays the engineers conducting the tests? Your editorial innuendos cannot be said to be motivated by "no commercial interest in the gear being analyzed."

Mr. Forman's request for "original lab report and testing facilities" is hard to justify and points up the big difference between Industry efforts to exorcise the findings of independent, consumer-supported organizations and the tests themselves: the results are published in widely circulated form and were available on newsstands. In every case the parameters reported are given in physical units defined by international commission or by technical society. They are *standard* and not particular to one laboratory.

The original impression sticks. At the findings of Consumers Union your persistent, pathetic yelpings, as the running dog of the advertising budgeteers that you are, are most contemptible.

RUSS LINTON,
2524 44th St.,
San Diego 5, Calif.

(*Those who are really interested in Mr. Forman's findings may obtain them easily by ordering a copy of* Electronic Technician *for January, 1958. Their address is 480 Lexington Ave., New York 17, N. Y.* ED.)

Stereo Discs

SIR:

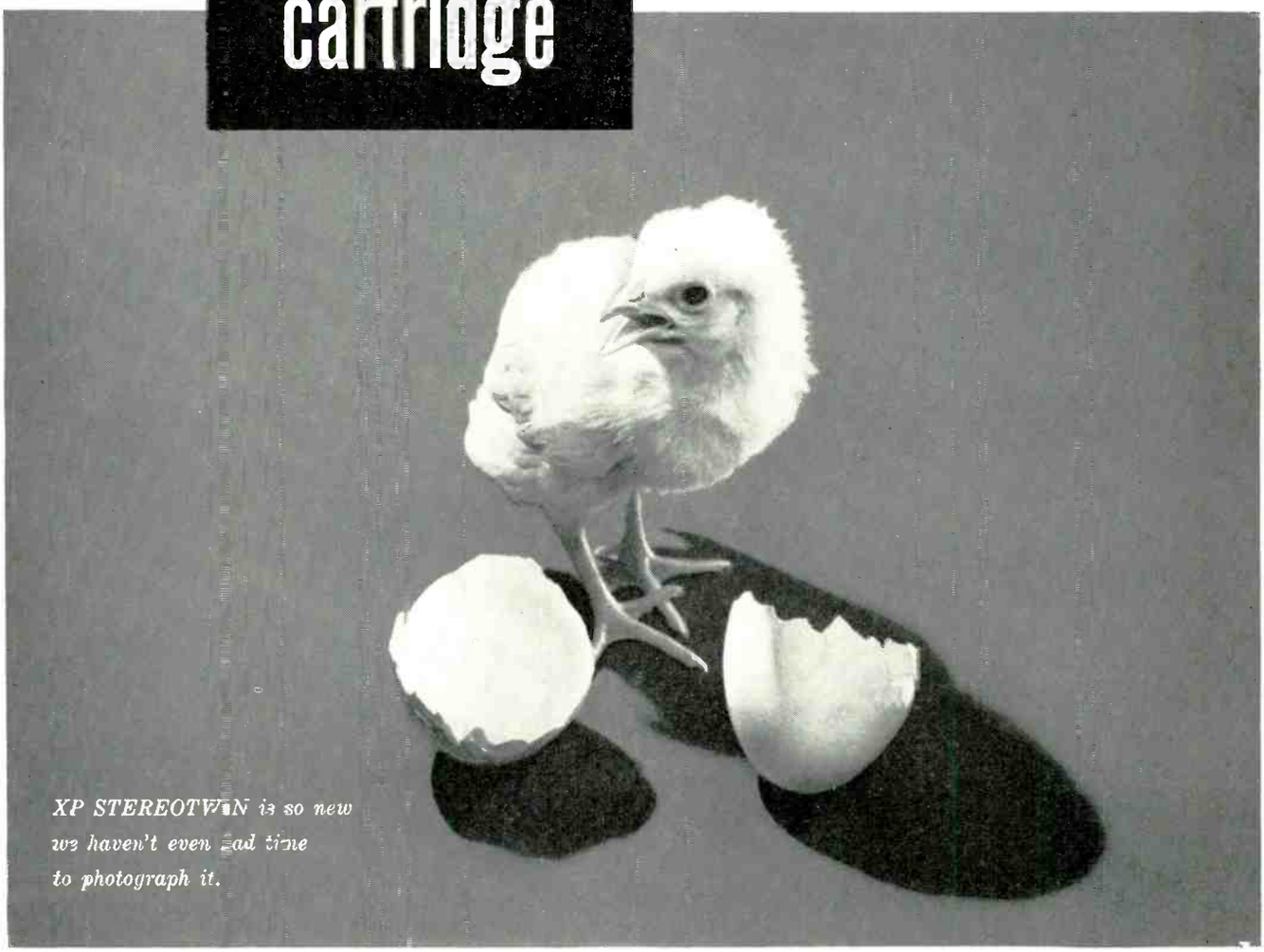
In Editor's Review for the November issue, it is stated that ". . . our present monaural pickups will play them (stereo discs) satisfactorily until we are ready for the new equipment."

We would like to point out that this is only correct provided that the monaural pickup has an extremely good vertical compliance. By far the majority of pickups in use today have little or no vertical compliance and the playing of stereo discs with these pickups would result in immediate ruination of the discs. This applies to any system used for stereo discs where there is a vertical component in the recording cutting.

When the stereo discs come on the market, record companies should give warning on the jackets of their stereo discs against playing them with unsuitable monaural

(*Continued on page 69*)

JUST BORN! a stereo cartridge FOR A LIMITED FEW!



XP STEREOTWIN

by the makers of famous Miratwin

STEREO SOUND — the sound of reality on records — is here! And just as stereo calls for new records, it calls for a new type of cartridge . . . brought to you in XP STEREOTWIN, by the makers of famous Miratwin.

XP STEREOTWIN is so new we can't even show it to you in this ad, which was prepared weeks ago. But the first experimental model is at selected shops now . . . in limited quantities, waiting for the favored few who want to be first with the finest!

XP STEREOTWIN will help you achieve sound like none you have ever heard before. It makes reality a reality. *You are there!*

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SPECIFICATIONS: *Variable reluctance cartridge • can be used for both monaural and stereo reproduction • recommended tracking pressure from 4 to 6 grams • has ½ mil diamond stylus • transient response within 2 db from 20 to 20,000 cps. • no magnetic pull • instant stylus replacement • fits all standard tone arms • perfect shielding eliminates hum problem • very simple to install*

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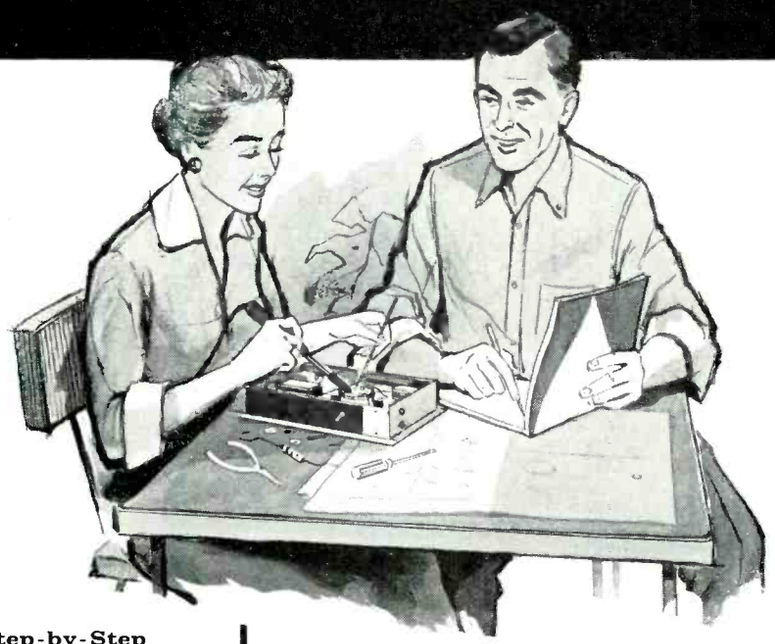
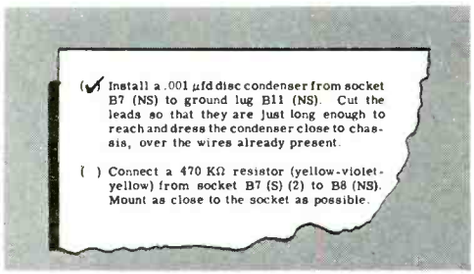
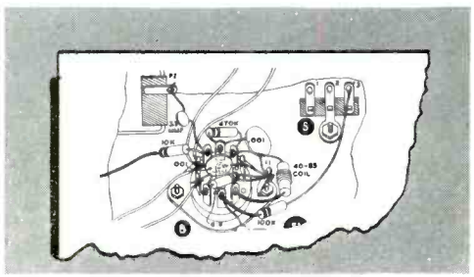


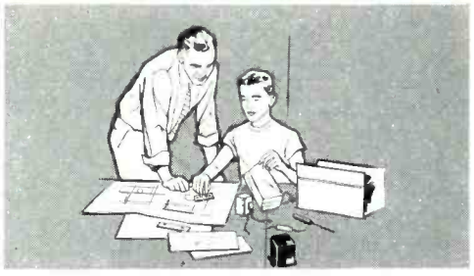
Look . . . how simply you can assemble your very own high fidelity system! Fun-filled hours of shared pleasure, and an everlasting sense of personal accomplishment are just a few of the rewards. Heathkits cost you only HALF as much as ordinary equipment and the quality is unexcelled. Let us show you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



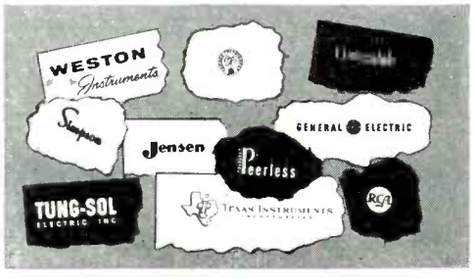
Step-by-Step Assembly Instructions . . .
Read the step . . . perform the operation . . . and check it off—it's just that simple! These plainly-worded, easy-to-follow steps cover every assembly operation.



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



Learn-by-doing Experience For All Ages . . .
Kit construction is not only fun—but it is educational too! You learn about radio, electronic parts and circuits as you build your own equipment.



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

HEATHKIT

bookshelf 12-watt amplifier kit

MODEL EA-2

$25.95

NEW

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

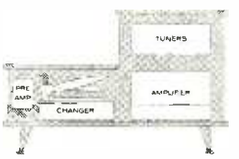
TIME PAYMENTS AVAILABLE ON ALL HEATHKITS WRITE FOR FULL DETAILS

HEATHKIT

chairside enclosure kit

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

CE-1C Mahogany
CE-1CB Birch
CONTEMPORARY



CE-1T Mahogany
TRADITIONAL

Be sure to specify model you prefer

$43.95 each

HEATHKIT

high fidelity FM tuner kit

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

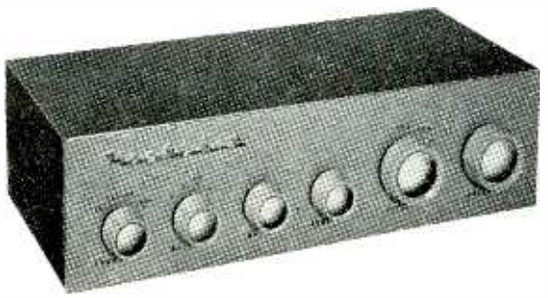
MODEL FM-3A $25.95 (with cabinet)

HEATHKIT

broadband AM tuner kit

This tuner differs from an ordinary AM radio in that it has been designed especially for high fidelity. A special detector is incorporated and the IF circuits are "broadbanded" for low signal distortion. Sensitivity and selectivity are excellent and quiet performance is assured by a high signal-to-noise ratio. All tunable components are prealigned before shipment. Incorporates automatic volume control, two outputs, and two antenna inputs. An edge-lighted glass slide rule dial allows easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

MODEL BC-1A $25.95 (with cabinet)



HEATHKIT

master control preamplifier kit

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

MODEL WA-P2 $19.75 (with cabinet)

pioneer in "do-it-yourself" electronics

HEATH

a subsidiary of Daystrom, Inc.

COMPANY • BENTON HARBOR 25, MICHIGAN

HEATHKIT 25-WATT MODEL W-5M **$59.75**

high fidelity amplifier kits

HEATHKIT 70-WATT MODEL W-6M **$109.95**

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

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

HEATHKIT DUAL-CHASSIS MODEL W3-AM **$49.75**

HEATHKIT SINGLE-CHASSIS MODEL W4-AM **$39.75**

HEATHKIT

high fidelity amplifier kits

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

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

HEATHKIT

high fidelity amplifier kit

MODEL A-9C **$35.50**

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

HEATHKIT

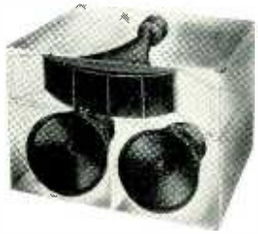
electronic crossover kit

MODEL XO-1 **$18.95**

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

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!

NEW! "DOWN-TO-EARTH" HIGH FIDELITY BOOK

THE HOW AND WHY OF HIGH FIDELITY, by Milton Sleeper, explains what high fidelity is, and how you can select and plan your own system. This liberally-illustrated, 48-page book tells you the HI-FI story without fancy technical jargon or high-sounding terminology. **25c**

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

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ALSO SEND THE FOLLOWING KITS:

QUANTITY	ITEM	MODEL NO.	PRICE

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

AUDIO ETC.

Edward Tatnall Canby

1. BETTER THAN EVER

I just caught the February issue in time to see Mr. G. A. Briggs' letter to the Editor (who *never* shows me things like that . . .) about the soft-surround Wharfedale speakers, cloth and foam, and my story thereon. It seems to have been fish.

Now, I do wish I'd had a notebook on hand one day some years back when I had lunch with Mr. B. in the Hotel New Yorker, after an Audio Fair. My recollection was indeed a bit fuzzy but the story of the "decrepit" cloth-surround men must have gone back to that day. That's the way I remembered it. Musta been dreaming. (It was hand *assembly* of the speaker surrounds not hand cutting, that Mr. Briggs evidently mentioned.) My apologies.

The good thing about Mr. Briggs is that he is able honestly to say, in so many words, that the new speakers are better than the old. He tells us how, with particulars. That struck me as interesting.

The trouble with most of us over here (to point a moral on the spur of the moment) is that we like to claim virtues for our new products, but we can't bear to hint that the old ones were less than perfect, in any respect we care to mention. You can't have that grammatical cake and eat it too. If the new product is better, then the old one was worse, and that's that. Our insincere, lily-white ". . . now better than ever" ads sometimes make me sick. So the old model can't quite match the new one—is that anything necessarily to be ashamed of?

As anybody knows, the cloth-surround Wharfedale speakers were rated up near the top in listening quality by plenty of experts and plenty of non-experts. Even their designer, Mr. Briggs himself, can't make them any less good than we thought them. But if you want to know just where the new ones are better still, read Mr. Briggs' letter. It is factual, where I wasn't.

2. GREAT MUSIC

A lady at the Dessoff Choir rehearsal the other day (I sing in it) came up to ask me about the new Great Music record club, launched by RCA Victor and the Book-of-the-Month Club jointly. Her boyfriend, she said, had seen the full-page ads in the paper and was worried as to whether he ought to join or not—and what did I think? What he wanted to know, specifically, was *whether I thought the records would be hi-fi.*

Now that flabbergasted me on two counts. First—imagine anybody questioning the fi on brand new RCA Victor Red Seal records. That, I'm sure, is the least of his worries. True, a few of the older jobs might not be super-hi-fi, perhaps including the inevitable Toscanini-NBC fare. But I was amazed that the idea could enter his head that RCA would launch a record club with sub-standard discs.

I suspect two things might have prompted his feeling. One is that some earlier clubs, selling at bargain prices, didn't do too well on hi-fi quality. Close-cut grooves, so-so plastic, from not-so-hot tapes. A few bad discs like that could spoil the reps of many better ones, sold at the same prices. I'm wondering also whether he isn't confusing such lines as RCA's low-priced Camden with possible RCA budget records via the club plan. These are strictly Red Seal and the fi, at least, should be plenty hi.

But what really floored me was that this guy was bothered by the fi—not the music. It's the music that bothers me, plus that fine offer of benevolent guidance, to choose our discs for us.

Frankly, the record club sort of deal always leaves me upset. Not because of the savings in cash—more power to the clientele in that respect. What I can't take is the combination of papa-knows-best paternalism and that deadly restrictive phrase, "great music," so prominently plugged in record club advertising.

If you stick to *good* music, your horizons are unlimited, your freedom complete, your choice as wide as the LP catalogue—and you have all sorts of help available from the record reviewers, if you want it. But "great music" is another matter. It's supposed to be the cream of the cream, the ultimate distillation of all music history. Actually, it is nothing of the sort. Go in for "great music" and you're limited to an utterly safe, small, secure corner of the musical scene where there are very few surprises and darned little variety.

The record club usually has a panel of distinguished experts who choose the monthly offerings and alternates; RCA's is, in all truth, an excellent one. In fact the brochure suggests that with these fine men at the helm you just can't go wrong. Authority incarnate—just let the Gods decide your music for you, through their chosen jury, and all will be well!

Nothing personal, you understand. The panel is made up of good men. It's the system that gets me, the very idea of this safe, trusting, idiot surrender of all the rights and prerogatives of collecting in favor of the pre-selected automatic safety package. I find this sort of thing pretty terrifying. Are we to be musical robots forever?

If it weren't for that term "great music," we might get somewhere with this kind of plan. But keep in mind that the record club, unlike the book clubs, does not deal with brand new music. It promotes the classics—the "great" classics. Book clubs promote *new* books, just-written, and their authors are often unknown. Book clubs (including the Book-of-the Month Club) choose their offerings from the whole field of publishing—not just from one publisher.

The usual repertory of the record club is defined by that term, "great music." That means—or it always has meant—the ultra-familiar safe-and-sound classics of the last century, beginning inevitably with Beethoven and Schubert (the Beethoven Fifth and the Schubert Unfinished) and progressing through Tchaikowsky, Brahms, Grieg, Mendelssohn, perhaps even Debussy. These are the "music appreciation" pieces —Virgil Thomson once called them the Fifty Pieces—the stuff that was considered ultra-ultra in up-to-date culture back around 1900. Time marches on, but music appreciation dawdles. "Great music" is top-notch stuff, most of it, of course. But right now, the choice covers about one per cent of the market.

As most old AUDIO readers will realize, our own record recommendations have gone on just the opposite principle. We aim to keep the furthest horizons in view—because there *always* is something new under the sun, for those with ears and eyes open and a spark of curiosity about them, a yen for new things, new experiences.

We have ranged from one side to the other of the record field, excluding nothing, because you never can tell . . . you can never be sure ahead of time what's going to be good for *you*, the individual, and what will leave you cold.

We aren't robots and we do change, all of us and each of us. People's *potential* interests, in music they don't even know, changes enormously with each passing year —in ways they may not even realize, themselves. You can't ask them what they like best—now. And, most of all, you can't roll people through the mill of statistics and bring 'em all out the same.

The pleasure in playing records and in collecting them is in learning, I don't honestly think that learning means getting to know just the so-called "great music." It may well bore you to tears. It may not be *your* great music. Maybe the piece that will whack you between the eyes or in the pit of the stomach is some obscure little item out of another century—somebody else's "great music." On records, it's yours for as long as you wish; you can play yourself to sleep with it every night and hear it again for breakfast. That's your right as an individual.

The main thing, you see, is to keep the channels open, to maintain contact with the wider world of music—just in case. Again, *you never can tell.* If you're curious, if you want to be around when *your* special music comes along, you'll never submit to

any papa-panel of benevolent judges, who must face the conservative economic necessities of mass operation in their choices, no matter how good their intentions.

You're not going to widen your channels of communication by joining a record club. You'll close them safely off, most of them. You won't have to bother with nine tenths of the music on LP records. What you don't hear about you'll never miss, I guess. So, go ahead and enjoy the hi-fi stuff at the reduced rates, join the club and settle the record problem once and for all. The experts will buy your records for you.

But you might keep an eye on your record reviews now and then, just in case. You never can tell—you might want to get back your freedom, some day.

3. DISC STEREO—IT HAS TO BE BIG

A few days ago, I got to the subject of stereo in my new and enormous (so it seems to me) book on hi-fi for the music lover. My lady editor, the same one that worked with me on my first book a few years back, is still the best and most reasonable foil you can imagine. She represents the General Public and keeps me on the track. She it is who questions things that seem perfectly obvious to me, enthuses over sections that I thought were unspeakably dull, and generally balances my own somewhat erratic ups and downs, as I go alternately into a state of excitement or despondency, depending on how many dozen new developments have been announced that particular day.

Anyhow, when we got to editing my chapter on stereo, she asked me the question of questions, which I think will show you where the General Public is likely to stand on the subject of stereo disc, in these present days.

"45–45," says she. "Now that's interesting. Does that mean they use two 45-rpm records? What an ingenious idea. . . ." So I wrote *that* page over again.

Maybe this is a nutty time to be speculating on stereo disc. For all I know, things may have "broken" by the time I am in print. I first stuck my neck out, however, way back last August, without a trace of official information on hand but a lot of hunchy feeling that something was up. The fall demonstrations of stereo disc, from English Decca (lateral-vertical) and Westrex (45–45) saved my long neck for me nicely and I've let the rest of the audio gentry stick *their* necks out ever since. Now, a bit more neck.

You see, as of this writing there is exactly one stereo disc on the market, strictly for experiment. (Audio Fidelity) At this moment (February 5), there's exactly one stereo pickup *on the market* and you can buy that, too, for $250, cartridge and arm. I'm not in this particular market. But behind all sorts of scenes, right now, the stereo pot is red-hot in everybody's audio kitchen. Dozens of pickups are under development and a number have been played in public. Lots of people are busily turning out Westrex 45–45 test records for themselves. Everybody's ear is to the ground, or more likely, ear to ear with the next

(Continued on page 82)

✻ New Transcription-Type Tone Arm Makes Collaro World's First True High Fidelity Changer

When Thomas Edison tested his first phonograph he played back a recording of himself singing "Mary Had A Little Lamb." Raspy and imperfect as the sound might have been, he was delighted to hear anything at all. Today's high fidelity systems can stand sterner tests—and they are, of course, ages beyond Edison's primitive cylindrical machine.

Today, you place your record on the changer, flick the switch—even a child can do it—then automatically, the changer does the rest. And that's where **the music begins.**

Because the record changer is so critical in a fine music system, you can't afford to compromise with quality. That's why today's outstanding high fidelity systems require the all new Collaro—*the turntable that changes records*—featuring the revolutionary transcription-type tone arm.

The new arm is one-piece, counter-balanced and will take any standard cartridge. Resonances are below the audible level. Between the top and bottom of a stack of records there's a difference of less than 1 gram in the tracking weight as compared with 4 to 8 grams on conventional changers. This insures better performance for your precious records and longer life for your expensive styli.

In addition to the transcription-type arm, the Collaro Continental features:

Four speeds, manual switch that permits playing single record or portion of a record; jam proof mechanism, hold the arm in mid-cycle and it won't jam; automatic intermix, plays 7", 10" or 12" records in any order; automatic shut-off after last record has been played; wow and flutter specifications, ¼ (0.25%) RMS at 33⅓ RPM, superior to any changer in the world; muting switch and pop filter to eliminate extraneous noises; extra heavy duty 4-pole induction motor; heavy rim-weighted, balanced turntable for fly wheel action; removable heavy rubber turntable mat; pre-wiring for easy installation; attractive two tone color scheme to fit any decor; factory custom-testing for wow, flutter, stylus pressure and correct set-down position. Reflecting their custom English craftsmanship Collaro changers are tropicalized to operate under adverse weather and humidity conditions. The base, in blond or mahogany, is optional at slightly extra cost and the Collaro mounts easily and quickly on a pre-cut mounting board or base.

When you buy your Collaro, you're buying professional quality equipment at a record changer price. Collaro prices start at $37.50. The Continental, featured above, is $46.50. (Prices are slightly higher west of the Mississippi.)

ROCKBAR Corporation

FREE: Colorful new catalog, containing guide on building record library plus complete Collaro line.

WRITE TO DEPT. A-015
ROCKBAR CORPORATION
MAMARONECK, N. Y.

Rockbar is the American sales representative for Collaro Ltd. and other fine companies.

EDITOR'S REVIEW

ERRATUM

MUCH AS WE HATE TO ADMIT IT, we made a very misleading statement in the February issue that should be corrected immediately. So far no one has noticed it—or at least, no one has written in about it yet—but some undoubtedly will. We trust this will be an apology in advance and may be accepted in lieu of an individual letter to each and every one who tells us of the error.

The error in question—that of proofreading—occurred in the third column of page 36. The end of the first paragraph states that the number of lines on a stroboscope disc for a 60-cps line frequency should be 91, 160, and 216, respectively for speeds of 78.26, 45, and 33.33 rpm. The number for the old 78.26 speed should have been 92, and we respectfully suggest that readers make the correction in the February issue. Fortunately this speed is now so little used, in the U. S. at least, that no trouble should result from the error, but we are still embarrassed about it.

The only consolation we can think of is in the old proverb, "To err is human." Perhaps it may prove something.

LOS ANGELES STEREOPHONIC CONCERAMA

Almost on the eve of departing for Los Angeles and the IHFM High Fidelity Show, we received a notice of rather exciting plans for a Stereophonic "Concerama" to be held at the Philharmonic Auditorium on the evenings of March 3, 4, and 5. This will be the first such event in Los Angeles, it is claimed, but we can't even think of any other such concert having been held anywhere, so it may be the first for the industry.

C. T. "Cap" Kierulff, as spokesman for the L.A. Hi Fi Industry stated that one of the important "firsts" of the event will be a live Stereo AM/FM-TV broadcast of the arrival of and interviews with many recording stars and other celebrities who will be on hand for the Monday night performance. The entire event is open to the public without charge, and will feature program material that has not yet been released to the public. All the material will be especially supplied by four of the major recording companies. Another feature of the program will be the first public performance of stereophonic disc recordings—about which AUDIO readers have already heard considerable. Attendance at this event, particularly following so closely the High Fidelity Show, should be high, and those who are new to hi fi should gain a clearer insight into the various aspects of stereo in all forms.

We trust that the plans and program information will be made available to groups in other cities for further dissemination of the Word about this newest (in practice) of all high fidelity phenomena.

"PASS THE BUCK" DEPARTMENT

Every so often we receive a letter from one of our readers which says, substantially, that he encounters considerable laxity on our part in fulfilling requests for literature. One recently told us that he had circled several numbers on the reply card and had yet to receive a single reply. For this reason, he said, he was dropping his subscription.

This is one place where we can say, "Not us." Assuming that the reader actually does put his name and address on the card before sending it in—and we receive about twelve cards each month, on the average, with no name—we process them and send out our notices to the advertisers well within two weeks from the time we receive the card. We do not maintain stocks of advertisers' literature—we don't have room for it and besides it would be an enormous job in itself. Nor do we send each advertiser the card the reader sends us. That too would be impossible, since the average number of items circled on each card is 10.7. Instead, we prepare a number of individual 3 × 5 cards for each request—the number being equal to the items circled—and after identifying the issue and the page or code number, we forward these cards to the advertiser.

After that, it is entirely out of our hands. Most advertisers want inquiries—by that means they are able to judge the effectiveness of their ads and of the magazine in which they appear. We have to assume that they want their additional material in the hands of those who have taken the trouble to fill out the card and send them in. But we can't do a thing about it except to mention it in this column or in our promotion material to advertisers. From then on, it is up to them.

Our concern, primarily, is in the interest of readers. We know that they are disappointed when they write in for something that was promised them and then they don't get it. Certainly, some advertisers are extremely prompt and send their material out at once. Those that don't give both us and themselves a bad name.

But remember one thing, our divining rod is on its sabbatical this year. If you don't put your name and address on the card before you drop it into the post box, our hands are tied. The system—like our hi-fi systems—depends on the perfect functioning of *every* component. If your tuner fails to send out the proper signal, nothing comes out of the speaker; If you should fail to fill in your name and address, everything breaks down.

Now let's hope this jogs everybody up for a month or so.

Come on—CELEBRATE!

PICKERING'S 12th Anniversary Special

THIS YEAR — 1958 — PICKERING & CO. marks its twelfth year as leader in the field of high quality transducers and precise electronic devices for the most exacting engineering applications.

THIS YEAR — 1958 — PICKERING & CO. announces its readiness for the new stereo-disk. Yes, it is twelve years since PICKERING & CO. was first with a high quality miniature magnetic pickup for high fidelity reproduction from records and broadcast transcriptions. And now, PICKERING & CO. is ready for the stereo-disk with the STANTON 45/45, a stereo model of the renowned FLUXVALVE cartridge.

THIS YEAR — 1958 — PICKERING & CO., in its twelfth year of progress, will celebrate their anniversary by giving each purchaser of a FLUXVALVE product a bonus gift valued at ($6) six dollars to extend the utility of the product they have purchased.

THIS YEAR — 1958 — marks another first for PICKERING & CO. with the PICKERING $6 BONUS BILL! Beginning February 1, 1958 and until April 15, 1958—each PICKERING FLUXVALVE product will be packaged with a bonus bill valued at $6. *Redeem it on the spot at your PICKERING dealer.*

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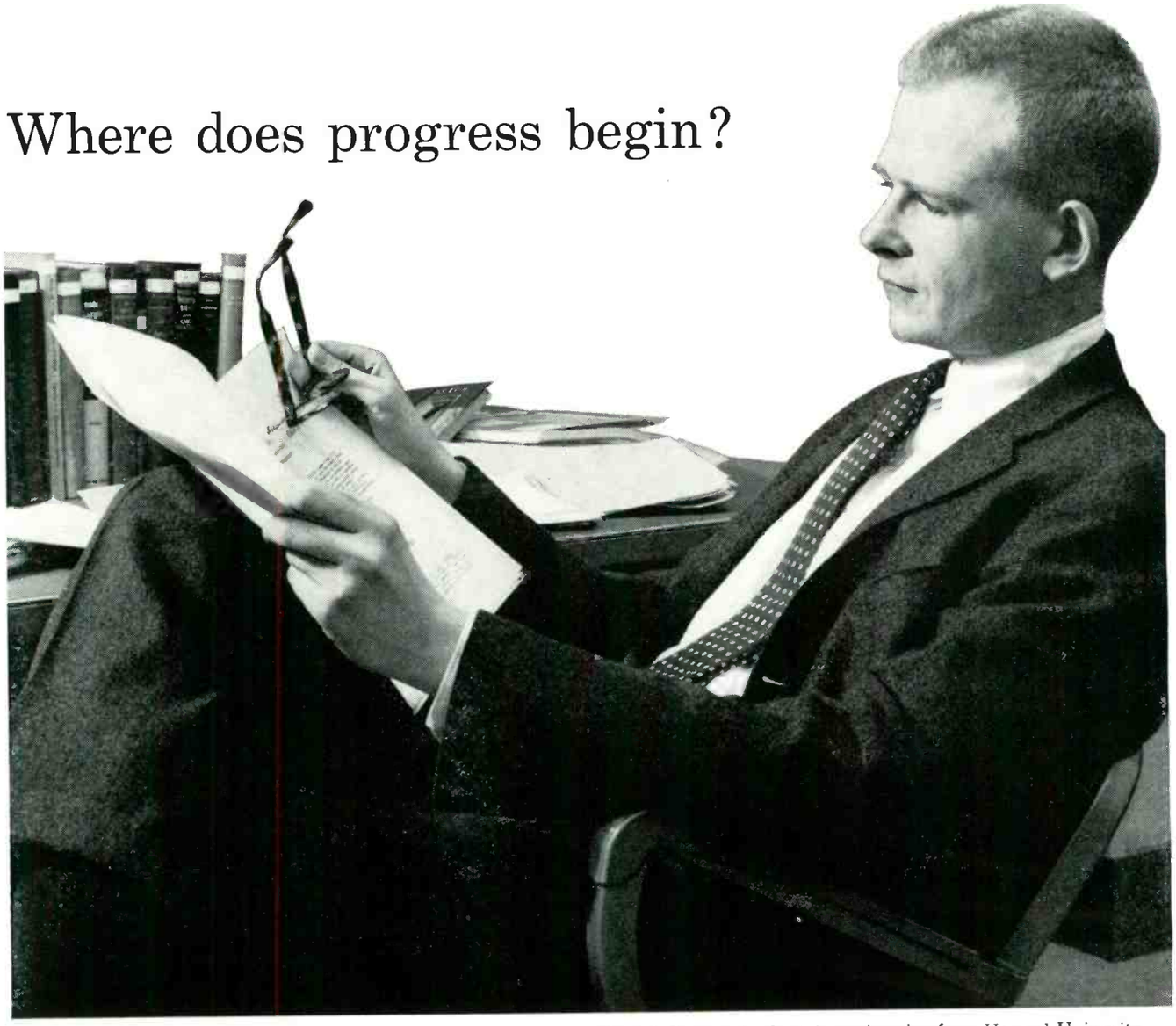

Kendall Preston Jr., S.M. in engineering from Harvard University . . .
graduate of the Laboratories' Communications Development Training Program.

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An Auto Audio System

WILLIAM B. FRASER*

With Spring and Summer coming up rapidly, many of us will look forward to more hours in our automobiles. And if we like good sound reproduction, we'll just have to do something about the car radio so we can enjoy it.

RADIOS are an important accessory in modern automobiles. Practically all de luxe cars are delivered with a factory-installed radio, and less elaborately equipped vehicles often include a radio as one of the optional accessories.

In view of this widespread use of automobile radios, one would expect that considerable effort would have been expended to insure a completely adequate and satisfactory item of equipment. Strangely enough, this is not the case. The automobile radio has evolved into a remarkably compact and generally reliable accessory, but its ability to reproduce program material satisfactorily is limited in respect to both fidelity and audio output power. At higher volume levels, the listener is subjected to such a rich variety of distortions that program material sometimes becomes almost indistinguishable from wind noises and other sounds inherent in moving vehicles.

In order to discuss automobile radios in detail, a schematic of a typical circuit should be available. Such a schematic is shown in *Fig.* 1. It is extracted from the RCA RC-17 Tube Manual by permission of RCA. The r.f. amplifier, converter, and i.f. amplifier shown in this schematic, operate quite effectively. The detector, AVC, and first audio amplifier function in a generally satisfactory manner, although benefits may be achieved by several minor changes which will be discussed later. However, the audio system, including the power amplifier tube, output transformer, and loudspeaker, is entirely inadequate, and is principally responsible for the distortions mentioned in the preceding paragraph.

The power amplifier tube is capable of only very modest output power and produces substantial distortions at higher output levels. The output transformer and loudspeaker are equally inadequate. Even with optimistic ratings, the audio system is not capable of producing an output of more than four or five watts at perhaps 4 per cent intermodulation distortion. These deficiencies are accentuated by the almost complete absence of low-frequency response. In those cases where a second speaker has been mounted behind the rear seat in an attempt to improve the audio system, the inherent limitations of the power amplifier tube and output transformer minimize the potential benefits of multiple speakers.

Why are automobile radios built in this manner? It is apparent at even a casual glance that most of them have been designed with two principal factors in mind:

(a) Low cost
(b) Compactness

These objectives have been achieved (although the purchaser may question the low cost, if he pays dealers' list price). But the compact dimensions which make it possible to mount the entire radio under the dash conflict with the space requirements of high quality amplifier components—transformers, power supplies, and speakers with enclosures. Moreover, the use of high-quality components is not compatible with low cost.

Fortunately, it is not necessary to accept these limitations in the car radio. Since the principal reasons for poor reproduction of program material are the use of inexpensive, undersized components of low power-handling ability, and a failure to baffle the speaker properly, it may be concluded that the remedy is to design a good quality audio amplifier and speaker system, and to locate these components where space is available.

After a study of possible locations for the various components of a sound system, it was decided that the following arrangement was optimum in the typical automobile:

1. Radio tuning unit, consisting of the car radio, (with plate supply and audio system disconnected) to remain located in the automobile dash.

2. Audio amplifier and plate supply, mounted on a single chassis located in the trunk. The plate supply furnishes current to both the audio amplifier and the radio tuning unit.

3. Speaker (or speakers as will be discussed in detail later) mounted in the shelf behind the rear seat. The trunk serves as a speaker baffle.

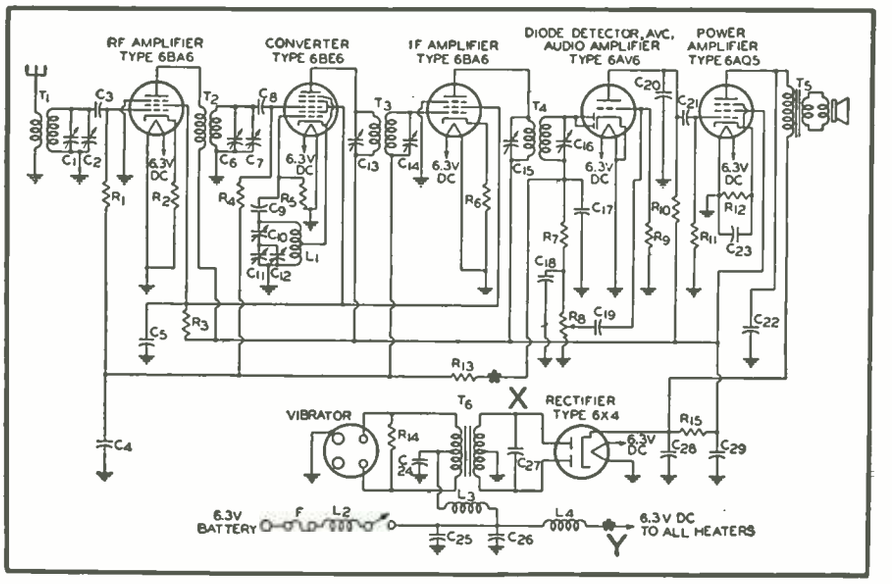


Fig. 1. Schematic of typical automobile radio receiver of 3-4 watts output.

* *1540 Pershing Drive, Presidio of San Francisco, Calif.*

Amplifier

In designing an amplifier, a question requiring early consideration is the audio power output which will be required. In the case of an amplifier to be used in an automobile, this question raises several unique problems. The audience of necessity consists of a small, compact group of persons in a space of limited volume and fully enclosed (except when windows are opened). If no other environmental factors were involved, a low-powered amplifier would certainly suffice. However, when the vehicle is put into motion, various mechanical and wind disturbances became apparent. These noises become so obvious at higher speeds that relatively great audio power is required for satisfactory listening. Using existing techniques and components, it is not difficult to design an amplifier which will produce sound of the necessary intensity at low distortions, but a practical limit is placed on audio power of equipment used in an automobile by the inherent limitations of the sources of primary energy, the automobile battery and generator. As a practical rule of thumb, it may be accepted that most modern passenger cars equipped with 6-volt batteries will not tolerate accessory equipment drawing more than 10 or 12 amperes except for short periods of time. There are exceptions of course, but ordinarily, violations of the rule will result in run down batteries, generator difficulties and the like.

A vibrator power pack, producing approximately 100 ma at 250 volts will require about 7 amps at 6.3 volts. A vibrator power pack producing 120 ma at 360 volts requires about 12 amps. Without considering current required for heaters, pilot light, and so on, it is apparent immediately that push-pull output tubes in the 6V6 class are the largest which can be used within our design limitations. A check of tube manual data shows that a pair of 6V6's with a total cathode current of 75 ma at 250 volts will produce 10 watts of audio output.

At this point, a breadboard 10-watt amplifier was actually constructed and tested in a car to determine its adequacy. It was our opinion, verified by a number of friends, that such an output was satisfactory even in an unusually noisy automobile. When these preliminary tests were completed, the design and construction of a 10-watt mobile audio amplifier and speaker to be used in conjunction with the typical automobile radio shown in *Fig.* 1 was commenced. The output rating of 10 watts automatically eliminated transistors from further consideration.[1] Since the final product was to be used in an automobile, and subjected to vicissitudes of vibration, temperature changes and power supply voltage variations from 5.5 to 7.5 volts, the design had to be rugged, reliable, and self-balancing. Furthermore, an article on the completed system was to be prepared with a view to making the design available to audio enthusiasts who were interested in installing a high-quality sound system in their automobiles. This latter requirement made it desirable that the circuit be simple and foolproof.

The popular and highly esteemed Williamson circuit might seem to fulfill many of these requirements, but it was rejected for three reasons:

1. The absence of a cathode follower in the Williamson circuit made it impractical to locate the amplifier remotely with respect to the tuning unit, unless a separate cathode follower tube was added, which introduced circuit complexity.

2. Recent experimental work[2] has shown that under certain conditions the negative feedback from the output transformer secondary becomes positive in many Williamson amplifiers, because of phase shifts in the transformer. These phase shifts occur at subsonic frequencies when the level of the input signal is changed suddenly, as often occurs in music. They may also occur at ultrasonic frequencies even in the absence of an input signal, because of the capacitive loading placed on the transformer by the stray capacitance inher-

[1] These limitations are changing rapidly. Ed.)

[2] Equipment Report, Audio, June, 1954.

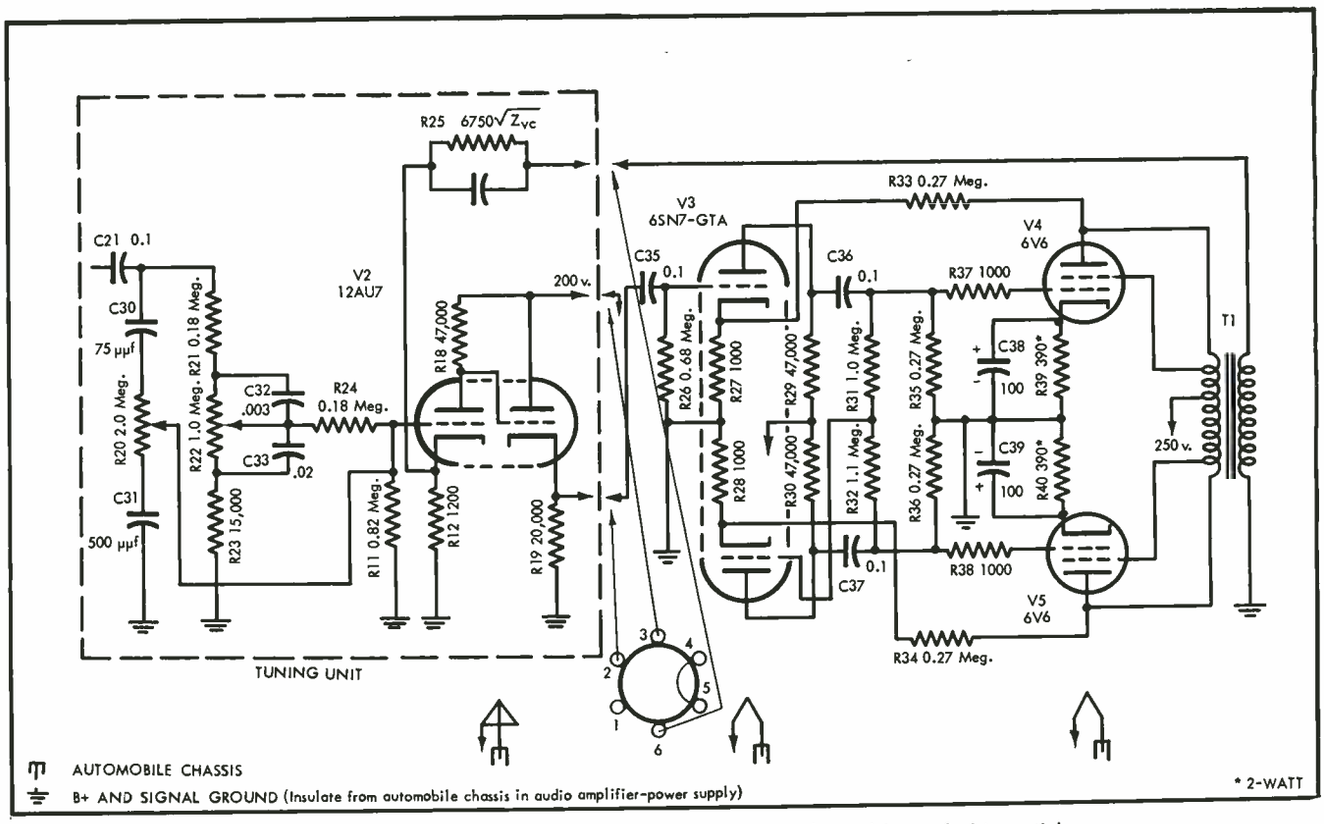


Fig. 2. Schematic of new audio amplifier which is the subject of this article.

ent in the speaker voice coil. While these phase shifts produce audible distortion under the above described conditions, they are not discernible as intermodulation distortion under routine test conditions. Hence, they often remain unreported in the literature.

3. The very low intermodulation distortions claimed for the Williamson circuit, can only be achieved by carefully balancing both the driver and output tubes with respect to amplification factors, as well as matching corresponding resistors, and balancing output tube cathode currents. In use, tube amplification cannot be maintained in a balanced condition, even though provisions are incorporated to permit d.c. balancing of the output tube cathode currents. In the most carefully constructed and balanced Williamson circuit, after a period of time, it is entirely possible that the signal voltage of the output tube plates may become as much as 50 per cent unbalanced. This unbalance increases distortions to a significant degree. Thus, an amplifier which shows 1 per cent intermodulation distortion at 30 watts as originally constructed, (with tubes especially selected for balanced amplification), may produce this same amount of distortion at only 20 watts after a period of use,[3] even though the tubes test "good" on a tube tester.

The amplifier finally evolved for our purposes is shown in *Fig.* 2. The circuit is simple and straightforward. Attention is invited to four features worthy of special attention:

a. The cathode follower, V_2, is directly coupled to the preceding stage. The cathode follower is used primarily as a low-impedance source to transmit the signal over 8 or 10 feet of cable without pickup of extraneous noise and disturbances. We would have preferred a 6SN7 tube in this application, but space considerations forced the use of the 12AU7.

b. Local feedback is used in all stages of the voltage amplifier.

c. The use of a combined phase splitter-driver, so arranged that the signal delivered to the grids of the output tubes is accurately balanced. This particular arrangement, coupled with negative feedback from the plates of the output tubes, minimizes tube amplification differences so effectively that the signal at the output tube plates is balanced within 2 per cent, with tubes selected with no attempt at balancing amplification factors. This circuit ensures that the amplifier will operate at low values of intermodulation distortion regardless of the effects of aging.

d. The use of individual cathode resistors in the output tubes to equalize

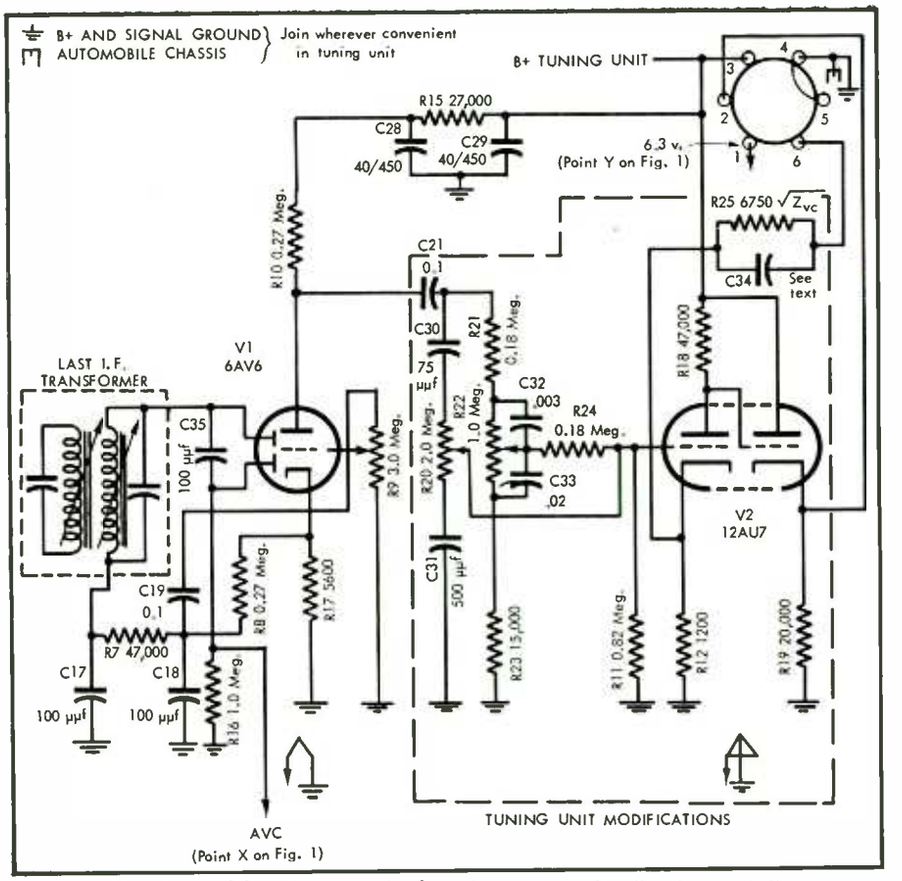


Fig. 3. Modifications required to improve radio "tuning unit."

cathode currents. Tests with random tubes showed that cathode currents remained balanced within 1 ma. Since a good quality output transformer will tolerate an unbalance up to 5 ma, the use of a balancing potentiometer and accompanying network of resistors is unnecessary.

Circuit Analysis

A detailed analysis of feedback arrangements shown in *Fig.* 2 is in order. As previously mentioned in connection with the Williamson circuit, large amounts of inverse feedback from the output transformer secondary frequently result in parasitic oscillations. The remedy is to reduce such feedback to 12 db or even less, depending on the quality of the output transformer.

However, when this is done, intermodulation distortion increases accordingly. The remedy is to use local feedback to ensure a low-distortion signal at the plates of the output tubes. There are only two mathematical equations which are needed for a reasonably accurate analysis of these feedback arrangements in *Fig.* 1. The first of these equations deals with the gain of a cathode follower. (such as the second half of V_2):

$$A = \frac{Y \times R_L}{(R_P + R_L)(Y + 1)}$$

where A = gain
Y = amplification factor (from tube manual)
R_L = load resistance
R_P = plate resistance (from tube manual)

The second equation expresses the gain of a circuit containing feedback:

$$A_f = \frac{A}{1 - AB}$$

where A_f = gain after feedback is applied
A = gain without feedback
B = feedback ratio (i.e. percentage of output fed back to input). When negative feedback is used, B will be negative.

Employing the above equations, the following results are obtained:

Feedback in the first half of V_2 is:

$A = 14.1$ (from tube manual)

$$B = \frac{1200}{1200 + 47000} = .0249$$

Therefore

$$A_f = \frac{14.1}{1 - (-14.1 \times .0249)} = 10.4$$

and

$$Feedback = 20 \log_{10} \frac{10.4}{14.1} = 2.6 \text{ db}$$

Gain of the second half of V_2 is

$Y = 20$ (from tube manual)
$R_P = 7000$ (from tube manual)
$R_L = 20{,}000$ ohms

Therefore

$$A = \frac{20 \times 20{,}000}{(7000 + 20{,}000)(20 + 1)} = 0.71$$

[3] Aerosound Output Transformer Bulletin. (no date or number given)

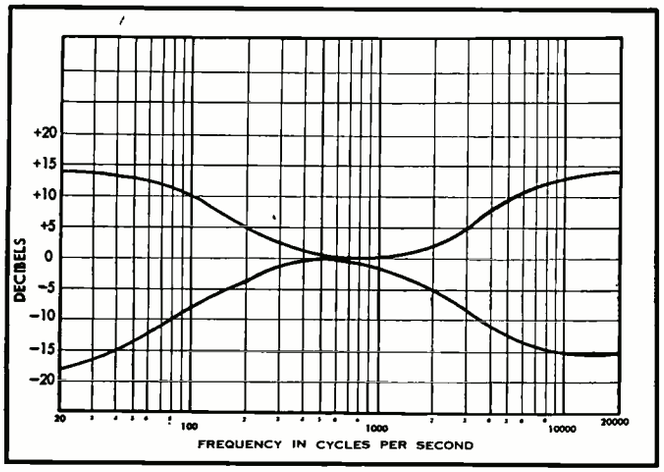


Fig. 4. Curve of tone control ronge available in modified tuning unit.

Feedback in one half of V_4 (disregarding temporarily the feedback from plates V_5 and V_6):

$$B = \frac{1000}{1000 + 47{,}000} = .0208$$

$A = 15$ (from tube manual)

Therefore

$$A_f = \frac{15}{1 - (-15 \times .0208)} = 11.4$$

and

$$Feedback = 20 \log_{10} \left(\frac{11.4}{15} \right) = 2.4 \text{ db}$$

Feedback in the combination of one half of V_4 and one output tube

$$B = \frac{1000}{1000 + 270{,}000} = .0037$$

$A = 11.4 \times 9 = 103$ (gain of one half of $V_4 = 11.4$ and gain of V_5 is approximately 9)

Therefore

$$A_f = \frac{103}{1 - (-103 \times .0037)} = 75$$

and

$$Feedback = 20 \log_{10} \left(\frac{75}{103} \right) = 2.8 \text{ db}$$

Feedback from secondary of output transformer to V_2

$$B = \frac{1200}{1200 + (6750 \times \sqrt{16})} = .0425$$ (assuming feedback loop is connected to 16-ohm tap)

$$A = 10.4 \times .71 \times (2 \times 75) \times \frac{\sqrt{16}}{\sqrt{10{,}000}}$$

$= 43$ (assuming that turns ratio of transformer reflects a 10,000-ohm load to the plates of output tubes)

Therefore

$$A_f = \frac{43}{1 - (-43 \times .0425)} = 15.2$$

and

$$Feedback = 20 \log_{10} \left(\frac{15.2}{58} \right) = 12 \text{ db}$$

Total feedback = 2.6 + 2.4 + 2.8 + 12 = 19.8 db (neglecting local feedback of cathode follower V_2). As much as 10 db of additional feedback can be used in the outside feedback loop, but such large amounts of feedback from the output-transformer secondary could result in the subsonic and ultrasonic parasitic oscillations previously discussed. Test results of the completed amplifier are shown in Table II. It should be explained that these results were obtained with a purely resistive load and a very short cable connecting the amplifier and tuning unit. When the equipment is installed in a car, the 8 to 10 feet of cable necessary to connect the tuning unit with the amplifier shunt an appreciable stray capacitance across the output transformer secondary. Furthermore, when a speaker is connected in lieu of a resistive load, the stray capacitance in the speaker voice coil is also shunted across the output transformer. These capacitances all tend to degrade the performance of the amplifier. Therefore the length of the interconnecting cable should be kept to the minimum consistent with reasonable ease of installation. For the same reason, it is desirable to use speakers of impedances which permit them to be arranged in series rather than in parallel.

While this amplifier was designed specifically for use in an automobile, it is eminently well suited for a home installation, merely by providing a suitable power supply and substituting higher powered output tubes such as the 6550 or 5881.

An underneath view of the completed amplifier-power supply is shown in *Fig.* 5.

TABLE I

Power Requirements:	
Amplifier-power supply	10 amps. at 6.3 volts
Tuning unit	1.5 amps. at 6.3 volts
Power Output:	10 watts ± 1 db, 20 to 70,000 cps
Frequency Response (at 1 watt):	±1 db from 15 to 100,000 cps
IM Distortion:	1.2% at 10 watts
Sensitivity (audio amplifier):	1.8 v. rms input for 10-watt output
Feedback stability margin:	10 db
Hum and noise:	Barely audible in front seat of automobile

Tuning Unit Modification

A few changes to the diode detector and AVC system will result in noteworthy improvement in the radio tuner.

The AVC system shown in *Fig.* 1 is combined with the signal detector. Such an arrangement introduces distortions into the detected signal by changing the time constant of the detector load and at times clipping the negative peaks of the audio signal, as well as producing certain distortions at low frequencies.

These adverse effects may be avoided by separating the AVC function from the detector function as shown in *Fig.* 3.

It will also be noted that the triode section of V_1 is changed so that grid bias is developed by a cathode resistor. This modification results in desirable negative feedback and reduction in distortion, as well as providing a positive potential of approximately 1 volt at the cathode of V_1, which prevents the application of AVC action on weak signals. As changed, the tuner unit is considerably more sensitive to weak signals, since the AVC voltage is not applied until the r.f. carrier peaks at the detector exceed 1 volt in amplitude.

With reference to *Fig.* 3, volume control R_9 has been placed in parallel with R_8. This arrangement prevents the d.c. component of the rectified signal from passing through the volume control and avoids the scratchy noises so often associated with the operation of the volume control shown in *Fig.* 1.

C_{20} of *Fig.* 1 has been removed to enhance high-frequency response.

Power Supply

The audio amplifier tubes V_3 to V_6 inclusive require approximately 88 ma, and a typical tuning unit requires from 15 to 20 ma additional. The heavier vibrator transformer commercially available is capable of an output of only 100 ma, hence something unconventional must be used. An ordinary 117-volt primary transformer with two 6.3-volt secondaries each rated at at least 8 amperes or a center tapped 12.6-volt secondary rated at 8 amperes will provide the required plate current by use of the full-wave voltage-doubler circuit shown in *Fig.* 6. The vibrator should be capable of handling at least 7 amperes.

All vibrator power supplies generate r.f. interference, or "hash," which will cause annoying noise if suitable preven-

tive measures are not incorporated in the power supply. The r.f. choke L_4 and capacitors C_{49} and C_{50} filter hash from the plate supply. L_1, L_2, and L_3 with C_{40}, C_{41}, C_{42}, and C_{43} prevent hash from being radiated through the heater wiring. Omission of these various filtering components will usually result in a great deal of r.f. interference.

The problem of furnishing battery current to the amplifier-power supply is difficult because of the large current requirement—about 10 amperes. The ON-OFF switch in the tuning unit is not adequate to handle currents of this magnitude and usually the accessory section on the ignition switch will also be overloaded. Furthermore, the IR drop of this heavy current passing through these two switches and associated wiring will be unacceptably large. The problem can best be solved by locating a relay in the amplifier-power supply chassis as shown in the circuit of *Fig.* 6. An ordinary 6.3-volt horn relay available in practically any junk yard, will serve nicely for this purpose.

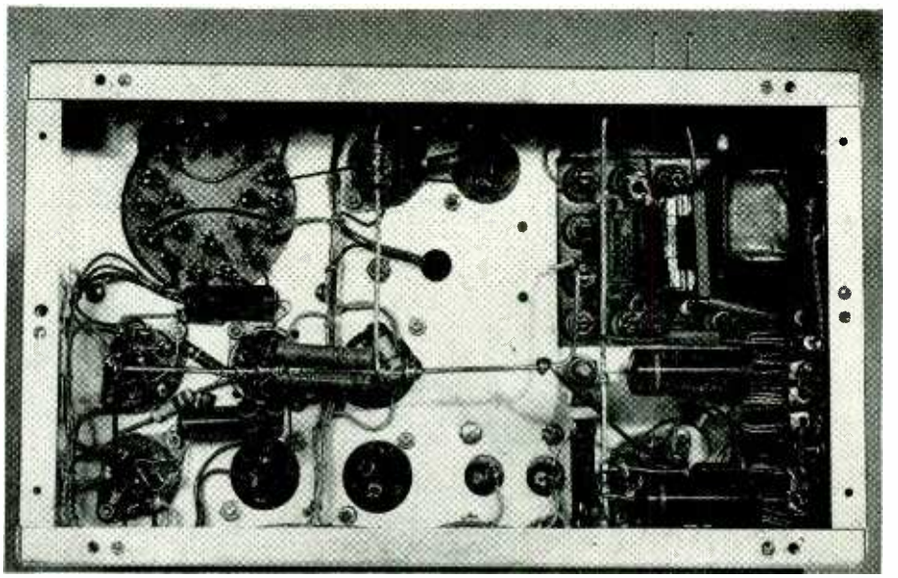


Fig. 5. Underside of amplifier-power supply unit on its separate chassis.

Speakers and Enclosure

The speakers should be mounted in holes cut in the shelf behind the top of the rear seat in such a manner that sound radiated from the rear of the cone is dissipated in the trunk. This arrangement prevents sound from the rear of the cone intermingling with that from the front. At lower frequencies, intermingling is very marked, and combines the sounds from the two sources 180 deg. out of phase, resulting in decreased bass response. As frequencies increase, the sounds become more directional and resist such mixing. Consequently, most speakers reproduce treble frequencies as satisfactorily without an enclosure as with one. The typical auto radio shown in *Fig.* 1 has no baffling at all, with resultant poor bass response.

When a single small speaker is baffled as described above, its bass response will be improved, but the lack of piston area will make it impossible to achieve really good reproduction of low-frequency sounds. This latter deficiency can be remedied by using several small speakers all phased together and mounted in the rear seat shelf. It is not generally realized that when so used, the efficiency of the speakers is proportional to the square of the number of speakers employed. Thus, if 5 identical small speakers are used, the over-all effectiveness of 5^2, or 25 times the effectiveness of a single speaker of the same size. Distortion products are simultaneously reduced to one twenty-fifth of the distortion of a single speaker.

Five 3.2-ohm speakers arranged in series have a characteristic impedance $5 \times 3.2 = 16$ ohms. The speaker combination should be connected to the 16-ohm winding of the output transformer, just as a single 16-ohm speaker would be connected. Other combinations are possible, of course, including parallel connections and series-parallel connections. Regardless of how they are arranged, the following conditions must be met:

a. The combination must be attached to the proper winding of the output transformer.
b. The power dissipated by each speaker must be proportional to its rated characteristics as stated by the manufacturer.

Thus, if a single 8-ohm speaker is to be connected in series with two 16-ohm speakers connected in parallel, the over-all impedance would be 16 ohms. The 8-ohm speaker should have a rated power dissipation equal to the two 16-ohm speakers combined.

Generally speaking, it is desirable to connect speakers in series, rather than in parallel, because the series connection produces a lower capacitive loading on the secondary of the output transformer. Capacitive loading of the transformer tends to cause ultrasonic oscillations in the amplifier, as discussed previously.

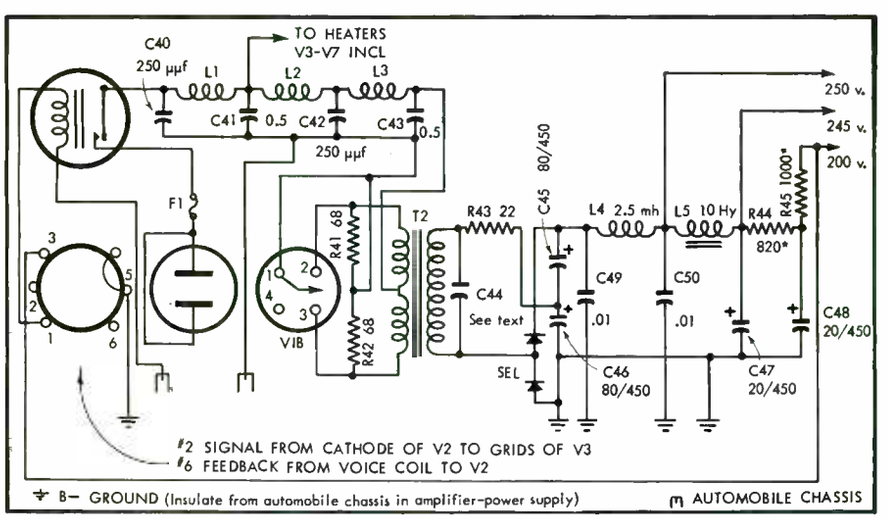


Fig. 6. Schematic of power supply section of the system.

Construction

The first step in construction should be a determination of the plate current requirements of the radio tuning unit. This can be done by referring to a service manual, or if a manual is not available, the voltage and amperage of the plate supply should be measured while the radio is in operation. When this information has been obtained, it is a simple matter to calculate the proper value of dropping resistors R_{44} and R_{45}, *Fig.* 6. The values shown are suitable for a tuning unit requirement of 20 ma at 200 volts, plus 5 ma for V_2.

The vibrator, power amplifier tube, and rectifier tube may now be removed

(*Continued on page 86*)

HI-FI in the Home

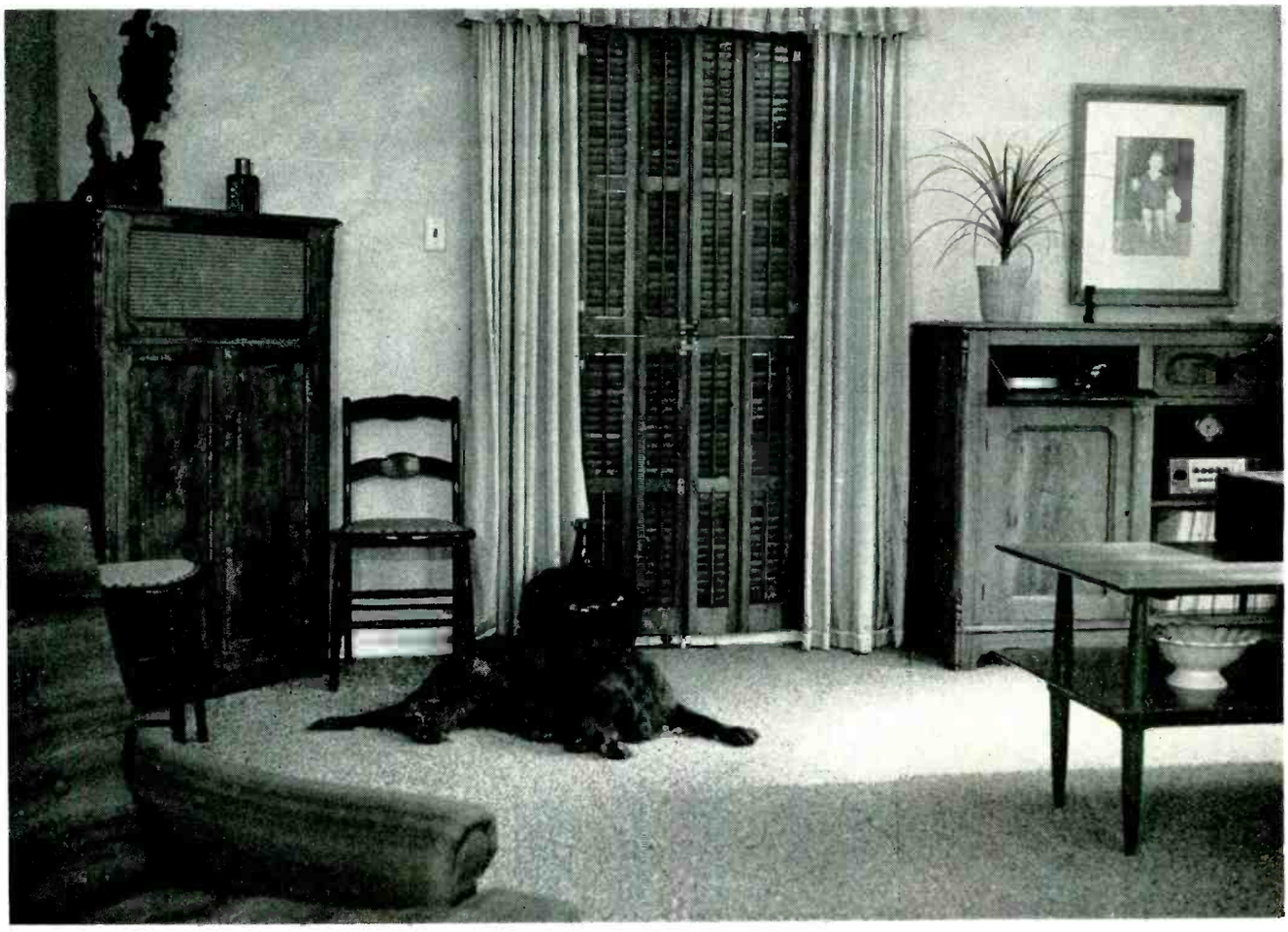
While we haven't been completely swamped by readers' photos of their home installations, we are so far ahead now that we couldn't use them up this year without having more than one front cover. Here are five of those we liked best.

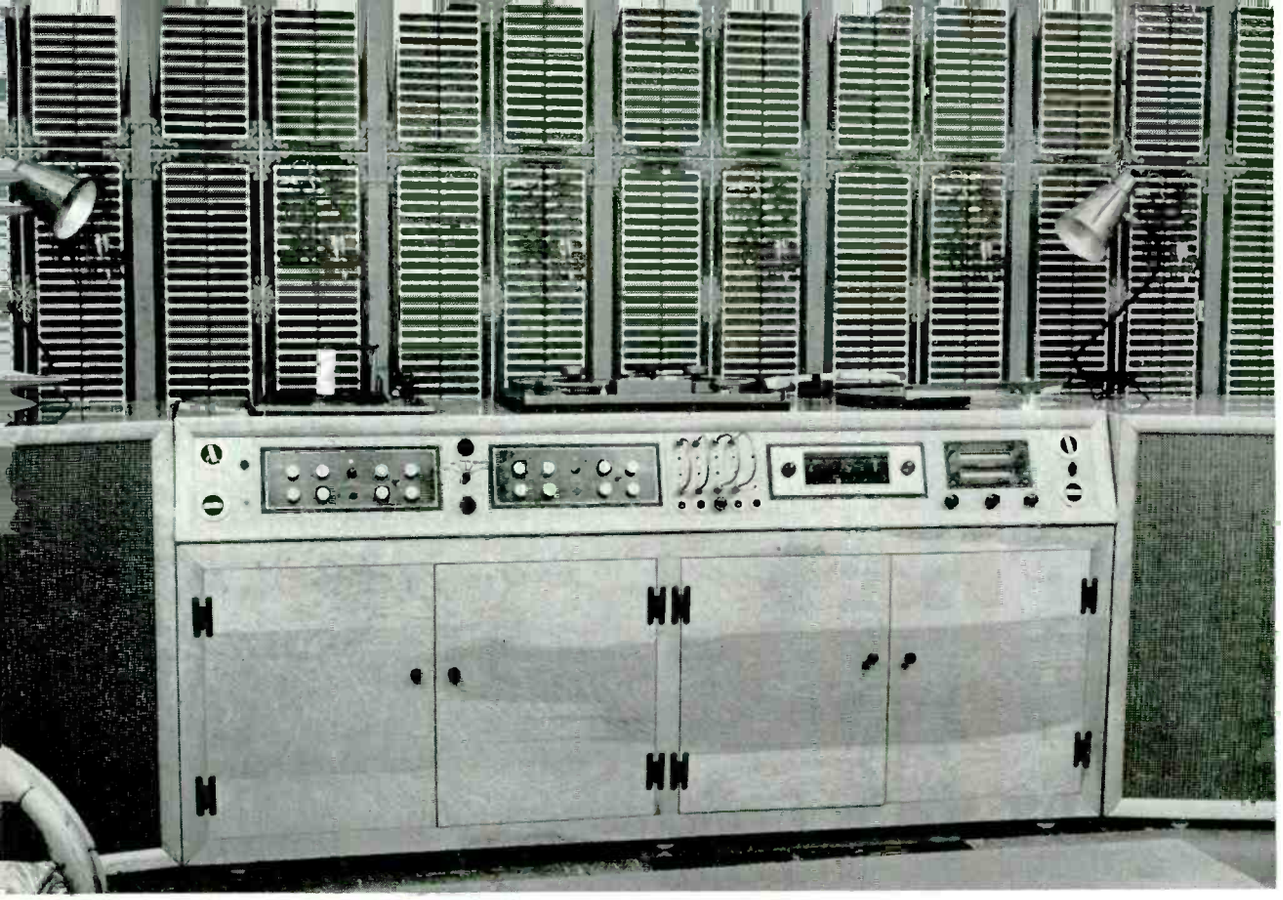
LAST SUMMER—with the advent of the current cover design—we invited readers to send in photos of their own installations. In return, we promised to pay ten dollars for each one used on an AUDIO cover.

We still have a few more in readiness for future covers, we will admit, but the novelty and interest in those displayed in these four pages should not be withheld from readers until we can find space for one on a cover. We trust the readers who submitted these pictures will be equally pleased to find them here instead—and here the pay is better by fifty per cent. Checks will go out about the fifteenth of March.

The installation shown below was accompanied by a letter pointing out that rooms with period decor do not lend themselves to built-in components. Joseph C. Etzler, of 302 West 20th St., Hutchinson, Kansas, says, "It just doesn't look aesthetic to have a tuner or control unit with its contemporary face peaking out over the wife's precious antiques." He told us he had found that most editors shy-away from reproducing this type of installation, preferring to print photos from members of the Build-'em-in-the-bookself school. "This may be well and good," he says, "but there *are* thousands of period-decorated homes. The chest at the right contains tuner, turntable, preamp, changer, and record storage, and the power amplifier is located in the basement. The corner horn is covered by a dummy shell, which can be made up from antique furniture parts or from scratch, *if* (italics ours) you have the tools and talent."

From Sweden comes the photo at the right. Georg Sylwander, of Lidingovagen 75, Stockholm, removed the strings from the 200-year-old piano and installed a Grundig tapedeck and Ebner record player, as well as Heathkit amplifiers, using a panel of electroplated goldstained aluminum. The grilles are used for ventilation, and at the narrow end there is space for records. The deep lustre of the old mahogany surfaces has been restored, "with much work," Mr. Sylwander says modestly. He adds, "I can assure you that the pleasure of resting your eyes on this old instrument while you hear a perfect recording is a good complement to the musical entertainment.





At the left is a stereo installation in the home of Mr. Mort Miller, 962 Paloma Drive, Arcadia. The equipment: two Scott 121A preamps, Concertone stereo tape recorder, Fisher FM80 tuner, Collaro record changer, D&R turntable, Fairchild arm and cartridge. The power amplifiers are identical McIntosh MC30's, and the speakers—at right and left—are Jensen G610 Triaxials. The installation was done by High-Fidelity House, 536 S. Fair Oaks, Pasadena 1, California, with most of the cabinet work and electrical planning being done by Mr. Miller himself.

The photo below comes from Marrt Electronics Laboratories of N.Y. Inc., 1053 Broadway, Woodmere, L.I., N.Y.

"Hi-Key Hi-Fi" is the title given this picture by Max Eckert, P. O. Box 535, Sepulveda, California—an installation designed and executed by Robert de Horoch, Hollywood. Located in the entry hall, all controls are at eye level with shelves for tape and record storage. Speakers are in living room adjacent—two James B. Lansing D130's, two University HF206's, two University crossover networks. Concertone Series 20 tape recorder, Thorens CD43N changer, Sherwood S-2000 AM-FM tuner, and Harman Kardon A-400 FM tuner furnish the sources to National amplifiers and preamplifiers.

Equalization in Tape Recorders

HERMAN BURSTEIN

Complete understanding of the fundamentals of equalization as applied to a tape recorder should make it easy to understand the circuits encountered in commercial products. The author leads the way through these fundamentals.

TO ANYONE who ever expects to become involved in the use, alignment, repair, or construction (of the electronics) of a tape recorder, an insight into the recorder's equalization—and the resulting effect upon frequency response, distortion, and signal-to-noise ratio—should be of value. The following will attempt to illuminate a somewhat elusive subject.

Unless stated otherwise, the discussion is predicated upon a tape speed of 7.5 ips, the most popular speed for high fidelity purposes so far as home use and commercial prerecorded tapes are concerned.

Figure 1 is an introduction to the problem of equalization. It shows the typical response of a tape recorder at 7.5 ips without equalization of any sort, based upon a high-quality record-playback head (or separate heads) and normal bias. The figure also presents suitable bass and treble equalization curves that would achieve virtually flat response between 20 and 15,000 cps.

The story told by *Fig.* 1 is far from complete. Moreover, while the scheme of equalization therein is practical—in fact, something like it is employed by many moderate-price tape recorders—it is not the one almost universally employed in professional American machines and generally used for production of commercial recorded tape. Instead, so-called NARTB equalization is employed. Actually, NARTB has officially promulgated an equalization standard only for recordings made at 15 ips. However, the 15 ips standard has been found practical at 7.5 ips, at least in high-quality machines, and therefore it has been widely adopted, particularly in professional and semi-professional use. So today NARTB equalization characteristics and principles constitute a *de facto* standard for 7.5 ips.

The advantage of NARTB equalization lies in a higher signal-to-noise ratio, although in exchange it causes the recorder to skirt the borderline of distortion more closely and accentuates the problem of maintaining high-frequency response. The reasons for this will appear in the section on Turnover Frequency.

Using NARTB equalization for purposes of illustration, *Fig.* 2, in eight parts, traces the equalization process in a tape recorder from signal input to signal output.

(A) represents an input signal to the recorder, flat from 20 to 15,000 cps.

(B) shows the typical record equalization in a machine conforming to NARTB requirements. The slight bass boost is a specific characteristic, namely 3 db up at 50 cps and rising thereafter with declining frequency at a rate approaching 6 db per octave; this rise, however, is not maintained below the audio range. The treble-boost curve is not specific but is that required to make over-all (record-playback) response flat over the audio range, as will be shown in (G), a specific curve covering the bulk of the audio range is provided only for playback.

A record head is operated so that the current through the head, and thus the magnetic flux *applied* to the tape, is essentially proportional to the signal voltage. Since a flat signal, (A) is assumed, (B) therefore essentially represents the magnetic flux applied by the record head to the tape.

(C) shows the losses that typically take place in the record process at 7.5 ips. That is, the magnetic flux *recorded* on the tape is less than the flux *applied* by the head. These record losses are principally due to the erasing effect of bias current, which becomes more severe with increase in bias, and to the phenomenon of demagnetization. The latter may be explained as follows. Frequencies recorded on the tape form equivalent bar magnets. The higher the frequency, the shorter the magnet. The opposite poles of a magnet exert a mutual cancelling (demagnetizing) effect, which varies inversely with distance between poles. Thus demagnetization losses are greatest at high frequencies, where the opposite poles of the equivalent bar magnets are closest together.

(D) is the net result of applied flux and record losses, that is (B) and (C). Thus it is the magnetic flux actually recorded on the tape, as *implicitly* required by the NARTB standard. To measure recorded flux directly is a complex laboratory procedure. Therefore NARTB does not specify recorded flux as such. Instead it sets forth a playback characteristic, (F), which bears a complementary relationship to recorded flux, as will be explained. Thus, given a playback-equalization characteristic, recorded flux is implicitly defined, on the assumption that over-all response is to be essentially flat.

It should be noted that NARTB re-

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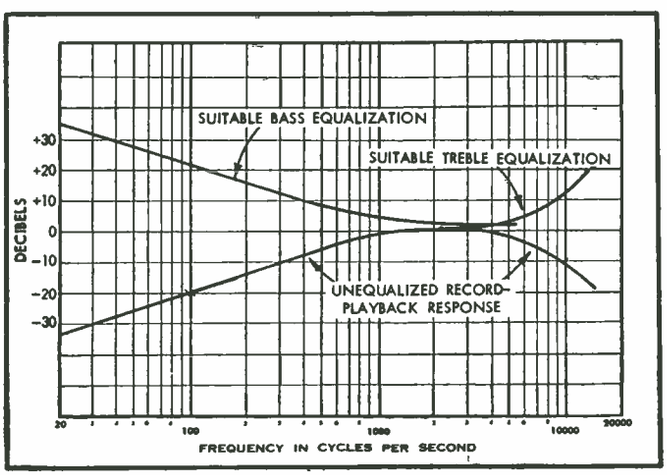

Fig. 1. Typical response of tape recorder at 7.5 ips without equalization.

corded flux has a turnover frequency at 3180 cps, at which point it drops 3 db. Thereafter it declines with increasing frequency at a rate approaching 6 db per octave. There is also a turnover frequency at 50 cps, where recorded flux is 3 db up; and the rise approaches 6 db per octave at lower frequencies.

(E) is the typical response of a high-quality playback (or record-playback) head at 7.5 ips, assuming that recorded flux is constant at all frequencies. The head is an inductive (velocity) device, so that its output is essentially proportional to frequency. In other words, its output tends to rise at the rate of 6 db per octave. However, high-frequency response of the head is limited by width of its gap. The particular response curvature in (E)—that is, departure from a 6-db-per-octave characteristic—is based upon a physical gap of .00025 in. and allows for the fact that the effective, or magnetic, gap tends to be somewhat larger than the physical one. Typically, the physical gap is about nine-tenths of the magnetic gap. Some heads have physical gaps as small as .00015 in., so that below 15,000 cps their response departs substantially less from a 6-db-per-octave line than the head represented in (E).

By adding the record losses of (C) to the playback response of (E), one obtains the unequalized record-playback characteristic of *Fig.* 1.

(F) is the net result of recorded flux and the response of the playback head —that is, (D) and (E). Thus it is the signal output of the playback head.

The solid line in (G) is the playback equalization specifically stipulated by NARTB. This characteristic has two turnover frequencies, which are the same as for recorded flux: (1) At 3180 cps the rise in response with declining frequency reaches 3 db and thereafter approaches a rate of 6 db per octave. (2) At 50 cps bass boost is 3 db below the maximum it ever attains.

The distance between the solid and dashed lines in (G) represents the playback treble boost required for flat response, as provided for by NARTB in general rather than specific terms. The actual amount of treble boost depends upon the losses in the playback head, chiefly due to gap width, as suggested in (E). Some heads, including the one upon which (E) is based, have gaps so narrow and losses so limited that adequate, though not perfectly flat, high-frequency response is obtained without playback treble boost.

The solid line in (H) is the net result of signal output of the playback head and playback equalization—that is, (F) and (G). Thus flat response is obtained, unless playback equalization does not incorporate treble boost, in which case there is a moderate decline at the high end, as shown by the dashed line. Flat, or nearly flat, response is not a coincidence but the result of maintaining the same turnover frequencies of 3180 and 50 cps in the recorded flux, in the signal output of the playback head, and in the playback equalization characteristic.

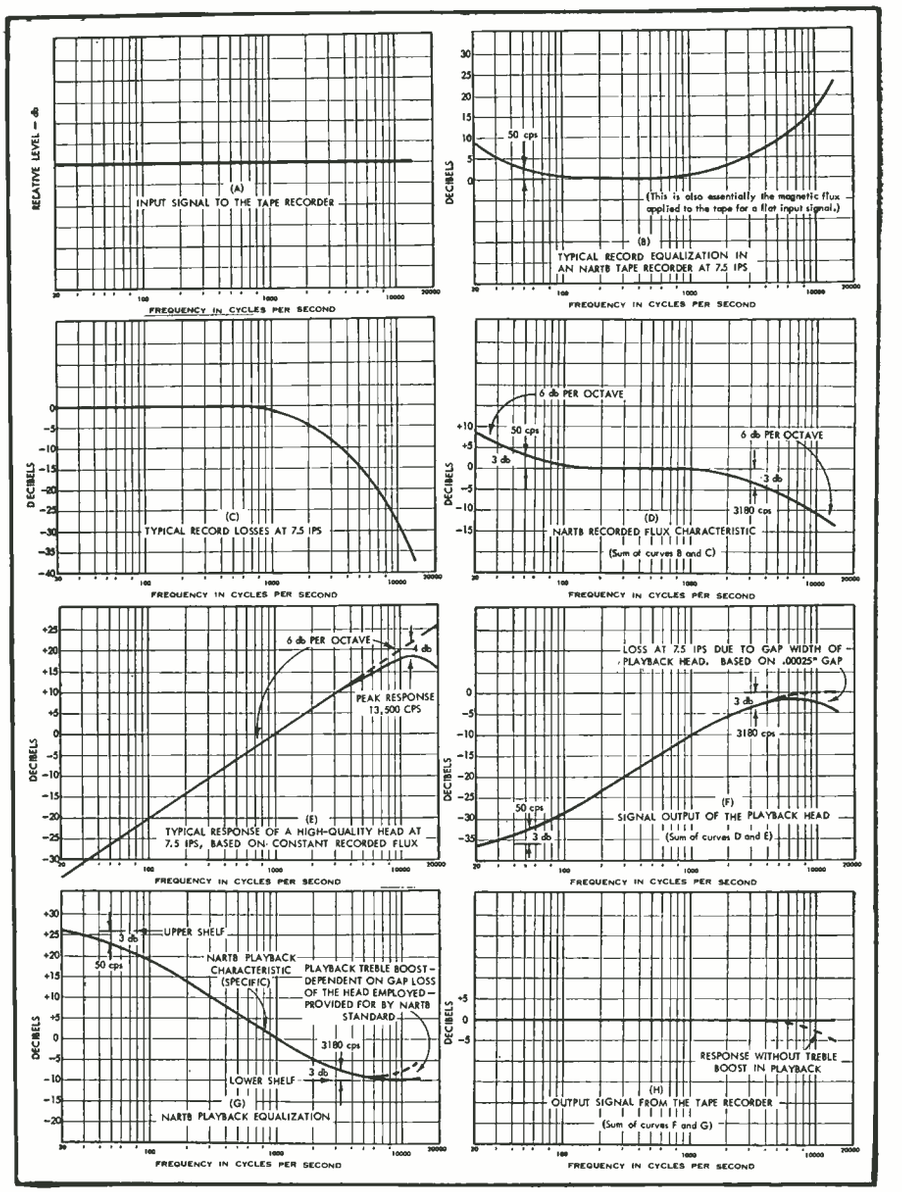

Fig. 2. Eight curves tracing the equalization process through a tape recorder and its associated amplifiers from signal input to playback-signal output.

Turnover Frequency

In the case of NARTB playback equalization, as just indicated, the first turnover frequency is 3180 cps. On the other hand, as shown in *Fig.* 1, flat reponse can equally well be achieved with the aid of bass boost having a turnover frequency of approximately 1200 cps. One may well ask: How can different bass equalization characteristics achieve flat response in the same situation? And why is one turnover frequency superior to another?

To find the answers, let us commence with the fact that the response of a high-quality playback head at 7.5 ips essentially rises 6 db per octave with increasing frequency. For simplicity, we shall ignore the relatively slight head losses of (E) in *Fig.* 2. Thus playback head response may be depicted in the simple fashion of (A) in *Fig.* 3.

Obviously, the rest of the tape recording system must then have a slope that *declines* 6 db per octave with increasing frequency, as shown at (B) in *Fig.* 3. From the discussion pertaining to *Fig.* 2 it can be realized that such a declining

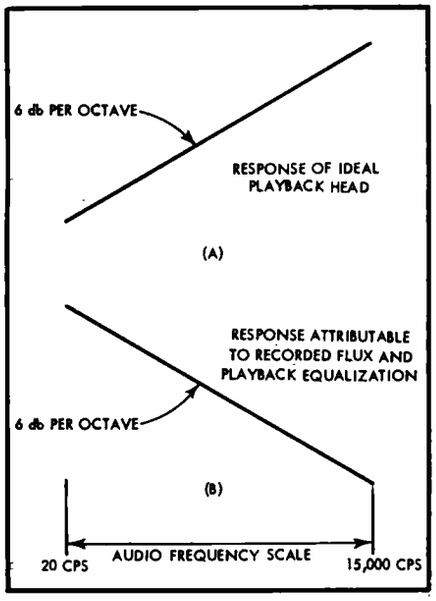

Fig. 3. Comparison of the playback head response (A) and the response of the balance of the recording system (B) in order to arrive at a flat over-all response curve.

slope is due to two factors: (1) recorded flux; (2) playback equalization. If the reader takes the trouble to add the curves (D) and (G) of *Fig.* 2, he will see that they produce a straight line declining 6 db per octave with increasing frequency.

Thus recorded flux and playback equalization bear a complementary relationship to each other, the sum of the two being a 6-db-per-octave declining slope. Given either characteristic, the other is implicitly defined. (Since we are here ignoring treble losses due to the playback head, it is assumed there is no treble boost in playback. If there were treble boost in playback, then the reference to playback equalization would be exclusive of any treble boost intended to compensate playback head losses. Thus in the case of (G) in *Fig.* 2 the reference would be only to the solid line.)

Recorded flux and playback equalization may be combined with each other in an infinite number of ways to produce the 6-db-per-octave slope. Five possibilities appear in *Fig.* 4. For ease of illustration, the characteristics are shown with sharp transition points—turnover frequencies—although in actuality they would have the gradual transition of *Fig.* 2. Furthermore, for simplicity, the 50-cps turnover frequency is ignored.

In *Fig.* 4, (A) represents a situation where recorded flux declines 6 db per octave throughout the audio range, so that zero playback equalization is required. At the other extreme, (E) in *Fig.* 4 indicates constant recorded flux throughout the audio range, in which case playback equalization must rise with declining frequency throughout the spectrum. (B), (C), and (D) of *Fig.* 4 are intermediate cases, where both the recorded flux and playback equalization have turnover frequencies. As recorded flux changes from flat to a 6-db-per-octave slope, playback equalization undergoes a complementary change from a 6-db-per-octave slope to flat.

At 7.5 ips, (A) in *Fig.* 4 is unrealistic because it is extremely wasteful of signal-to-noise ratio. Taking into account the nature of record losses at this speed and the permissible record treble boost, based largely upon the distribution of audio energy over the spectrum, more flux could be applied to the tape without overloading it; therefore a good deal more flux could also be recorded on the tape, resulting in an improved ratio in playback between audio signal and noise produced by the tape (hiss) and the playback amplifier.

On the other hand, the recorded flux of (E) in *Fig.* 4 is virtually impossible to achieve at 7.5 ips in the present state of the art (although feasible at 30 ips). Excessive record treble boost would be needed to overcome the record losses indicated at (C) in *Fig.* 2 at 7.5 ips. Such treble boost would produce considerable distortion by overloading the tape.

Between the extremes of (A) and (E) of *Fig.* 4 are combinations of recorded flux and playback equalization practical at 7.5 ips. (B) and (C) may be viewed as approximating equalization practices found in moderate-price recorders. It can be seen immediately that these practices involve fairly limited playback bass boost, thereby mitigating the problem of hum, which of course becomes more severe as such boost increases. Also, they indicate inferentially that relatively moderate amounts of treble boost are needed (because of substantial decline in recorded flux), which permits a saving in gain and tubes in the record amplifier.

(D) in *Fig.* 4 represents a tape recording system conforming to the NARTB standard. The recorded flux is just about as much as can be put on the tape at 7.5 ips without incurring appreciable distortion due to the large amount of treble boost required in the record amplifier, on the order of 23 db at 15,000 cps as indicated at (B) in *Fig.* 2. In complementary fashion, a great deal of playback bass boost is necessitated—36 db all told—so that very careful precautions against hum must be exercised in playback. In exchange for these disadvantages, namely a close risk of distortion and greater danger of hum, one obtains a high signal-to-noise ratio because of the relatively large amount of recorded flux.

In sum, the questions posed at the outset of this section have been answered as follows: (1) various playback equalization characteristics can be used to obtain flat response because each one is complemented by a different recorded flux characteristic, the sum of the two producing a 6-db-per-octave downward slope. (2) Playback equalization with NARTB turnover (3180 cps) is superior to equalization with a lower turnover frequency in that it reflects a scheme of equalization which permits a better signal-to-noise ratio because of greater recorded flux; at the same time, high fidelity requirements as to distortion and high-frequency response can be met.

Qualifications and Addenda

The first two sections of this article contain the basic story of tape recorder equalization as exemplifed by the NARTB standard. To facilitate explanation, certain factors have been omitted

(*Continued on page 85*)

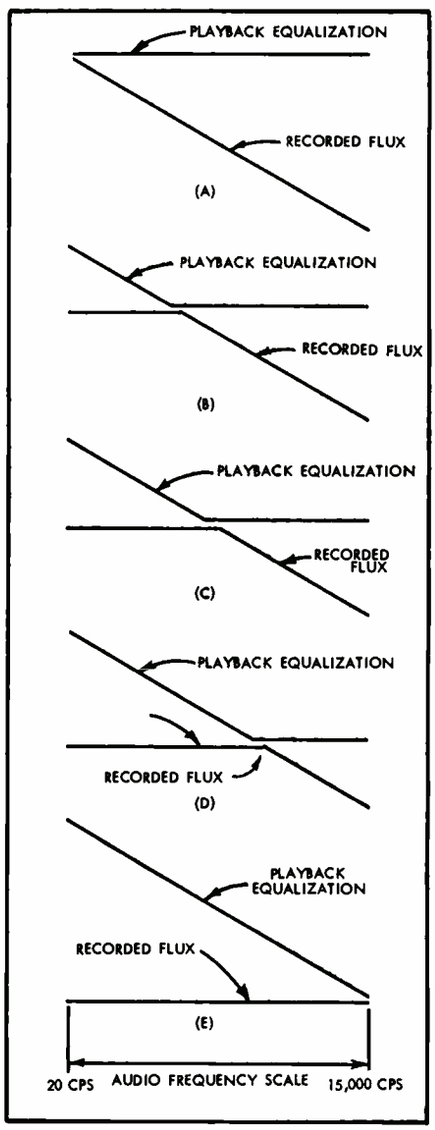

Fig. 4. Five possible combinations of recorded flux and playback equalization which combine to produce an over-all flat response curve.

Transients in Feedback Amplifiers

GEORGE FLETCHER COOPER*

Transients may be hard to visualize or understand without considerable training in electronic theory, but the author clarifies how they behave and shows why they are troublesome in audio amplifiers.

HAVE YOU EVER TRIED the experiment of sitting down for an hour to think about something you know all about? It is not particularly easy, because you tend to think along well-worn tracks and to arrive at well-worn conclusions. Sometimes, however, you can force yourself, at some critical junction, to say "Why?" or "Is that true?" In practically no time at all you discover that your easy assumptions break down just where they are most important and that everything you have thought about a particular topic is, well not untrue, but only partly true.

Some months ago, I wrote an article about the craze for unnecessary bandwidth which has afflicted many hi-fi enthusiasts and in the course of that article I recommended the use of rounding off circuits in the feedback path to prevent the "ring" on the front of a square wave. I don't propose to take back anything I wrote then. I still think that you should make your overall response droop away smoothly at, say, 15,000 cps. But I have come to the conclusion that this is by no means the whole story.

Nothing in this article affects the man whose amplifier is far too big for his home. If you built a 25-watt amplifier and the neighbors send protests if you peak over 2 watts, this is not for you, but if you have an amplifier which just drives nicely up to half power on the loudest passages, you may find food for thought in this discussion of transitnts.

One obstacle which I shall avoid is that we do not know too much about transient distortion. The reason for this is that we cannot measure it in any way which enables us to finish up with a single number—not that the single number we get for harmonic distortion tests does us very much good. There is still quite a lot of active discussion about weighting distortion measurements according to the harmonies produced, but most of us dodge that issue by aiming to get enough below 1 per cent for it to be unimportant. We haven't even a rough sort of number to argue about when we come to transients.

To add to our difficulties, or to make life easier, according to the way you look at it, we haven't got any real definition of what a transient is. At this point you must imagine the author is in a state of reflection, rather like the statue by Rodin, but more conventionally dressed. After working out an attractive definition of a transient, however, I realized that it did not help very much in the discussion of distortion. I guess I am not the first person to discover this.

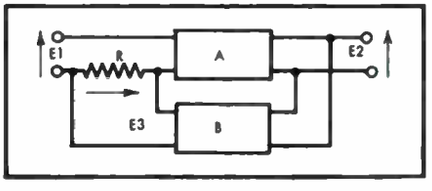

Fig. 1. The feedback amplifier in all its simplicity—if it is simple.

Even though we cannot easily find a useful definition of transients in a form suitable for measurement and mathematics, we can make use of an analogy to sort out various aspects of a transient. My automobile has a V-8 engine in a special light-weight body. When I press the starter button there is a loud "clunk" as the pinion flies home, a whirring noise as the engine is turned and then the buzzing of the engine running alone. As my ears get used to this buzzing, I can hear again the squeaking of birds and barking of dogs. This three-headed monster of a transient is a spread-out-in-time version of the behavior you can still hear distinctly with a big bell. Now each part of this triple transient is characteristic. With a solid well-padded body, such as my own, the impact of the starter pinion would not produce the loud "clunk": a light high-speed engine would be spun at quite a different rate. Even the tick-over of another type of engine sounds different, at first. Once running, you don't really notice it much, anyway.

Don't Listen for Transients

As our sound producers get lighter, the whole transient process gets faster. With the big bell, anyone can sort out the various stages in the development of the sound, but when we turn to the ordinary instruments of the orchestra it becomes a question of how good your ears are. I am inclined to say that it all depends on whether you are listening to the music or to the reproduction, because I know that engineers fall easily into a habit of watching out for the odd distortion, rather than ignoring it. If you go to a course on phonetics you may finish up listening to strangers' vowel sounds, rather than what they say, in an effort to pose as a new Higgins. Get over this: remember that distortion is strictly for the workshop, and develop a split personality.

It looks as though we must be satisfied to say that the transient is the first part of the sound produced by some device before it settles down to producing its main sound. I don't know that I like that definition too much, so I offer you another one: a transient is the sound produced by the initiation of a sound before the resonant and harmonic characteristics have had time to take control. That is not too good either. What about: a transient is the part of a sound which looks different on an oscillogram from what comes after? Read the first paragraph of this article again, and then *you* define a transient.

This difficulty with definitions need not hold us up any more, I think, because although we may not be able to

* *London, England.*

define a transient we have a fairly good idea of what we are discussing. Bertrand Russell says somewhere that "mathematics is the science in which we do not know what we are talking about, and do not care whether what we say about it is true." This statement is much more profound than it looks at first sight. Anyway, now we don't know what a transient is, let us see what happens to it on its way through a feedback amplifier.

To begin with we draw almost the standard drawing of a feedback amplifier in *Fig.* 1. As usual, A is the amplifier itself, with a gain of A times—there should not be any confusion due to the use of A with these two meanings—and B is the feedback network, with a gain of B times, B, of course, being a small fraction. The only deviation from the usual form is that I have shown the terminating resistor of B, the resistor R, outside the network. In a normal amplifier R might be partly hidden in the amplifier A, for example as the cathode resistor of the first tube. That

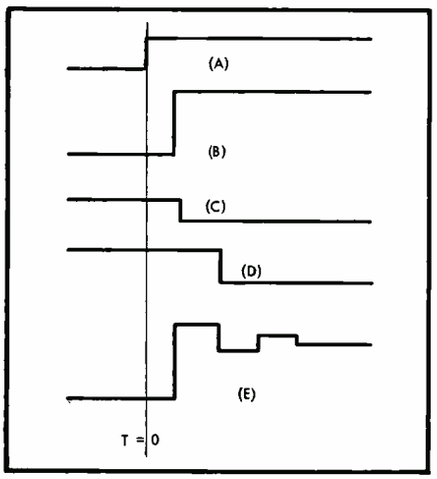

Fig. 2. The step function (A) (an instantaneous voltage change) is fed in, is amplified to give (B), which produces (C) across the feedback resistor, which when amplified produces (D). If we modify things to avoid a theoretical blockage, the output becomes (E).

does not make any difference to the basic theory, but it is much easier to keep the ideas sorted out if one component does one job, and one job only. The reason that R is shown is this: we shall assume that R is small compared with the input impedance of the amplifier in order to avoid considering the effect of the input impedance.

When we apply an input signal E_1 we get an output E_2, a fed-back voltage E_3, and we have $E_2 = A(E_1 - E_3)$

and $E_3 = B E_2$

That is just what you expected me to write, and it just is not true. When we first apply the input signal E_1, the feedback voltage E_3 is zero, so the whole of E_1 is applied to the input of the amplifier. That is why we want to make R small. The signal goes bumbling through the amplifier and after a certain amount of time—which, even though it might only be 10 microseconds, is still time—reaches the output as $A E_1$. This is the state reached at (B) of *Fig.* 2, the input signal being that of (A). After some further time the message is passed back through B that there is an output, and E_3 leaps smartly up to $A B E_1$. To the amplifier this seems as though a new signal has been added to the one already there, but in the opposite polarity. There are some rather tricky theoretical reasons why we cannot explore in too much detail what happens to this perfectly square wave. Put rather simply, for the perfectly square step we need an infinite frequency band and for the finite time of travel we need a phase characteristic which increases with frequency. For stability, however, the phase must not exceed 180 deg. at the maximum frequency. This is one of those problems you run into sometimes when people ask you if you can explain something really simply; actually, you can, only the explanation gives the wrong answer. If we make a number of approximations in the right order, however, the story told in *Fig.* 2 is not too far away from the truth, and you see that it shows a sort of cubist ring in the leading edge of the final output (E).

Step Inputs

In the very much simplified picture we have just examined one thing should stand out clearly. The first thing an amplifier tries to do when you give it a step input is produce an output multiplied by the full gain, not the gain with feedback. If we try to think of a sort of rounded step wave we can see that matters will not be so bad, because the initial signal, which is the one which goes straight through at full gain, is much smaller and the feedback gets a grip on things before we reach maximum output. I shall come back to this in a moment.

So far as our ears are concerned this large, but very short, peak might not be important. The trouble is that it will drive at least one and possibly more of the tubes into grid current. After all, we probably have 20 db of feedback in a good amplifier, and that means that the spike is 10 times the size of the final level. Our amplifier will not normally like that. Of course, if there are no capacitors anywhere things will not be too serious. The tubes will get rather a blow, but it is soon over. The coupling capacitors which most of us regard as normal change the picture entirely. The sudden burst of grid current will charge them up, and there they are, with a dis-

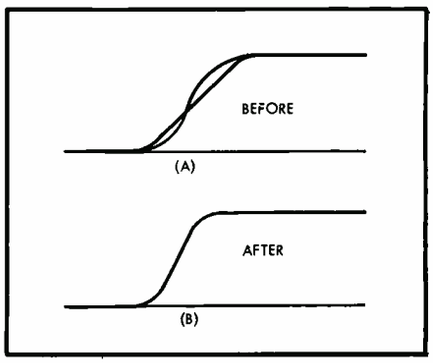

Fig. 3. The use of feedback will just steepen up the rise, we hope. But see Fig. 4.

charge time constant of somewhere between one-tenth and one second, holding the tube at quite the wrong bias. Everything is wrong now: the signal cannot get through, the product AB in our feedback equation means nothing because we can't tell what A is. We may not know what a transient is, but we certainly can wreck one.

Of course what we very commonly do with our feedback is "improve" the frequency response. The result is that the square wave which came out of the amplifier alone shaped like (A) in *Fig.* 3 is improved to the shape shown at (B). Here we have been very clever and designed matters so that there is no overshoot, no ringing on the top of the leading edge. Are we safe now? Rather reluctantly I have come to the conclusion that we are still not absolutely sure that we shall avoid transient distortion due to overloading. To help in analyzing the situation I have drawn *Fig.* 4. When I drew *Fig.* 3, I made both the rounded steps the same size because it is easier to compare them, and also because we usually think in terms of a given output. But in doing this, I threw away a lump of information. Those readers who have followed what goes on outside audio and TV will know that in recent years a lot of engineers have been spending all their time studying nothing but the theory of information and that they actually measure it in units called

"bits." I don't doubt that some very clever man has produced the following theorem: "If you throw away any information you don't know as much as you did before."

To keep in the information about the feedback we must show the outputs based on the same input level and this reveals a rather interesting effect. The faster rise time with feedback on may just be due to the fact that the output isn't going so far, or it may be because it is actually rising at more volts per second. I have shown the first of these conditions at (A) in *Fig.* 4, and the second at (B). We can reasonably say that during the rise period in (A), the negative feedback just hasn't come into operation, while during the rise period in (B), there is some positive feedback, or negative feedback which has gone more than 90 deg. away from the right place, helping to speed things up.

There will be more transient distortion in a system which behaves like (B), simply because the feedback is making matters worse, instead of better. A system which behaves like (A) has its feedback neutral during the initial period so that though it doesn't do any good, the only harm it does is make you think matters are better than they really are.

I am confident that readers will have accepted the use of a step wave for studying transients, because square-wave testing—and a step is only the front half of a square wave—is pretty well known by now. I won't say that we all use square waves for testing our amplifiers always, but we do know that it's the right thing to do. Some readers may be in doubt, however, whether big transients really exist: is there really the possibility of overloading the amplifier with the transient part of the signal. Now that the orchestra may include everything, even the kitchen stove, and I have seen vacuum cleaners and hot water bottles (the old-fashioned variety, not the rubber bag) in full cry on the platform of a concert hall, you can get some pretty violent transients. Anyway, maybe there's a double bass booming away and using up most of the available grid swing, so that even a small transient may cross the grid current line. I just don't think you can compromise over quality.

How pleasant it would be to stop right here, to say "well, there's the problem, you can solve it." Of course, that isn't allowed. Unlike the politicians, and especially their experts who think up the taxes, I can't say "we'll do the headaches, you provide the aspirin." Fortunately the mere formulating of the problem helps in its solution, just as the men who work on the Budget get paid so they can pay the taxes they are paid to work out.

Eliminate Unnecessary Highs

In an article I wrote recently, I pointed out the basic fact that we can't hear frequencies above 12–16,000 cps. Anything above that, then, is no use to us, though it may push a tube nearer overloading. Start off, then, by getting rid of these inaudible ultrasonic signals which may have crept in. Any sort of filter will do, though it should not have a sharp cut-off. Cheapest and easiest is probably a parallel-T R-C filter designed to have a maximum attenuation at 25,000 cps, but a single L-section of

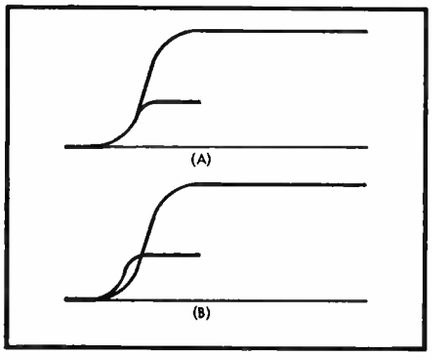

Fig. 4. Drawing the curves of Fig. 3 to the scale of equal inputs, we may find (A) no feedback during transient, or (B), positive feedback.

constant-k L-C filter will do the job, too.

Now we must think about the amplifier. We want to avoid any positive feedback, so we must look at the phase characteristic rather carefully. Usually when we design feedback amplifiers, we worry about stability. For transients we need what we might call super-stability, and I propose to lay down a rule that at 16,000 cps, the phase shift should not be more than 90 deg. This rule is almost too strict and that it should really be specified by a complicated formula depending on A and B, but its better to be safe than sorry. Let us stick to 90 deg.

This, oddly enough, is just the sort of condition you get when you design one of those super-wide amplifiers, as you can see by looking at *Fig.* 205 of High Fidelity Circuit Design.[1] All it is necessary to do, if your design is along these lines is to limit the input to what you can hear and follow the response shaping methods I have suggested in Golden Ears or Bats Ears.[2] It is worth-while doing a small sum. The phase shift of 90 deg. will be mostly in the frequency range from 11,000 to 16,000 cps, a band of 5000 cps. The delay is given by the simple formula (angle/frequency), so that it is $(\pi/2)$ $(\frac{1}{2}\pi \times 5000)$, or 50 microseconds. This, if anything, is an overestimate, because I took a rather narrow band just in order to get easy numbers. I doubt very much whether the average driver tube will push the output tube into more than 10 ma of grid current —if it will you are using too big a driver. Now 10 ma flowing into 1 μf, the coupling capacitor, for 50 μsec will only set up a signal of 0.5 volt, though if the coupling capacitor is 0.1 μf you will get 5 volts. Good big coupling capacitors are a help, then, though their capacitance to ground may be a worry. A driver which hasn't anything to spare for grid current and an output tube which doesn't expect driving power are perhaps even better.

Practical Cure

Many of us, however, must use output transformers which are not merely as good as the one considered in the book. The trouble here is that there is a lot of phase shift and delay in the transformer itself, so that it is the transformer which holds up the return of feedback information to the input. As we have seen, it is during this period that the distortion may be caused. The obvious thing to do is to put on some high-frequency feedback from the plate side of the output transformer. When I think about class-B operation this makes me rather worried, and in the interests of safety I should recommend taking feedback from each plate back to the appropriate point in the early stages. I realize that balancing up these two feedback paths may be rather tricky, but it will not matter if they aren't exactly equal, because the main feedback will still be from the secondary of the transformers.

Perhaps the general conclusions to be drawn from this article are that transients are the main problem for the designer who wants to get the best possible quality, that it is difficult for him to know by bench tests if he has achieved his aim and that the good basic doctrine of making sure that the feedback is available for distortion reduction and isn't wasted in correcting the frequency response holds good for transient distortion as well as for steady state distortion. Æ

[1] Gernsback Library No. 56.

[2] *Radio Electronics.*

High-Power Audio Amplifiers

MANNIE HOROWITZ*

As we increase the power output of an amplifier, we run into a whole new set of problems which are of importance to the designer and which must be solved properly and efficiently. Learn what these problems are and how they have been handled by one manufacturer.

THE CURRENT TREND toward more reserve power from high-fidelity audio amplifiers, has led to the need for the exertion of more care in the design of the power and output stages. Poor design can lead not only to electrical component or tube failure within the amplifier, but may result as well in tweeter-voice-coil burn-outs when an unchecked supersonic, audio, or parasitic oscillation is present at the output.

Output Tube Efficiency

There are several tube types capable of high power output. The European EL-34/6CA7 can deliver as much as 100 watts in push-pull pentode operation. The Tung-Sol 6550 can do the same. However, the EL-34 is more efficient, dissipating less heat within the tube for specific power outputs, than does the 6550.

The efficiency of an output tube is defined as

$$\frac{\text{AC power delivered to the load}}{\text{plate + screen + heater power dissipations}} \times 100\%.$$

Table I compares the power dissipated at the quiescent conditions by both the EL-34 and the 6550, when operated so as to permit the delivery of 100 watts to the load. The EL-34 dissipates 26 per cent less power than does the 6550. Although both tubes are excellent and especially well designed for high power applications, economy in design tends to indicate the use of the EL-34 rather than the 6550.

For clean, high power output, it is obvious to resort to push-pull operation. Maximum power considerations dictate the use of pentodes, but maximum curve linearity for the low distortion necessary in high-fidelity amplifiers would suggest triode operation. However, the best compromise is accomplished with true Ultra-Linear circuitry, (A) in *Fig.* 1, where linearity equal to or better than triodes is achieved while at the same time delivering power outputs comparable with that of the pentodes.

Tests that I have run indicate that this method of operation permits raising the screen voltage about 20 per cent above the manufacturer's specifications without any injury to the output tubes. However, this should not be done if the screen power dissipation ($E_{sc} \times i_{sc}$) or plate power dissipation ($E_{bb} \times i_b$) is higher than that recommended by the manufacturer. (Note: the above formulas for plate and screen dissipations are for fixed-bias applications only. When cathode bias is used, the plate and

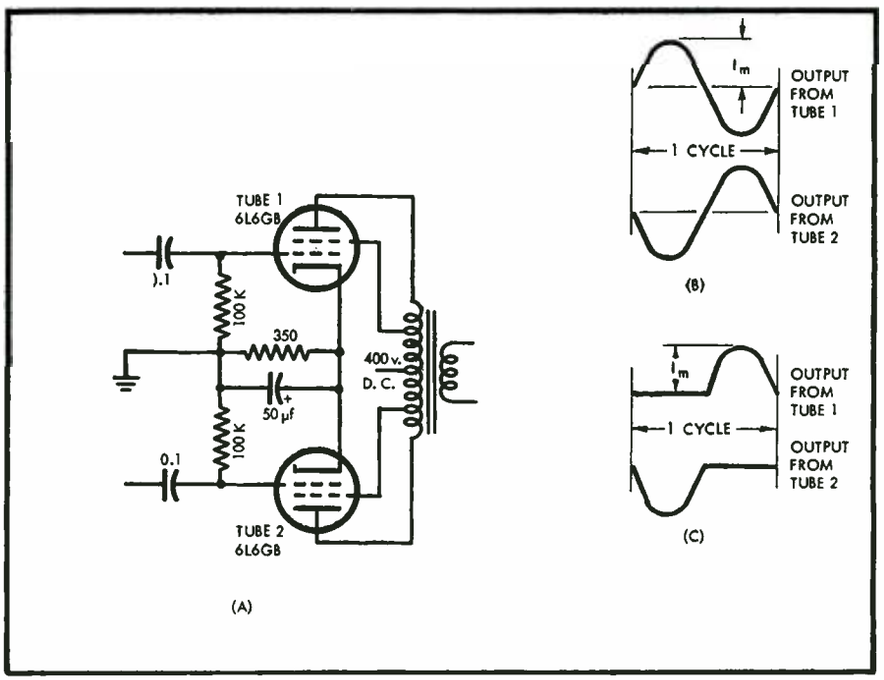

Fig. 1. (A) Schematic of typical Ultra-Linear push-pull output stage using 6L6GB tubes in Class AB. U-L tap is at 43% of turns from center on each side, or at 18.5% of total impedance. (B) Output over one cycle from each tube when biased for Class A operation. (C) Output from each tube if fixed bias is applied to obtain Class B operation.

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

TABLE I

COMPARISONS BETWEEN 6550 and EL-34

	6550	EL-34/6CA7
Plate Dissipation $E_{bb} \times i_b$ watts	$600 \times 50 \times 10^{-3} = 30$ watts	$800 \times 25 \times 10^{-3} = 20$ watts
Screen Dissipation $E_{sc} \times i_{sc}$ watts	$300 \times 1.5 \times 10^{-3} = 0.45$ watts	$400 \times 4 \times 10^{-3} = 1.6$ watts
Heater Power $E_f \times i_f$ watts	$6.3 \times 1.8 = 11.4$ watts	$6.3 \times 1.5 = 9.45$ watts
Total Dissipation per tube—watts	41.85 watts	31.05 watts

E_{bb} = plate supply voltage
E_{cc} = fixed cathode bias voltage
E_{sc} = screes supply voltage
E_f = filament voltage
i_b = zero signal plate current
i_{sc} = zero signal screen current
i_f = filament current

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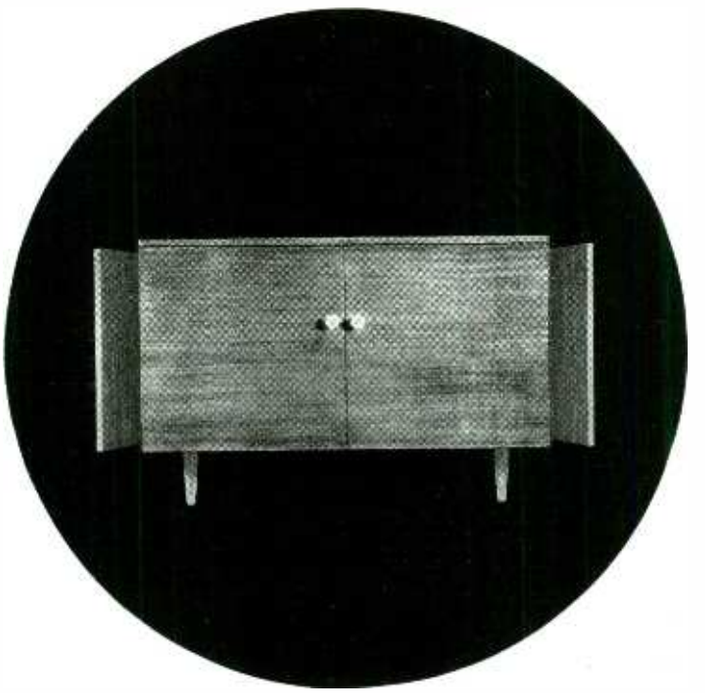

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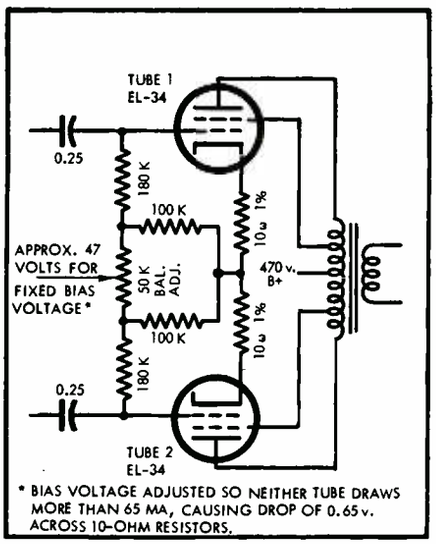

Fig. 2. Typical Class AB or Class B amplifier as used in EICO HF-50, HF-52, and HF-60 amplifiers. "Balance adjust" pot biases each tube properly for its individual curve variation.

screen dissipations become $(E_{bb} - E_{cc})i_b$ and $(E_{sc} - E_{cc})i_{sc}$ respectively.)

Two tubes, connected in push-pull circuitry and operated class A [each tube conducts through the complete cycle as in at (B) in *Fig.* 1] can deliver a specific amount of power before the plate and screen power dissipation ratings are exceeded. For more power output from the same pair of tubes without exceeding the ratings, they must be operated more efficiently.

This can be accomplished by decreasing the amount of plate and screen current the power supply must deliver per tube in each cycle—each tube would conduct for a shorter period of time per cycle, or for less than a complete cycle. The limit of this in audio work is class B, where each tube conducts for exactly one-half of each cycle, (C) in *Fig.* 1. The effective current per cycle that each tube takes from the power supply is low, for each tube conducts current only half the time—for one-half of each cycle.

Power Dissipation

The power dissipated in the tube is proportional to the total current passing through each tube over a complete cycle, that is, the average current. For the same amount of power being delivered to the load, each tube will dissipate less plate and screen power in class B than would be the case for class-A operation. Since plate and screen currents are lower per cycle in class B, the voltage applied to these electrodes can then be increased until the maximum plate and screen d.c. power dissipations are once again reached. These permissible additional voltages permit a pair of tubes to deliver higher output powers.

Although class B is used when there is a need for greater efficiency, class A provides better linearity and lower distortion. The obvious course is to choose a condition between class A and class B for best operation, in which the tube conducts for more than one half the cycle, yet less than the complete cycle. This is known as class AB. For maximum power, it is best that the bias on the tube grids be adjusted so as to approach as closely to class B as is possible without introducing excess distortion.

Figure 2 shows a schematic of a power output stage which can be used in class AB operation. A d.c. balance control was included for lower hum, distortion and output tube protection. Fixed bias, a necessity for the cutoff conditions in class B, is used here in class AB to maintain constant operating conditions for the tubes.

When tubes are biased so as to operate close to class B, each tube works on a nonlinear portion of its individual plate characteristic curve, although the composite curve for the two tubes is reasonably linear. On a curved portion of the characteristic, only a substantial change in bias voltage can alter the amount of plate current each tube is conducting as shown in *Fig.* 3. Near cutoff, tube characteristics vary considerably from tube to tube due to curvature. Each tube must have its individual bias adjusted so as to control the individual tube currents. This can be accomplished with the balance control.

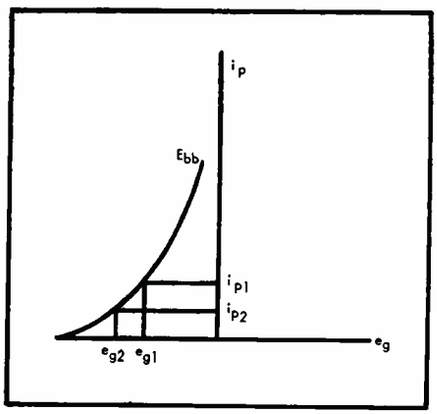

Fig. 3. Plate current variation with bias voltage.

Unbalance, resulting in excess current in one of the tubes, can damage it irreparably, for added current through the tube means added power dissipation by the tube. The d.c. balance control adjusts the bias on each tube just differently enough (consistent with its own peculiar plate characteristic) to allow each tube to conduct the same amount of current, even if each one must work at slightly different portions of their respective grid characteristic at quiescent conditions.

Under high signal conditions, the d.c. is slightly unbalanced despite the use of a balance control. This is because the different tube characteristic of each output tube near cutoff, as described. However, the tubes are protected. Much of the power that is dissipated in the plate and screen circuit in the quiescent state is dissipated by the output load when a signal is fed through a class AB amplifier.

The slight d.c. unbalance is also insignificant at high signal conditions, since any inequality in each curve is applied to a minute portion of the complete signal, thus not appearing as distortion. This condition, coupled with an excellent phase splitter (such as the Clare Cathode-Coupled type) makes an a.c. balance control unnecessary.

This balance adjustment can be checked in several different ways. It may be checked audibly by adjusting the control for a minimum hum condition. A more accurate method provides an accommodation to use a milliameter temporarily in each cathode. Here, the balance control is set to make the currents equal.

A simpler method is the addition of a small 1 per cent resistor in each cathode, as in *Fig.* 2. When the voltages across both resistors are equal, the currents through the tubes are equal ($E = IR$).

The Output Transformer

A good output transformer is extremely important in high-power applications. An efficient unit will permit more of the power developed by the tubes to be delivered to the load.

Efficiency in a transformer is a function of the core losses (hysteresis) and the d.c. resistance of the winding. Since the magnetizing current through the transformer is low, efficiency is primarily dependent on copper losses—the winding resistance. The unit with lower primary and secondary resistance is thus the most efficient.

It is well known that the maximum power delivered to any type of load, is at its peak when the source impedance is equal to the load impedance. However, for minimum distortion, the impedance the output tubes must "see" is different from their actual internal (source) impedance. When the EL-34 "sees" 4000 ohms, the best compromise between maximum power and minimum distortion is achieved.

A speaker—usually about 16 ohms—is the actual final load impedance. For maximum undistorted power to be delivered to the speaker, the output transformer should match the 4000 ohms to the 16-ohm speaker accurately.

Transformers used in high-power applications should have additional turns ratios to accommodate 4- and 8-ohm speakers. Many high-quality speakers have 8-ohm impedances. A 4-ohm impedance is necessary for use with several

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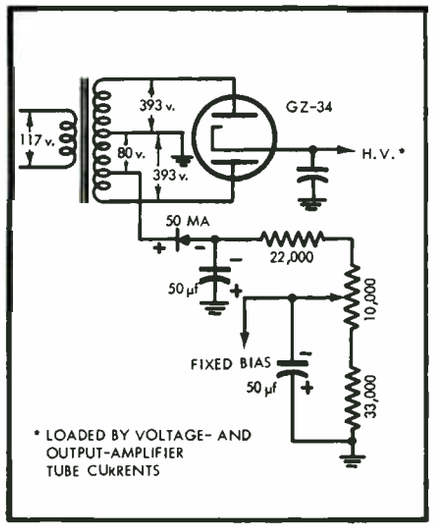

Fig. 4. Fixed bias supply voltage as used in amplifiers of Fig. 2. "Bias" pot adjusts bias voltage—for EL-34's, plate current should be 65 ma in this circuit.

of the excellent but low-efficiency speakers now on the market. To provide these additional impedances, the secondary of the transformer is tapped at points providing appropriate impedance ratios. Transformer manufacturers indicate in their specifications the impedance ratios supplied in their units.

The transformer used should also be capable of a wide-band flat frequency response to provide for stability in feedback circuits, as well as fidelity. The primary inductance must be high enough to prevent a rolloff of the low frequencies while the leakage inductance (theoretical equivalent inductance between the primary and secondary) must be low, not to allow rolloff at the high end of the audio-frequency spectrum. There must be sufficient high-grade steel laminations to permit a full-output power response down to the lowest audible frequency.

Power Supply

The power supply affects the response as well as the power output. The fixed bias (necessary in class B or class AB when operated close to class B) as well as the high voltage must provide good regulation. These voltages must remain reasonably constant over a large range of current variations to keep the output tubes working at their prescribed conditions for maximum output. Low rectifier and power-transformer-winding resistances help maintain the regulation. This same low impedance is necessary to retain the high output power at the low end of the audio spectrum.

There are many methods of obtaining the fixed bias. Manufacturers of amplifiers can have a transformer made with an extra winding for this purpose. The voltage at this winding is rectified, well filtered, and applied to the grids of the output tubes. Some commercial high power amplifiers tap the high voltage winding as shown in *Fig.* 4.

Another method frequently used when special tapped transformers are not available employs a filament transformer in reverse. The 6.3-volt winding is connected across the filament winding on the main power transformer. Approximately 110 volts will then appear across the primary of the filament transformer. This 110 volts is rectified, filtered, and used to supply the bias for the output tubes as shown in *Fig.* 5. Although expensive, this method can be used by the

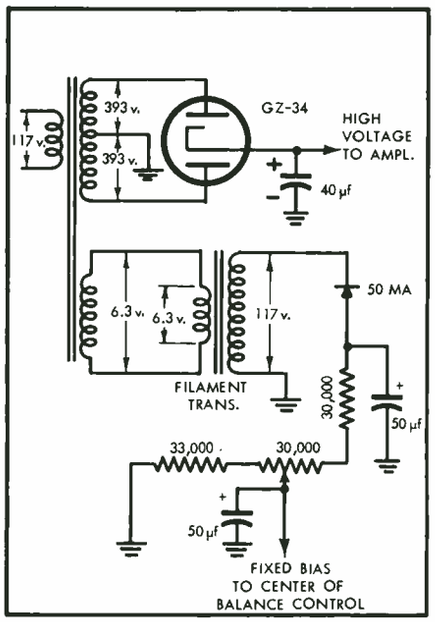

Fig. 5. Fixed bias supply using standard components.

amplifier builder without access to special transformers.

The high d.c. voltage shown in *Figs.* 4 and 5 is secured from a rectifier tube with a separate, rather than a filamentary type cathode. There is an important reason for this.

The filter capacitor used in this type of amplifier must be of the electrolytic type to conserve space. Oil-filled capacitors would require about six times the chassis area, providing no true advantage. Unfortunately, electrolytic capacitors are rated only at 500 working volts, with instantaneous peaks up to 575 volts. For longer life, the voltage applied to the capacitor should be kept within 500 volts. It should also be noted that the high voltage to be applied to the output tubes (such as the EL-34 under Ultra-Linear operation) is 470.

To fully understand why this requires the use of a rectifier with a separately heated cathode, it is only necessary to draw the equivalent circuit of a power supply. In *Fig.* 6, (A) shows the secondary of a power transformer supplying an a.c. voltage to the rectifier tube, which transforms the voltage into pulsating d.c. This in turn, is filtered to a smooth voltage by the electrolytic capacitor, C, and applied to the load, R_l.

(B) shows the equivalent of the circuit in (A), with the transformer drawn as an inductance, L, and the applied a.c. voltage in series with the transformer winding resistance, R_t. The rectifier tube is shown as a unidirectional element in series with the plate resistance, R_p, of the tube. Since these resistive elements are in series with the rectifier, the equivalent circuit can take the form of (C) in *Fig.* 6.

As a theoretical example, let the rectified voltage, $E_{dc} = 550$ volts, $R_t = 100$ ohms, $R_p = 200$ ohms, and the load resistance, $R_l = 1720$ ohms. When this total resistance, $R_t + R_p + R_l = 2020$ ohms is connected across the rectified d.c. voltage, E_{dc}, the current flowing is 550 volts/2020 ohms, or 250 ma ($I = E/R$). When this current flows through R_t and R_p, the voltage drop through these resistors is 250 ma × (100 + 200 ohms) = 75 volts. The voltage remaining across the load resistor, R_l, is then the total d.c. voltage, less the drop through R_t and R_p, or 550 − 75 = 475 volts. Since the load is

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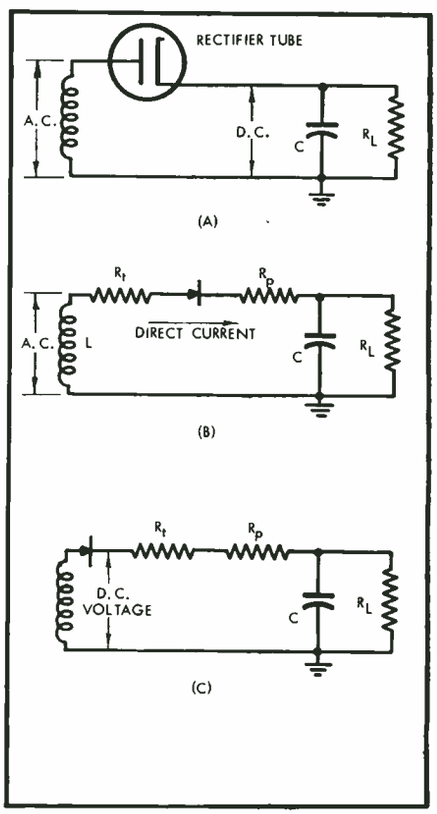

Fig. 6. (A) Power supply schematic. (B) Equivalent of (A), with transformer replaced by L and R_t, tube replaced by unidirectional element and plate resistance, R_p. (C) Positions of R_t and rectifier reversed, a permissible operation in a series circuit. When R_l is connected, direct current flow causes voltage drop in R_t and R_p.

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Universal Phonograph Reproducer

H. A. HENNING*

The problem was to develop a pickup which would reproduce both lateral and vertical records. The solution was the famous Western Electric Model 9A, which closely resembles the single-groove stereo pickup of today.

Because of the distinct parallel between design requirements of the Western Electric Model 9A vertical/lateral pickup of the early 30's and those encountered in today's single-groove stereo cartridges, this article is of unusual interest. The 9A, as most old timers will recall, was the first pickup designed to deliver both vertical and lateral voltages from a single stylus. While the two signals were not used simultaneously in the 9A as they are in stereo pickups, it must be admitted that the Bell Laboratories engineers who developed the unit came dangerously close to inventing single-groove stereo almost 30 years too soon.

A RECORDED VOICE is tireless, always available when needed, and of constant quality. These characteristics led to an early recognition of its value for telephone testing, but it could not be used for this purpose until the quality of the records and the reproducing system had been radically improved. It became possible in the 1920's when the Laboratories developed its electrical method of recording and reproducing. Not only was there greatly improved quality, but also the possibility of recording such phenomena as electrical interference.

A considerable library of records was then created by the Laboratories for telephone testing and for educational uses. These records were lateral-cut on discs; the recording was a spiral groove of constant depth which the needle follows. More recently, further improvements were made by the development of vertical recording.[1] The higher quality and longer playing time obtainable with records of this type led to a library of vertical-cut records. It became necessary therefore to have reproducers of both types available not only for telephonic purposes but also for the large number of broadcasters who in recent years have been using both lateral and vertical electrical transcriptions in their program broadcasts.

It is inconvenient to change reproducers when records cut by the two methods are selected successively, and a reproducer which would respond with equal facility to either type was obviously desirable. Its development was undertaken by the Laboratories. The idea of a two-purpose reproducer was not new but in previous devices it was necessary to alter their position or change the stylus when going from one type of reproduction to the other. The quality was usually poorer than that of single-purpose reproducers and the problem therefore was to devise one that could be used with either type of record without any adjustment whatever, and would equal the best single-purpose reproducer of each type.

During the early stages of design a reproducer was developed which met all the preceding requirements, but a field trial disclosed an unexpected difficulty. Some of the lateral records encountered in the field had so much vertical surface noise that it completely blanketed the laterally recorded sound when reproduced by a device which was responsive to both types of motion. Accordingly the original requirements had to be modified and a reproducer, the 9A, developed which would select the desired type of reproduction.

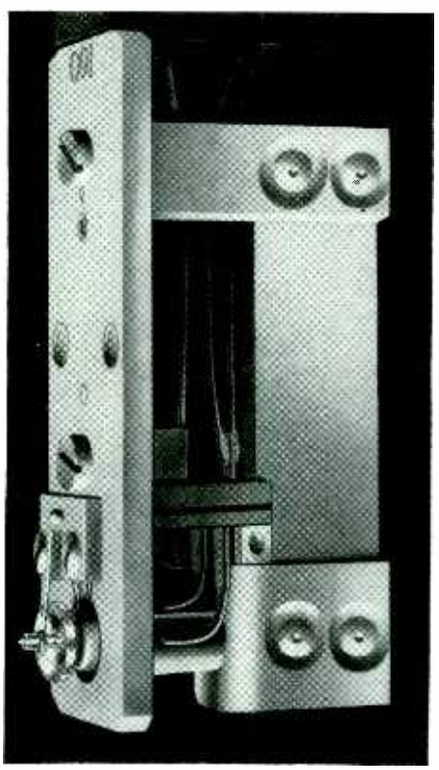

Fig. 1. The 9A reproducer is very small. Its diamond stylus is at the base of a T-shaped lever with minute coils on each arm.

Construction

A much enlarged view of the moving element of the Western Electric 9A reproducer appears in *Fig.* 1. Because the vibrating system is very small, it was designed as a separate unit to be attached as an assembly to the magnetic system. This unit consists of two voltage-generating coils mounted on a duralumin framework, which is supported by two cantilever springs. The fundamental design is the same as that used on straight vertical reproducers.

Two very small coils of insulated wire are wound on a duralumin cup and the

*Electromechanical Development, Bell Telephone Laboratories.

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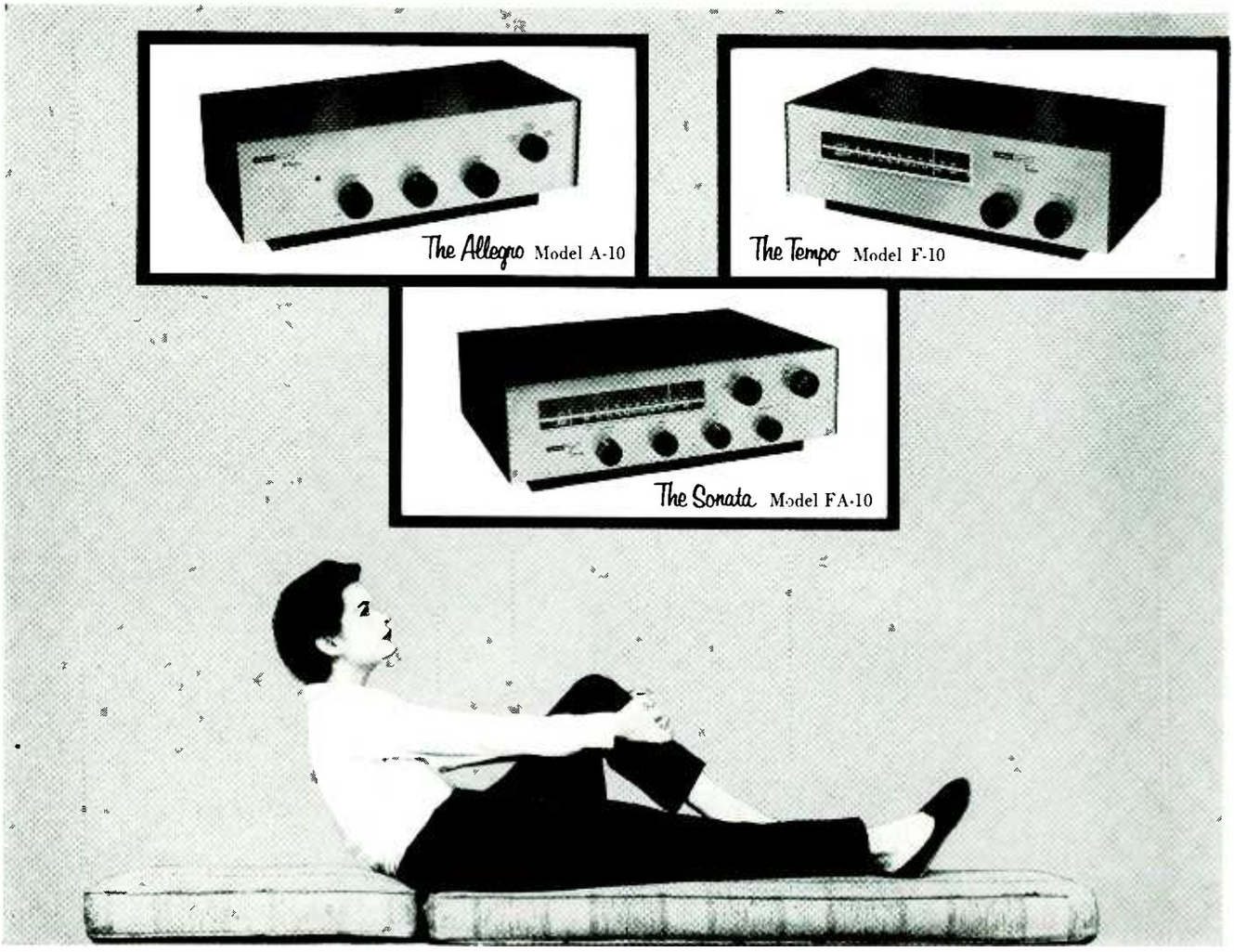
[1] *Bell Laboratories Record;* July, 1932, 389.



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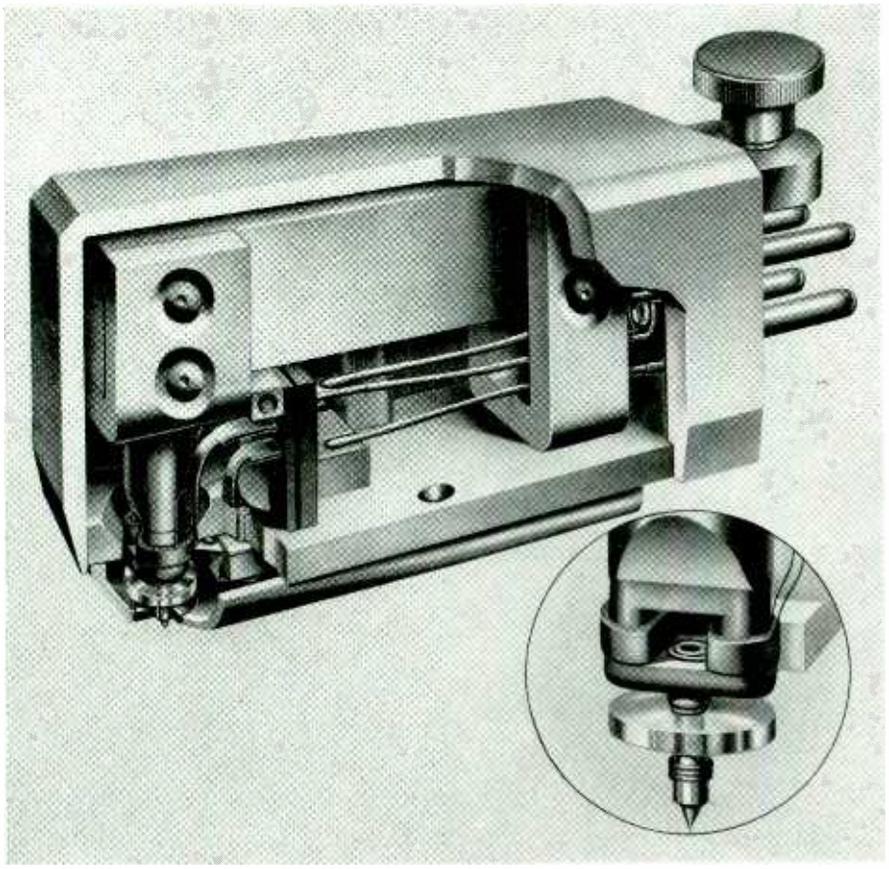


Fig. 2. The two pick-up coils are wound on a duralumin cup. A flat triangular spring between these coils supports them and the stylus. This spring flexes readily up and down but not sideways because of the wide cross section of the coils, thus restricting all motions except the lift required for vertical reproduction and the rotation of lateral reproduction.

four fine lead wires are coiled loosely around miniature terminals located directly above the cup. To achieve flexural strength and proper inertia, these coils are wound in an odd oval shape best suited to fit within the magnetic poles of the reproducer. The coil forms one part of a duralumin cup which is drawn to shape in a complicated series of operations and braced by a minute cross-rib as well as by its own contours. Supporting the moving structure and mounted midway between the two coils is a flat triangular-shaped spring that can readily flex up or down but not sideways because of its wide cross section. This spring restricts all motions of the cup except the straight lift required in vertical reproduction and the rotation required for lateral reproduction. A very small thin duralumin tube is riveted to the cup and to its cross brace so that it also supports the spring. This tube carries a vane of viscous material proportioned to damp out unavoidable high-frequency resonances caused by the elastic properties of the record. Into the other end of this tube is cemented the diamond stylus. The stylus is thus at the base of a T and the coils are at the extremities of its crossarm. One other support, a fine steel wire, connects the stylus end of the T to the frame of the reproducer. This wire flexes readily in any direction but holds the stylus from being pulled forward by the motion of the record.

In operation each coil moves axially in a radial magnetic field. This motion is substantially the same whether the coils are moving vertically or are being rotated from the drive of a lateral-cut record. The only difference in the voltages induced in the coils is a reversal in phase. If the coils are connected series aiding, the voltages in the two coils will add for vertical motion and cancel for rotary motion. When connected series opposing, the voltages due to vertical components are cancelled. This cancellation is not perfect but provides about 20 db of discrimination against the unwanted signal. A switch placed near the turntable changes the connection. At the changeover from one type of record to another, throwing this switch is the only operation required; if this is overlooked at the moment, it can be put right without stopping the record.

The magnetic circuit consists of a rectangular bar of magnetic material to which are riveted two soft-iron U-shaped yokes, one of which carries the center pole piece. The two yokes are secured directly to the outside pole plate, which serves as a mounting for the reproducer and for all its elements. A small terminal block and a protective housing surround the center pole piece and guard the lead wires. These details disassembled, and also the shape of the magnetic gap, show clearly in *Fig.* 2. A dust-tight aluminum housing or nose piece prevents dust or dirt getting in the small air gap in which the coil moves; the diamond stylus passes through a molded rubber diaphragm which fits the stylus tightly but flexes readily without hampering its motion.

Equalization

No matter how faithfully a recording is reproduced, the over-all result would be unsatisfactory if there was any very appreciable "surface" noise. This noise, which varies with the material used for the record, consists for the most part of higher frequencies. To decrease its effect, the recording is made through an equalizer that raises the relative amplitude of the higher frequencies. This increases the signal-to-noise ratio of the recorded material, and by being reproduced through an equalizer whose characteristics are complementary to those of the recording equalizer, the higher frequencies are restored to their proper relative values, while the surface noise is decreased by the amount of the equalization.

The characteristics required of the

(*Continued on page 92*)

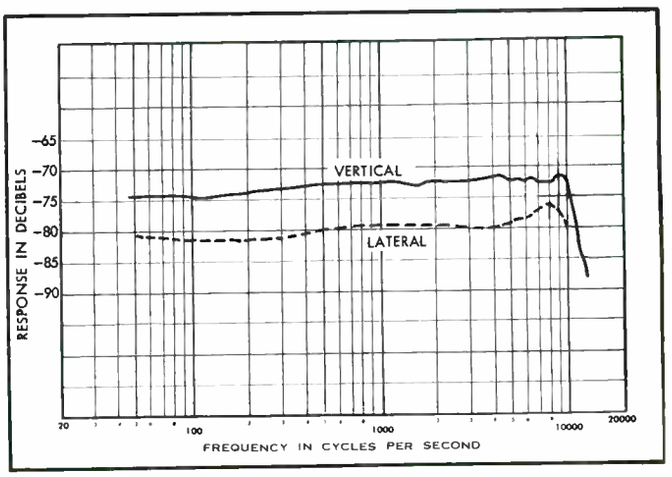


Fig. 3. The response of the 9A reproducer is essentially flat — up to nearly 10,000 cps. It is made more sensitive for vertical reproduction to compensate for the lower level at which vertical-cut records are usually recorded.

The Trinity of the Patent Law—Invention, Novelty, and Utility

ALBERT WOODRUFF GRAY*

Not every idea that appears to be an invention is one—the basic cardinal rules defining the invention must be complied with in order to maintain a valid patent.

UNDER THE PATENT LAW three features are essential for a valid patent—invention, novelty, and utility. In the 1952 patent statute it is provided, "Whoever invents or discovers any new and useful process, machine, manufacture or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor."[1]

For assistance in the preparation of a patent application for an invention related to an "electrical coupling system particularly adapted for use with radio-frequency vacuum tube amplifiers," a young man came to his former teacher, Professor Hazeltine.

Within a few weeks after the application had been granted and the patent issued and assigned to the Hazeltine Corporation, suit was brought by that company against an automobile manufacturer for infringement.

In its defense this manufacturer maintained that the discovery for which it was claimed this patent had been issued and infringed, was not a patentable invention within the meaning of the statute, and the patent invalid. Adopting as a conclusion the contention of the alleged infringer that here had been no patentable discovery the federal court said,

"In the radio art respecting patents having earlier dates than the one in this controversy, it has been held that the standard required in order that the subject matter should amount to invention, is a high one.

"The fact that there were a number of applicants for patents is well nigh conclusive that the idea was not the original act of an individual inventor but the simultaneous solution of half a dozen mechanical improvers, so making the alleged invention nothing but the natural advance of the art herein involved."[2]

In another instance in which a patent was also denied for lack of invention, the claim was for "an adjustable inductant tuning unit comprising a coil, a core of magnetic material arranged to be moved into and out of the coil in an axial direction thereof to vary its inductance between maximum and minimum values, a conducive, non-magnetic member positioned adjacent to one end of said coil and means to adjustably position said non-magnetic member with respect to said coil to adjust one of the above mentioned inductance values of the coil."

In its affirmance of the rejection of this application the Court of Customs and Patent appeals pointed out the absence of invention. "It is old in the art to vary inductance by movement of a magnetic core into and out of a coil."[3]

Failure of this discovery to attain the rank of invention as that term of the patent statute has been interpreted by the courts with the illusive clarity and outline of this essential feature suggests the doggerel,

> "We seek him here, we seek him there,
> Those Frenchies seek him everywhere.
> Is he in heaven? Is he in hell?
> That demmed elusive Pimpernel?"

By the United States Court of Appeals in an infringement action in Oklahoma has been outlined to some extent the meaning attributed by the courts to the word "invention" in this statute. Of the distinction between invention for which a patent will be, and mere mechanical skill for which one will not be granted, the court said here in reference to that feature in the construction of a pump, "The arrangement of the control valve in the piston assembly is new but we agree with the trial court that this is nothing more than an application of mechanical skill and is not an invention.

"It required no greater skill nor higher thought than that which would be expected of a mechanic trained and skilled in the art. The old and well known elements of the prior art perform the same mechanical functions in these claims as they have been known to perform in the prior art and they produce the same result and cannot be considered an invention.

"The changes made in this device would readily occur to one skilled and acquainted with the already crowded art. All that has been done here is to assemble old and known elements and use them for the same purpose as they were previously used.

"The design of the patent laws," continued the court, "is to reward those who make some substantial discovery or invention which adds to our knowledge and makes a step in advance in the useful arts. The device must not only be 'new and useful', it must also amount to 'invention or discovery.' Perfection of workmanship however much it may increase the convenience, extend the use, or diminish expense, is not patentable."[4]

Change of Material Not Invention

In a decision of the United States Supreme Court rendered in the middle of the last century is another example of the effort to define this evasive feature of the patent law—invention. Here suit has been brought for infringement of a discovery, claimed to be patentable, of the use of clay instead of metal or wood in the making of door knobs.

"But in this case," reads that old decision, "the knob is not new, nor the metallic shank and spindle, nor the dovetail form of the cavity in the knob nor the means by which the metallic shank is securely fastened therein. All these are well known and in common use and the only thing is the substitution of the knob of a different material from that heretofore used in connection with this arrangement.

"But this of itself can never be the subject of a patent. No one will pretend that a machine, made in whole or in part of materials better adapted to the purpose for which it is used than the materials of which the old one is constructed, and for that reason better and cheaper, can be distinguished from the old one, or in the sense of the patent law, can entitle the manufacturer to a patent.

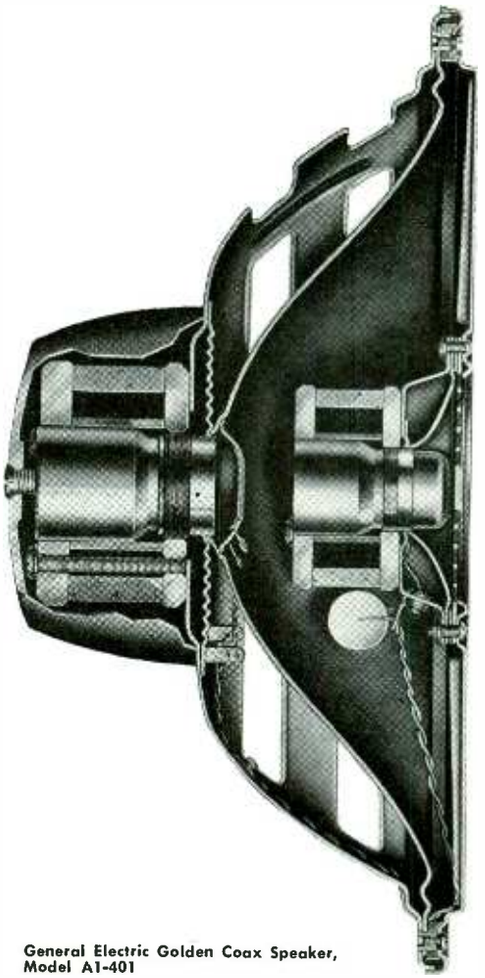
* *112–20 Seventy-Second Drive, Forest Hills, N. Y.*

[1] 35 U.S.C.A. Sec. 101.

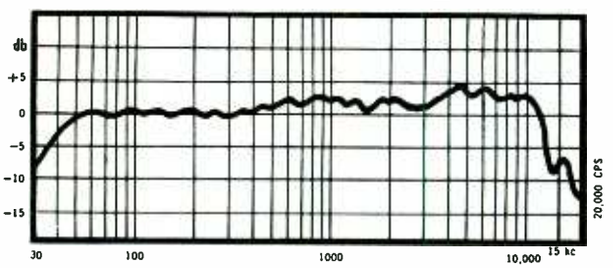
[2] Hazeltine Corp. v. General Motors Corp., 38 F.S. 880, Delaware, May 8, 1941.

[3] In re Van Yzeren, 185 Fed. 2d 705, December 5, 1950.

[4] Kobe, Inc. v. Dempsey Pump Co., 198 Fed. 2d 416, Oklahoma, July 5, 1952.



General Electric Golden Coax Speaker, Model A1-401



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Check these quality features:

Woofer Unit—Response range from 40 to 1500 cycles. Specially treated, deep-convolution cone edge, linearized air gap and suspension system result in extremely low distortion at high output power.

Tweeter Unit—Mounted on front baffle plate for direct high frequency sound radiation. Response range smooth from 1500 to 15,000 cycles. Built-in pressure equalizer cancels out secondary sound reflection, improves transient response and eliminates harsh peaks or cavity effects.

Slotted Baffle Plate—Serves as baffle for tweeter and low-pass filter to reduce interference between tweeter and woofer. Improves operation of crossover system by "braking" tweeter waves which might otherwise be reflected by woofer cone.

A3

General Electric Company, Specialty Electronic Components Dept. Section HF, West Genesee Street, Auburn, N. Y.

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"Unless more ingenuity and skill in applying the old method of fastening the shank and the knob are required in the application of it to the clay or porcelain knob than were possessed by an ordinary mechanic acquainted with the business, there was an absence of that degree of skill and ingenuity which constitute essential elements of every invention."[5]

This same characterization of a patentable invention was made a century later when the same court refused to sustain a patent granted the inventor of a tray used in cash and carry stores, the familiar "bottomless self-unloading tray in which to push the contents of the tray in front of the cashier."

By the lower courts the patent had been held valid and it was not until this litigation came before the Supreme Court that the futility of such a patent was apparently seen. "This counter does what a store counter always has done—it supports merchandise at a convenient height while the customer makes his purchases and the merchant his sales.

"The three-sided rack will draw or push goods put within it from one place to another—just what any such rack would do on any smooth surface—and the guide rails keep it from falling or sliding off from the counter as guide rails have ever done. Two and two have been added together and still they make only four."

This was supplemented by a further interpretation of the patent law limitations in a concurring opinion. "Every patent is the grant of a privilege of exacting tolls from the public. The Framers (of the patent law) plainly did not want those monopolies freely granted. The invention, to justify a patent, had to serve the ends of science—to push back the frontiers of chemistry, physics and the like; to make a distinctive contribution to scientific knowledge.

"That is why through the years the opinions of the court commonly have taken 'inventive genius' as the test. It is not enough that an article is new and useful. The Constitution never sanctioned the patenting of gadgets. Patents serve a higher end—the advancement of science. An invention need not be as startling as the atomic bomb to be patentable. But it has to be of such quality and distinction that masters of the scientific field in which it falls will recognize it as an advance."[6]

Must be Useful

Suit was brought several years ago for what was there claimed to be an infringement of a method of removing the rough edges and burrs from expanded metal fabric and smoothing the diamond shaped openings. By the lower court the patent had been sustained. In reversing that decision and holding that here there was no patentable invention the federal appelate court recalled these essentials of the patent law.

"Though it be elementary to do so at this late date in the development of the patent law, it is necessary to recall that three elements are requisite to validity, to wit: novelty, utility, and invention. It has been held in adjudications without number that one who appropriates the teachings of a patent may not deny the utility of the invention. This is, of course, both reasonable and logical. It does not follow, however, that one who is foreclosed from denying usefulness of a concept is likewise foreclosed from questioning its validity or the exercise of invention in the development of product, method or machine."[7]

Involved in a patent infringement action before a federal court in one of the midwestern states was the patent of a metallic core for concrete road culverts, which supposedly could be expanded or contracted to conform to the culvert into which it had been fitted. Resiliency was an indispensable feature, said the court in its decision, adding that the lack of it in this instance was fatal to the patentability of the invention.

"In other words," said the court, "the invention is 'new' but it is not useful. The term 'useful' as contained in the patent law, when applied to a machine, means that the machine will accomplish the purpose practically when applied in industry. It is to be given a practical and not a speculative meaning. It means that the machine will work and accomplish the purposes set forth in the specifications.

"Even if the machine can be made to accomplish the purposes specified it is not useful within the meaning of the patent law if from its inherent nature it will accomplish the purpose only to such a restricted extent as to make its use in industry prohibitive. This has been the interpretation put upon the term in the patent law from the earliest decisions to the present time."[8]

Of the remaining essential of this trio, novelty, an interpretation of the meaning of that term as used in this statute was made by a federal court in the decision of an action involving the use of tungsten wire in the manufacture of radio tubes. For a "wire form of ductile tungsten" one patent had been granted among 34 claimants. When this suit was brought for an infringement in the manfacture of this wire, the alleged infringer interposed as a defense that such a product was not patentable.

In its decision that the patents involved in this controversy did not relate to a process but to a product, and hence, were invalid, it was said by the court, "A manufacture is an entity distinct from the substances of which it is composed and from the instrument or art by which it is produced.

"The law seems to be well settled that if the product of a process or machine is itself patentably new it may be patented as a manufacture or composition of matter, irrespective of the method of production, but that the product is not patentably new merely because made by a new process or machine and it cannot be patented as an article made by such process or machine unless it is patentably new in itself. Patentable novelty consists in the production of a new device by the exercise of invention."[9]

During the last century a charge of infringement came before the United States Supreme Court based on the patent of a dredge-boat. The denial of the validity of this patent by that court has since become a classic as a definition of the essentials of patentable invention or discovery.

"The process of development in manufactures creates a constant demand for new appliances which the skill of ordinary head-workmen and engineers is generally adequate to devise and which indeed, are the natural and proper outgrowth of such development. Each step forward prepares the way for the next and each is usually taken by spontaneous trials and attempts in a hundred different places.

"To grant to a single party a monopoly of every slight advance made, except where the exercise of invention, somewhat above ordinary mechanical or engineering skill is definitely shown, is unjust in principle and injurious in its consequences.

"The design of the patent laws is to reward those who make some substantial discovery or invention which adds to our knowledge and makes a step in advance in the useful arts. It was never the object of those laws to grant a monopoly for every trifling device, every shadow of a shade of an idea, which would naturally and spontaneously occur to any skilled mechanic or operator in the ordinary progress of manufactures.

"Such an indiscriminate creation of exclusive privileges tends rather to destroy than to stimulate invention. It creates a class of speculative schemers

(*Continued on page 78*)

[5] Hotchkiss v. Greenwood, 52 U.S. 248, 1850.

[6] Great Atlantic & Pacific Tea Co. v. Supermarket Corporation, 340 U.S. 147, December 4, 1950.

[7] United States Gypsum Co. v. Consolidated Expanded Metal Companies, 130 Fed. 2d 888, Ohio, October 6, 1942.

[8] Besser v. Merrilat Culvert Core Co., 243 Fed. 611, Iowa, June 18, 1917.

[9] General Electric Co. v. DeForest Radio Co., 17 Fed. 2d 90, Delaware, January 15, 1927.

"University speakers were top performers on our *Hi-Fi Holiday** Concert Tour"

FRED WARING

"I had always dreamed of applying hi-fi techniques to our live concerts . . . but I hadn't thought it could be accomplished to my satisfaction. I presented the problem to University engineers prior to launching our most recent nation-wide tour. Result? University provided the most stirring sound I had ever heard in a concert hall, so dynamically effective that we named our show 'Hi-Fi Holiday.'

"'Hi-Fi Holiday' made sound history . . . it was sound success—and we plan to repeat the tour. University deserves a low bow for their contribution to the success of our show—a top performer most welcome to share the stage with The Pennsylvanians anytime."

**First such live stage presentation in musical and high fidelity history.*

AND HERE'S WHAT FRED WARING'S CHIEF ENGINEER HAS TO SAY . . .

"Fred Waring's 10-week 'Hi-Fi Holiday' needed loudspeakers which would withstand the abuse of a gruelling 200-500 miles per day in a trailer truck. The speakers had to be easy to set up in theaters, auditoriums and even large, hard-surfaced gymnasiums which, each night, would be physically and acoustically different, yet produce high fidelity sound that would make every seat 'front row center.'

"University loudspeakers were selected not only because of their reputation for quality and reliability, but also for their constancy of performance characteristics which is extremely important to the exacting achievement of aural 'balance' and 'perspective.'

"We were happy to find that these technical objectives could be accomplished using various speaker types and systems from University's standard high fidelity line. Not a single speaker failure occurred during the 20,000 mile cross-country tour."

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LISTEN *University® sounds better*

Equipment Review

Ampex A-122 Magnetic Tape Recorder-Reproducer and A-692P Amplifier-Loudspeaker—Nashaminy Z-200 Dynamic-Electrostatic two-way loudspeaker system—Conrac Fleetwood Television Receiver, Model 800

AMPEX A-122 RECORDER-REPRODUCER

TAPE RECORDERS have been with us for a long time—comparatively speaking—and most of the "rough edges" have been rubbed off so that one no longer needs a degree in electronic engineering to make and play acceptable tape recordings. In the process of converting a semi-professional machine into a reliable home instrument that anyone in the family can operate, Ampex has rung the bell.

The A-122 is so easy to operate and the results obtained are so consistently reliable that the tape recorder can now take its place as another music source on a par with the record changer as an important component of any home music system.

The A-122, *Fig.* 1, is only one of a series of machines which employ basically the same chassis but differ in head arrangement and housings. Models A-111, A-112, and A-113 half-track monaural machines housed, respectively, in a tabletop furni-

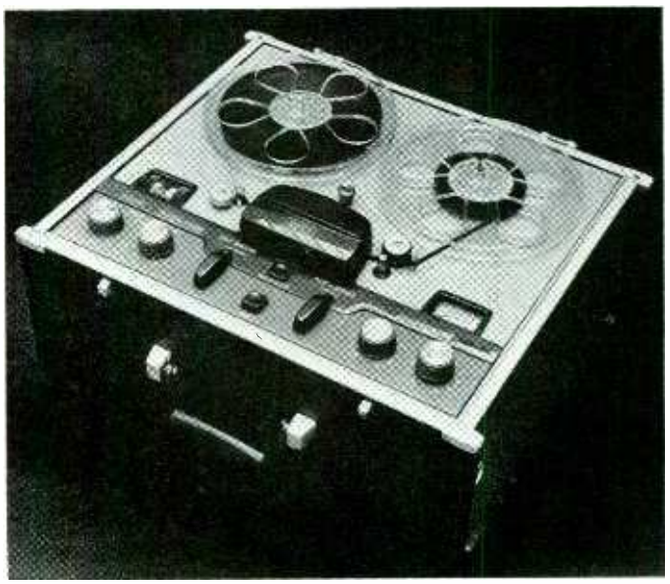
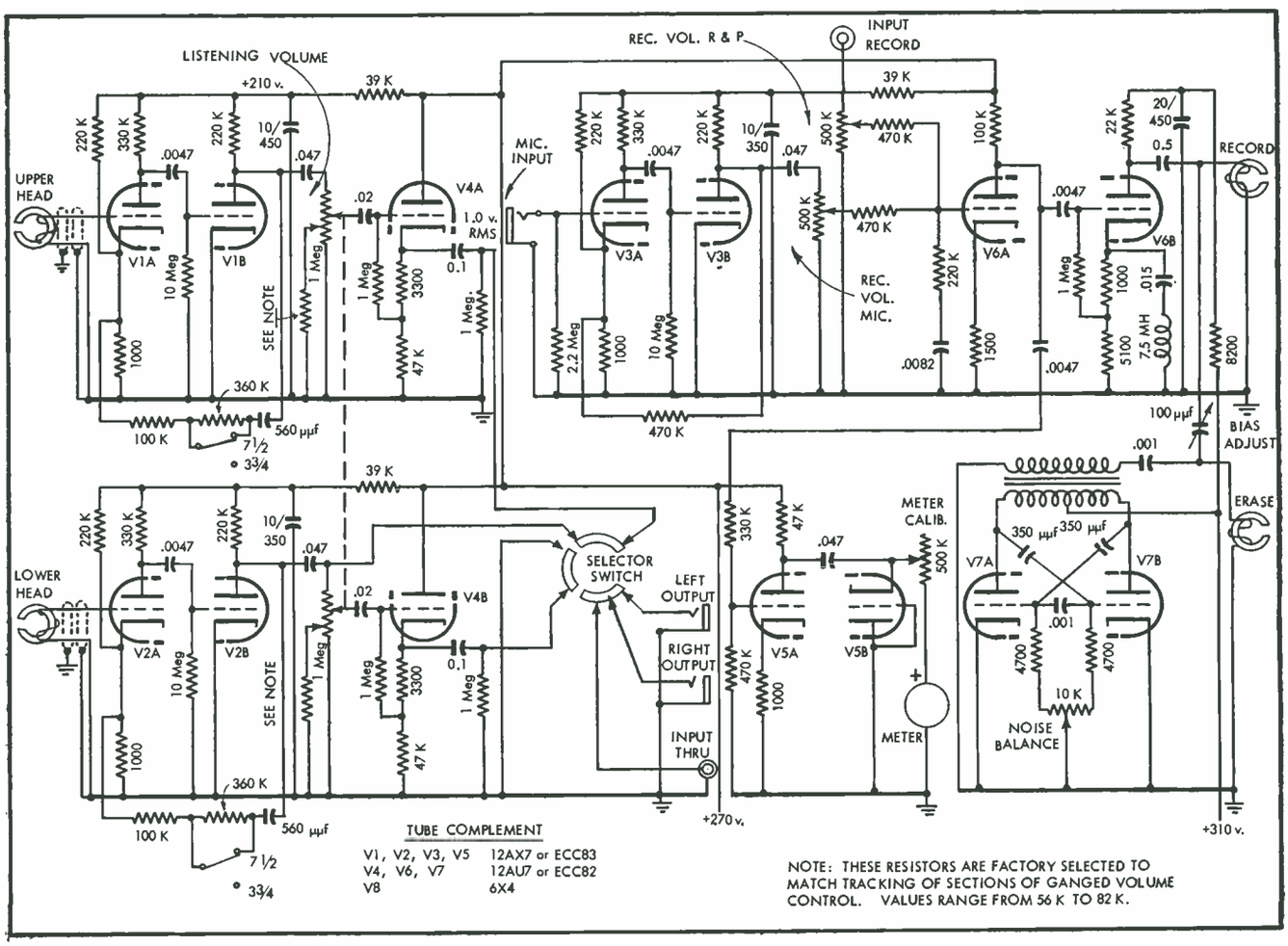


Fig. 1 (right). The Ampex A-122 magnetic tape recorder-reproducer—this particular model records and plays back monaurally, and plays stereo tapes.

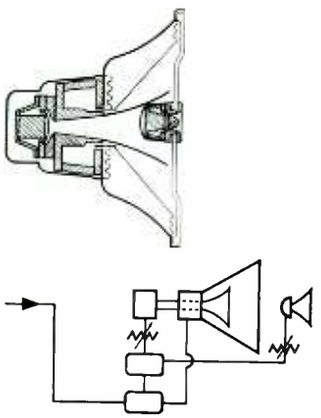
Fig. 2 (below). Complete schematic of the A-122 recorder-reproducer, except for the power supply section.



NEWEST

NEWEST

Jensen TRIAXIAL*



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. . . With Superb Performance!
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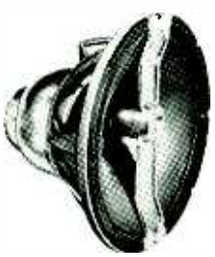
Jensen, the only maker of true 3-way unitary loudspeakers (with 3 separate radiating systems, each independently driven), now brings you the G-600 TRIAX* at half the cost of the famous G-610A! Now you can enjoy the advantages of a true 3-way speaker . . . solid bass, full middles and smoothly extended highs out to the limits of audibility, with ultra *low* distortion, ultra *high* listening quality . . . at this new low cost.



Lows from 30 to 900 cps are handled by the heavy duty 15" 3½ lb. magnet edge-damped woofer. Midchannel is a compression driver horn-loaded thru-bore unit for 900-4,000 cps. New compression horn supertweeter with phase balancing covers the range from 4,000 cps to limits of audibility (very high indeed by our standards). Power rating is 35 watts. Separate network with MF and HF Controls is included. Write for free Catalog 165-B

THE FAMOUS TRIAXIAL...JENSEN G-610A. Easily rated the world's most wanted speaker, the G-610A is "tops" in a unitary 3-way speaker assembly. It has the advantages of higher efficiency, higher power rating (40 watts). Desirable very low first crossover of 600 cycles is achieved by using the entire woofer cone as the final section of the midchannel horn. Priced at $252.75, complete with crossover network and controls.

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JENSEN MANUFACTURING COMPANY • *Division of The Muter Company*
6601 South Laramie Avenue, Chicago 38, Illinois

ture cabinet, a portable case, or a protective grill for mounting in another cabinet. Models A-121, A-122, and A-124 are in the same housings, respectively, but are equipped with in-line stereo playback heads and an additional amplifier so as to play stereo tapes in addition to recording and playing monaural tapes. Because of the great curiosity about the circuitry of stereo machines, the schematic of the A-122 is shown in *Fig.* 2. In order to conserve space, the power supply section has been omitted. It is quite conventional, however, except that it also furnishes d.c. for the heaters of V_1 and V_2. Plate supply to the bias-erase oscillator and to the output stage of the record amplifier is cut off except when recording.

The unit has a four-position switch to control its operation; in position 1 the a.c. switch is open and the INPUT THRU jack (which is normally connected in parallel with the INPUT RECORD jack and to a radio tuner or to two outputs of the tuner when two are used) feeds both channel outputs. Position 2 is MONITOR, and maintains the feed-through connection, but with the power on—actually a standby position. Position 3, SINGLE, connects both outputs to the upper-track amplifier (for monaural reproduction of either stereo or monaural tapes.) Position 4, STEREO, connects left and right channels to upper and lower tracks respectively for stereo reproduction of in-line tapes. In addition to this switch, there is a playback volume control, two record volume controls—one for microphone and one for radio or phono inputs —and a PRESS TO RECORD button which furnishes plate supply to the oscillator and the record output stage and cuts out a resistor in the plate supply circuit to compensate for the additional voltage drop

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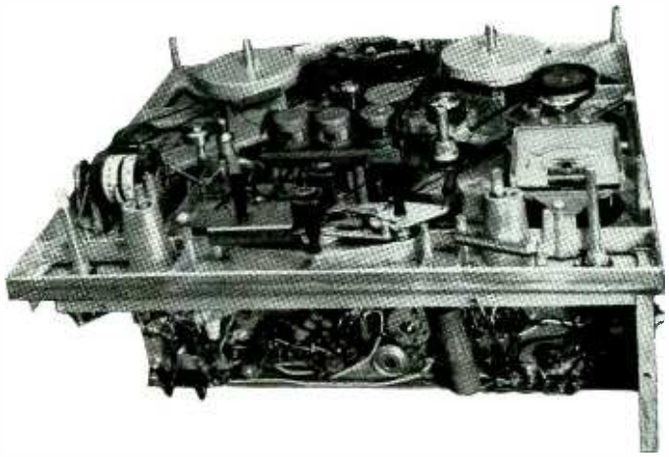

Fig. 3. Neat simple construction characterizes the A-122. Note use of cast aluminum chassis and integral mounting of electronic chassis.

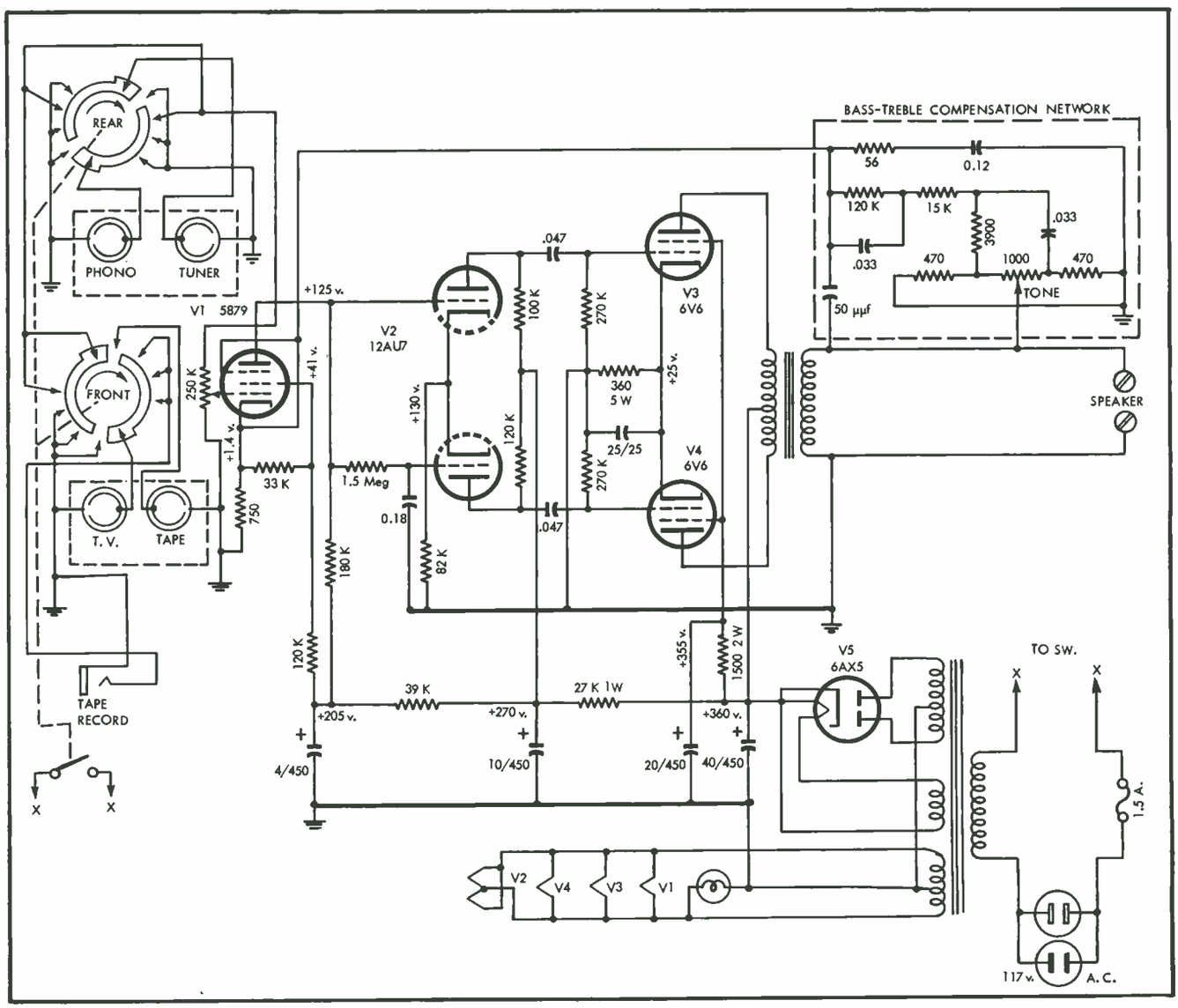

Fig. 4. Schematic of the A-692 amplifier-speaker. Note the compensation network and tone control in the feedback circuit.

NESHAMINY Z-200 DYNAMIC-ELECTROSTATIC LOUDSPEAKER SYSTEM

FIVE YEARS AGO we would have been inclined to say that loudspeakers had been developed to a high degree of perfection —and indeed some of them had, even as long ago as that. But with the advent of the acoustic-suspension system of loudspeaker building, it seems that quality that was previously associated with only the largest cabinets now becomes available in considerably smaller enclosures, and with the probability of smoother response throughout the entire audio spectrum. And with the development of the electrostatic high-frequency speaker there seems to be a smoother treble range—and possibly further extended—than most speakers of five years ago offered.

While we used to associate 12- to 15-cubic foot cabinets with response below 30 cps, the acoustic suspension woofers work down into that range with 3 to 4 cubic feet, which makes them more acceptable in the average home. We have long been of the opinion that proper and valid judgment of a loudspeaker requires some weeks of "living with it," we also know that just that "living with" is sufficient to equip our ears with an acceptance curve—in other words, one can become used to a particular sound, and after enough time this sound may appear to be right while that of another speaker may seem to be wrong, even though the latter might be of much better quality. Therefore, it is necessary to be doubly careful to keep another speaker within comparing distance so that continual and regular A-B checks can be made. As most readers know, this observer has been enthusiastic over a design first published in these pages in 1949 (and pictured below with a new and up-to-date television receiver installed therein) and that this enthusiasm has been reflected by many readers who employ the same type of enclosure and similar components, as well as many people in the industry and outside who have listened to this model over the past nine years. Admittedly it is a large

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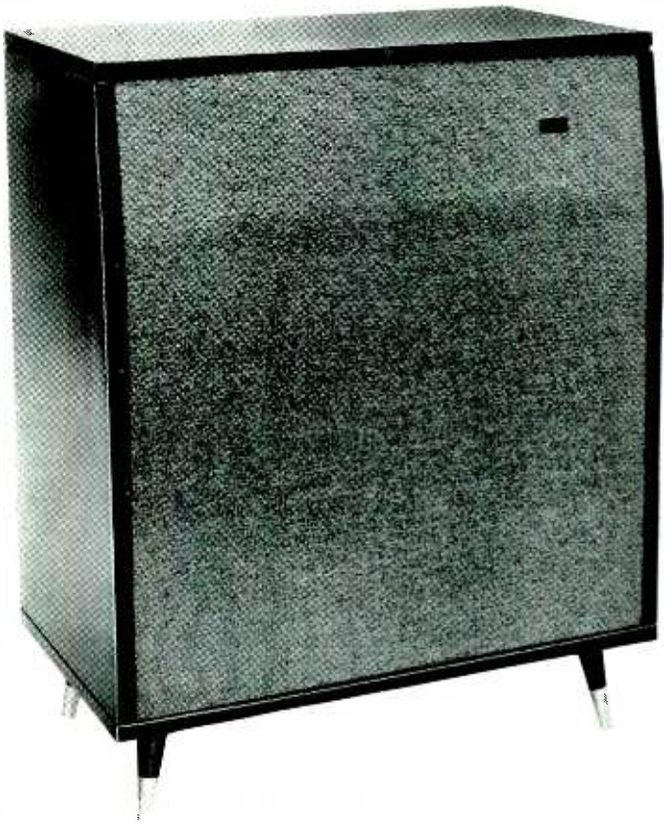
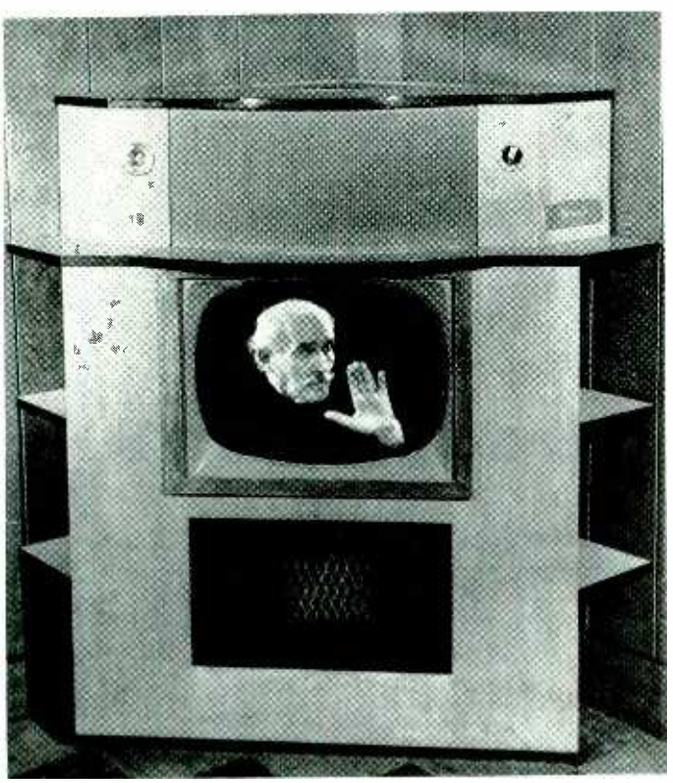


Fig. 5 (above, right). Combining in one cabinet on acoustic suspension type of low-frequency speaker and a four-unit JansZen electrostatic high-frequency speaker, the Neshaminy Z-200 is neat and compact in its modern design. Fig. 6 (below-left). The "Standard" speaker system brought up to date with the substitution of a 21-inch Fleetwood television receiver to produce picture quality equal to the sound quality from the speaker system.



CONRAC "FLEETWOOD" MODEL 800 REMOTE CONTROL TELEVISION RECEIVER

THE TERM "high fidelity" has been applied to almost everything on the market, including lipsticks, pianos, and even $29.95 phonographs, and it would seem almost an insult to apply it to a television receiver without qualifying the meaning of the term in that usage. But after observing many TV receivers over the past eight or ten years, we honestly believe that the Conrac Fleetwood offers the finest TV picture we have ever seen anywhere except on a studio monitor from a direct video circuit. At the time of building the combination loudspeaker and television cabinet shown at the left in *Fig.* 6, the largest tubes in common use were the 12-inch models. Some years we modified the tube enclosure to accommodate a 16-inch rectangular tube, and with the kit-model receiver we felt that we had a picture that was much better than the average "store-boughten" TV set. But then we saw the Fleetwood.

As a photographic hobbyist (in addition to audio hobbying for a living and a pastime) we have not always been satisfied with the poor definition of most sets, and with the simplification of controls as a sop to the non-critical user who just wants to be able to turn it on and get a picture, no means is normally provided for varying the video bandwidth. If it were not for the luxurious picture that the Fleetwood provides, we might liken it to the sports cars, with the controls they have available to get that last ounce of performance.

The Fleetwood Model 800 is built on two separate chassis —one which mounts the tube, furnishes the video and deflection circuits and the audio amplifier, together with the neces-

sary power supply, and one which is the remote control tuner. It is available with 21-, 24-, or 27-inch picture tubes. The picture chassis mounts the HEIGHT, VERTICAL LINEARITY, HORIZONTAL HOLD, and VERTICAL HOLD controls on the front and intended for access through a small ornamental door; on the rear are WIDTH, HORIZONTAL DRIVE, and HORIZONTAL LINEARITY controls, which rarely require touching once they are set.

Obviously it was necessary to modify the cabinet once more to accommodate the larger tube—we used a 21-inch model since the two larger ones could scarcely go into the space at all. The tube enclosure is made from ¾ in. plywood, and is in the form of a truncated unsymmetrical pyramid. It is completely sealed off from the interior of the cabinet, and is covered with two layers of Ozite rug padding. A few modifications to the main chassis were necessary, we found—the high-frequency horn used in the speaker interfered with the front part of the chassis. However, there is nothing under the front part of the chassis except the vertical output transformer and the front-panel controls. Consequently we cut out a section roughly 6 by 14 in. and constructed a new side wall to the chassis, giving it an "L" shape. The front panel controls were mounted at the right of the high-frequency speaker area, and covered with the ornamental access door, with an octal socket being used to connect the control circuits to the chassis.

One other problem bothered us for a while. The high-voltage cage stuck up two inches higher than the superstructure portion of the already existing cabinet, and we couldn't convince anyone else around the house that it wouldn't look bad to have a two-inch-high black box sticking out the top of the enclosure. Therefore—treading in where angels fear to—we removed the cage and cut it down by two inches, and took off the cage door and reworked it to fit. We also removed a bracket from under the flyback transformer, which lowered it by about 1 inch, and then relocated the H.V. rectifier tube about halfway between the top of the transformer and the inside top of the cage. This took some experimenting, but there *is* a place where it won't arc over. Since the picture tube is mounted below the chassis rather than above, we removed the leads to the socket and reconnected them so they come out under the chassis. The four leads to the deflection yoke are all above ground, so we ran a fifth lead to the mounting bracket for the yoke assembly—which is normally mounted on the chassis, but here it is simply mounted on the wood tube housing and therefore not grounded.

Having proceeded thus far, we let it cook for a while until we determined what to do with the remote control unit. Having a remote control set, it would be foolish to place the control unit back in the cabinet along with the tube, so we finally disassembled a small round table—shown in *Fig.* 7—and replaced one of the side walls with a new panel to accommodate the control unit, which rests on an aluminum U-shaped bracket attached to the table legs on the inside. In use, the table sits along one's favorite chair, and the viewer can

channel-hop as much as he wishes without having to move.

The remote cable which comes with the Fleetwood is 40 feet long, and carries video-, audio, and control circuits—no a.c. line voltage nor high d.c. voltages are fed through the remote cable; a 6.3-volt circuit from the tuner actuates a relay in the picture chassis which controls the a.c. power input circuit.

Control Unit

The control unit contains the v.h.f. tuner (which will accommodate u.h.f. strips) the four-stage i.f. amplifier, the two-stage sound i.f. amplifier (4.5 megacycle intercarrier) a dual cathode follower for video output, an audio cathode follower, and the controlled a.g.c. circuit, along with the power supply. The front panel has six controls—a station selector, a fine-tuning control, power switch and sound volume control, brightness control, contrast control, and a definition control. With both brightness and contrast controls at ones fingertips, it is possible to adjust the "gamma" of the picture to any desired value so that an ideal picture quality may be had even in fairly well lighted rooms. The definition control is a real joy to use, since it may be set for extremely sharp and "crisp" pictures when the incoming signal makes it possible to use the full bandwidth, yet for pictures with a slight ghost, for example, the sharpness can be reduced to that point where the over-all picture quality is most pleasing. The effect of the definition control is somewhat like changing the quality of a newspaper halftone to that of a magazine, for example, and it does produce as good a picture as the station is transmitting. One soon begins to recognize the source of the picture simply by the result on the screen.

The tuner chassis is provided with an audio take-off so that a signal may be fed to a preamp mounted next to the control unit, if desired, and another take-off is provided at the picture chassis so a high-power amplifier may be located in the cabinet with the tube and speaker system —which is the way we use it.

However mounted and used, the Fleetwood will give greater picture satisfaction than any other TV set we have ever observed, and for once we have really enjoyed

Fig. 7. The Fleetwood remote control unit as mounted in a chairside table gives a maximum of comfort in use.

excellent reception. We can only say that we wished all the program material made such picture quality worthwhile. But as most of us know, we may get excellently microphoned and transmitted radio programs only an hour or so each week, but we still feel that it is worthwhile having a good tuner, amplifier and speaker system just to enjoy the good programs when we can. The same goes for the Fleetwood—when transmission is good, the picture is excellent; when it isn't, we can adjust it to be the least objectionable. C-23

NESHAMINY SPEAKER

(*from page 52*)

enclosure, but it has served long and well and remains our standard.

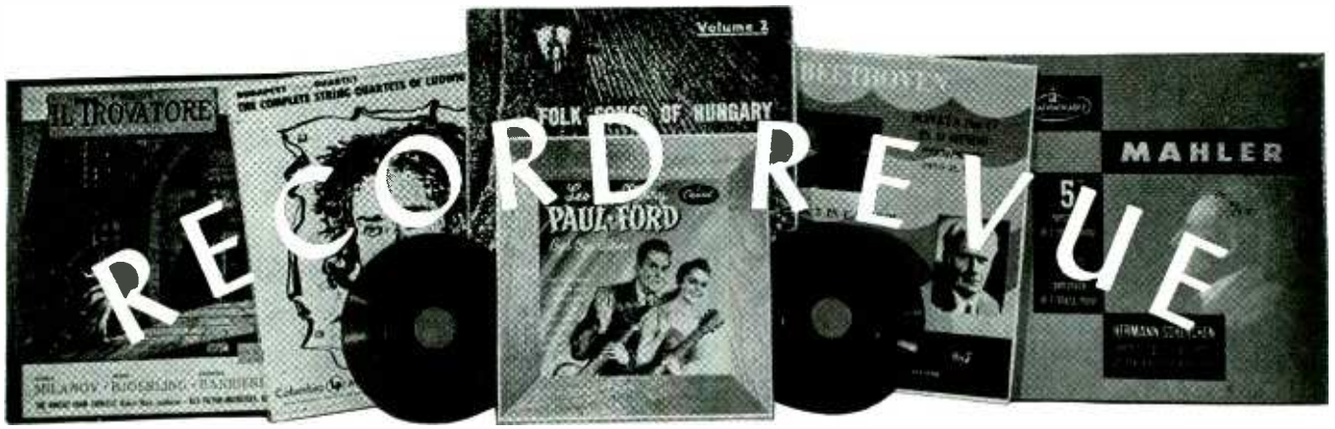
To make what we consider fair and valid statements about the performance of a given loudspeaker and enclosure, therefore, we like to compare it regularly with the "Standard," which means, of course, that it must be switched back and forth on the same type of program material, using the same amplifiers, and with the listening done in the same room. In this case, the

listening room is 17 × 30, with oak panelled walls and Celotex ceiling, concrete floor with linoleum tile covering, and fairly well broken up with furniture, an entering stair, and an alcove or two.

With this background, we now present an opinion based on many hours of comparative listening. The Standard speaker is believed to have a "bottom" at 24 cps, determined by playing the scale on Side 2 of Aeolian-Skinner's *King of Instruments, Vol. I.* This scale, played on the organ in Symphony Hall, Boston, 16 cps, played on a 32-foot Contra Violon, to over 8000 cps (in fundamentals) played on a 1-foot Sifflöte. For the lower limit of proper loudspeaker action, we believe that this scale is the quickest method known, for as the scale is played from the 16-cps C, one hears only a series of fluttery wind noises up to a certain note at which the scale becomes musical, and thence progresses from note to note as a scale. Counting up the scale, the listener observes the note at which the tones become musical; from a musical table, the frequency of that tone may be obtained. In less than two minutes, the listener can determine the lowest tone at which the loudspeaker begins to perform as a speaker and ceases to sound like a sail flapping in the breeze. Using this method, the Neshaminy Z-200 appears to "go to work" at about 27 cps, and the output is free from doubling, and is within 6 db of the output at 100 cps. At the top end, using an audio oscillator as the source, we found the output to go up to the limit of our hearing (14,500 cps) but measurements with an uncalibrated microphone indicate response well above that.

The Z-200 is one of the first combination models produced by Neshaminy, and employs a 12-inch cone speaker with a full half-inch excursion, mounted in a 2.5 cu. ft. enclosure filled with fiberglass. A 1-inch hole in the front panel is used to smooth out the very-low-frequency response, and should not be confused with a "bass reflex port," though it is probable that it works in somewhat the same manner. The high-frequency range is handled by a Janszen electrostatic speaker consisting of four radiators mounted in a "W" configuration, which is more suitable for a complete cabinet than the one commonly seen in its quarter-circle cabinet as a separate unit. The electrostatic unit covers the range from around 500 cps up, and the entire speaker is capable of handling 50 watts input on program material up to 10,000 cps. Polarizing voltage is supplied from the a.c. line by means of a built-in supply with a total power consumption of 2 watts, so little that one simply leaves it plugged at all times.

Distortion is exceptionally low, apparently, and the balance—which is adjustable—makes it possible to compensate somewhat for acoustic conditions in the listening room. We cannot help but say that loudspeakers are continually getting better, and this is certainly an example of one of the better sounding speakers on the market today. C-22



EDWARD TATNALL CANBY*

1. EYE-CATCHERS

Festival Casals de Puerto Rico, 1957: Rehearsal of Schubert "Unfinished" Symphony; Bach: Capriccio, Suite #1 for Orchestra. Casals, Serkin, Festival Orch., Schneider. **Columbia ML 5236**

The Casals rehearsal here is the one at which he suffered the heart attack which put him out of his own festival—I quickly inform the ghoulish-minded that the old man does *not* collapse with a groan at the end of Side 1! But, in this unique documentation of the moments leading up to a near-fatal attack, you will hear abundant evidence that a man over seventy who emotes like a teenager is running a big risk. Casals shouts, stamps his foot, yells the tempo and phrasing over the orchestral sound; the words tumble out in great excitement as his enthusiasm mounts and (though all is in fine good humor) you can't help feeling that he'll never last the whole record side.

I suspect that Casals here is medically in considerable contrast to other more seasoned elderly conductors, who are physically well trained for the podium, who know how to spare themselves for maximum impact with minimum muscular effort and, most important, are calm and self-assured inwardly, however temperamental they may seem on the surface. This was obviously a big emotional moment for Casals and he obviously was not sparing himself at all.

The recorded sound of the Schubert? Wretched, as though taken down on a ten-year-old home recorder with the volume turned up too high. But it doesn't matter.

The Bach Suite on the reverse is an anticlimax in that it bears the Casals name and, no doubt, some of the Casals interpretation, but is actually conducted by the indefatigable Alexander Schneider, who took over. It is a perfectly good performance, quite all right but nothing to add to anybody's collection. Up-to-date forces, with continuo, but the interpretation is more or less the old "symphonic" sort, beloved to symphony audiences, increasingly out of style for record collectors who have heard continental versions of the music. Rudolph Serkin plays the early Bach Capriccio about the departure of a beloved brother in an excellent pianistic way, though the music belongs on a harpsichord or even a clavichord.

Festival Casals: Mozart: Piano Quartet, K. 493. (Stern, Katims, Mischa Schneider, Istomin).
Schubert: Violin Sonata in A Minor (Schneider, Horszowski.)
Columbia ML 5237

The most practical parts of the Casals festival recordings over the years have been the chamber music offerings, with and without Casals himself. They are documents, records of a moment in time when important artists got together before an audience. On the small scale of a few performers, recorded results are often good in spite of the performance recording—and if not good, then at least revealing and interesting.

The Mozart is a very proper performance, if not exactly tops in considered and balanced ensemble. The performers are outstanding and no doubt about it. The Schubert violin sonata is given an oddly emotional, Romanticized playing, with much sighing and gusty breathing—to speak figuratively. Not my idea of the ideal approach to the music, but it's effective.

Festive nervousness and tension never quite get eliminated in these recorded performances, whether the audience is actually there or not. All in all, a festival is the last place to record music for permanent home-style listening. When the public finds this out, festival recordings may be further revamped for a more leisurely recording session, well away from all the hoopla. Maybe months later. You can still get *some* of the on-the-spot publicity sales value, via the "as played at the Casals Festival" approach, and the music would be an awful lot better.

Gluck: Alceste (Italian version). Flagstad, Jobin, etc. Geraint Jones Orch. and Singers, Jones. **London XLLA 49 (4)**

Monster albums of this sort are enough to floor any critic but I played every bit of this one—eight sides—and followed the Italian and English text from beginning to end. It was worth it.

Flagstad isn't exactly the ideal voice for the 18th century Gluck from a musicological viewpoint; but if you let that bother you, you will miss one more great appearance of the grand lady and, moreover, you'll miss a presentation that gets to the heart of Gluck's music and drama, whether its style is perfect or no.

As always, much that Flagstad sings is uneven, the coarse sounds inevitably mixed with the lovely ones. She has trouble "getting started"; her old upward slide is as prevalent as ever. But in the grand second act, where she has the stage almost to herself and most of the music, she is utterly moving—a very great performance of music requiring to the last degree a noble musical mind and a tremendous spiritual dignity.

This is the original Italian version, composed (in that paradoxical age) for Vienna before Gluck moved to Paris; its operatic reforms, real enough at the time, seem mostly insignificant to us today in the face of its far clearer adherence to the other traditions of static, noble opera tragedy. (The French version is considerably rearranged, even to the plot and sequence of scenes.)

With the musical know-how that is so lacking in our own mixed performances, this production combines Flagstad with a French leading tenor (the tenor was used in the French version, though the original calls for male castrato) and an English chorus and orchestra for a suave and beautifully unified performance. The choral singing, so extensive in Gluck opera, is superb of its sort. Recording is as good as it always is in London operas.

Wagner: Die Walküre; Act III (complete), Act II: Siegmund! Sieh' auf mich!". Flagstad, Edelmann, Svanholm, et al; Vienna Philharmonic, Solti. **London A 4225 (2)**

It'll take a while before I really get this one absorbed, so I hasten to report on it though I haven't finished listening to it.

Priceless, is the word—even though I have mild reservations about the recorded sound, which is "hi-fi" with a vengeance. I sampled the beginning of the first side, just to try out the "Magic Fire Music," and quickly became so absorbed in the excitement of the famous scene where the Valkyrie ladies gather together, complete with horses and battle cries, that I never stopped until the side was done. A splendidly exhilirating performance—which is plenty of recommendation in itself.

The suspense by which cagey old Wagner holds off the last of the ladies, Brünnhilde, favorite of Papa Wotan, until you are ready to pop with anticipation, is of course perfect for this recording, which features the great lady herself, Flagstad. She doesn't appear for minutes and minutes—but when she finally "rides" in, horse and all, she is unexpectedly good. Her voice, in this section, holds up remarkably well against the female battering-ram represented by the eight other Valkyries, all screaming at the top of their voices! Age before youth.

There has been a good deal of grumbling about the "exploitation" of Flagstad in her years of retirement, as represented in these records and the others coming forth so copiously of late. It's true that her voice is a something shadow of its former self. But two things are much in her favor. First, she is still the great dramatic artist, the same personality, with the same fine musical ear. Second, the voice has its ups and downs—and the ups are unbeatable.

After all, not every passage of top dramatic impact is also in the top notes of the scale. Most of the vital music is still singable for the Flagstad voice; only occasional spots are really beyond her and only occasionally does she lapse into her familiar croaks and slides.

The recording in this album was done with an interesting degree of stage movement, deliberately encouraged. The singers went through their stage motions instead of clumping themselves about a stationary mike. The idea worked—and much of the music was taped unbroken, without retakes. Nothing could be more essential to Wagner, who can be stopped in midstream about as easily as a golf stroke halfway through. The voices are somewhat less prominent than is usual—occasionally get lost in the orchestra; excellent, since that was the plain intention of the original.

I don't know what accounts for the exeremely sharp, brilliant "hi-fi" sound of the orchestra, but I don't much like it, as of now. Reservations on that are in order, since what today seems extreme may well be top-ranking sound tomorrow. But in any case you will find this Wagnerian orchestra blatty in the brass, scratchy in the strings, clashy in the cymbals, and generally very modern sounding, if undistorted.

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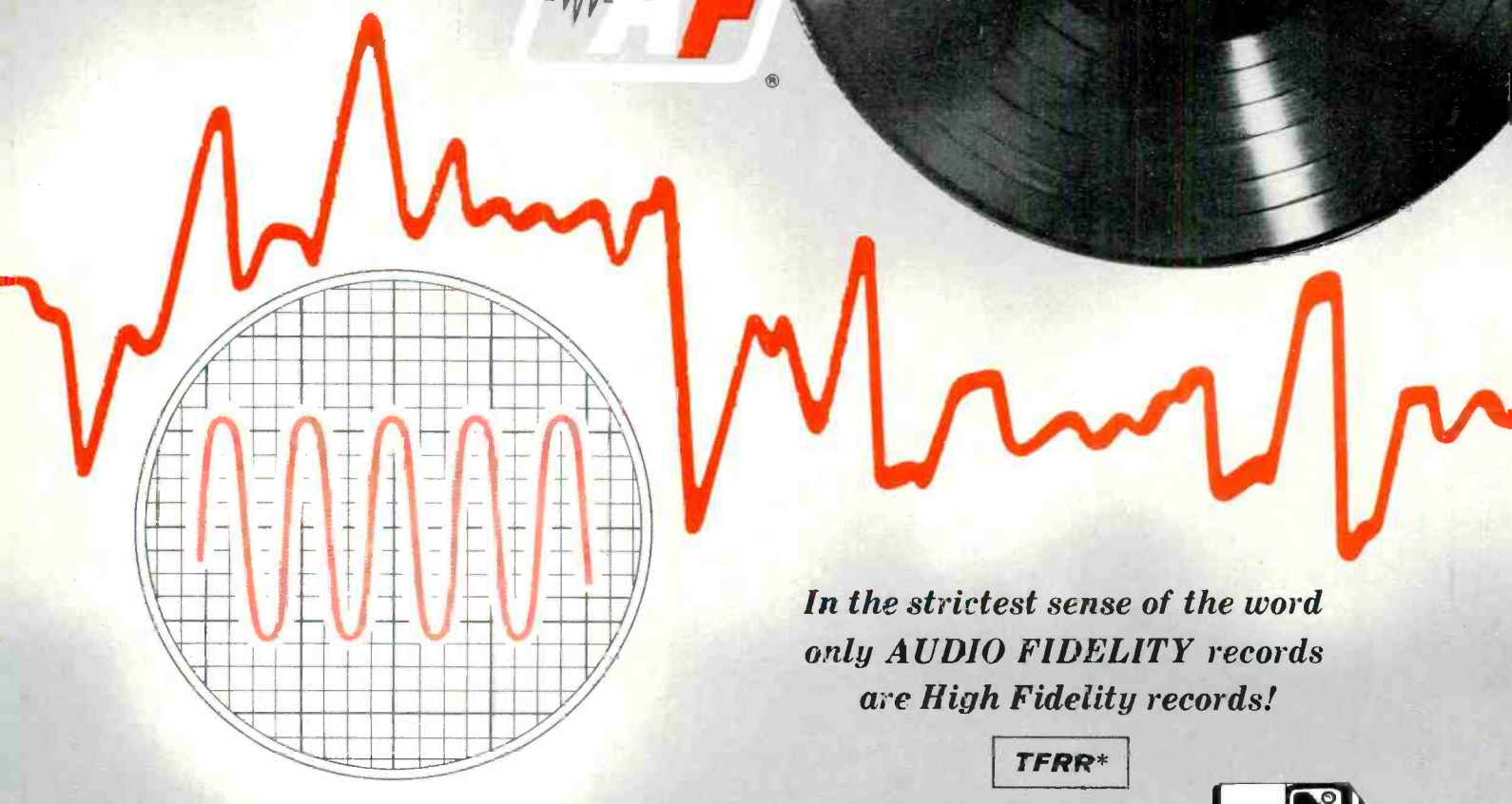

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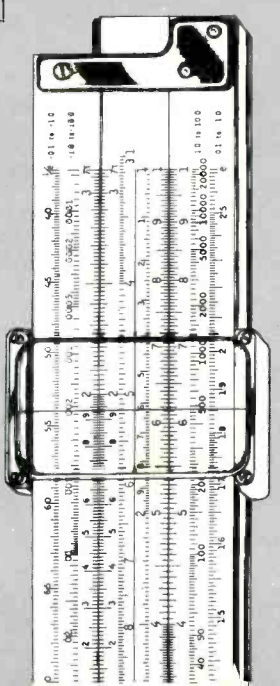

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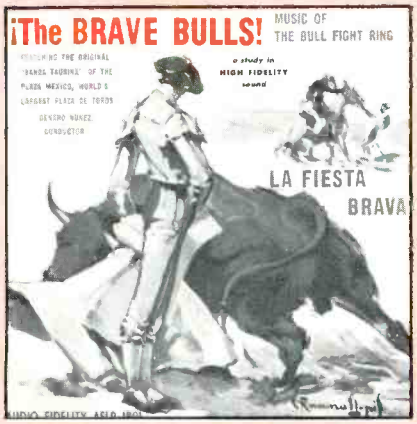

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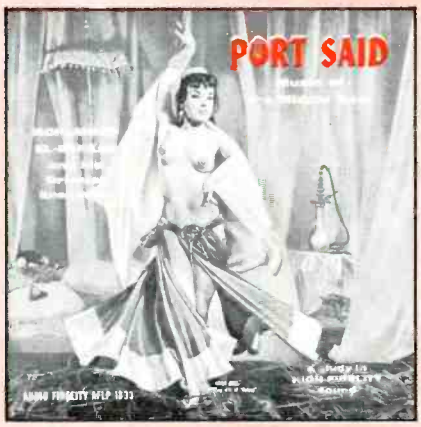

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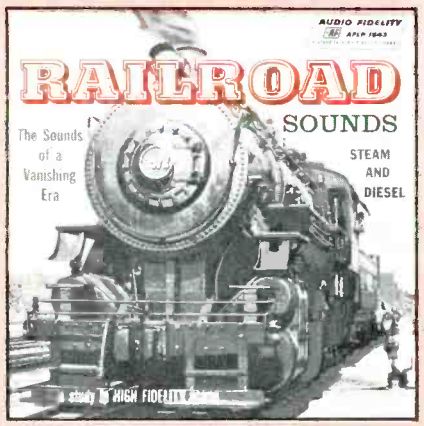

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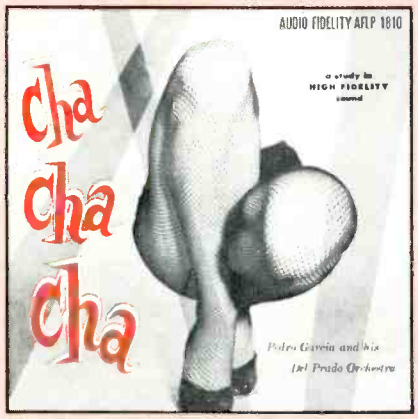

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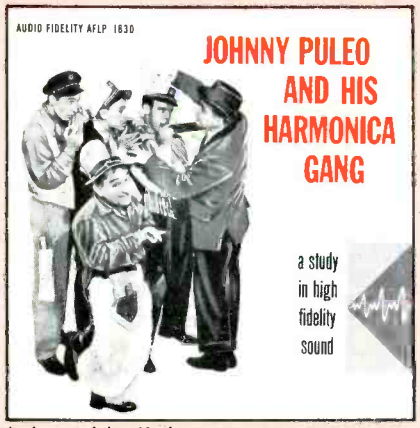

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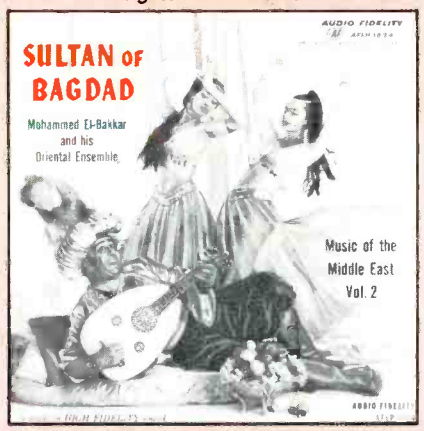

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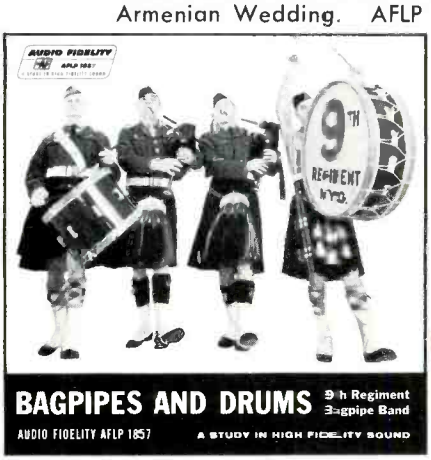

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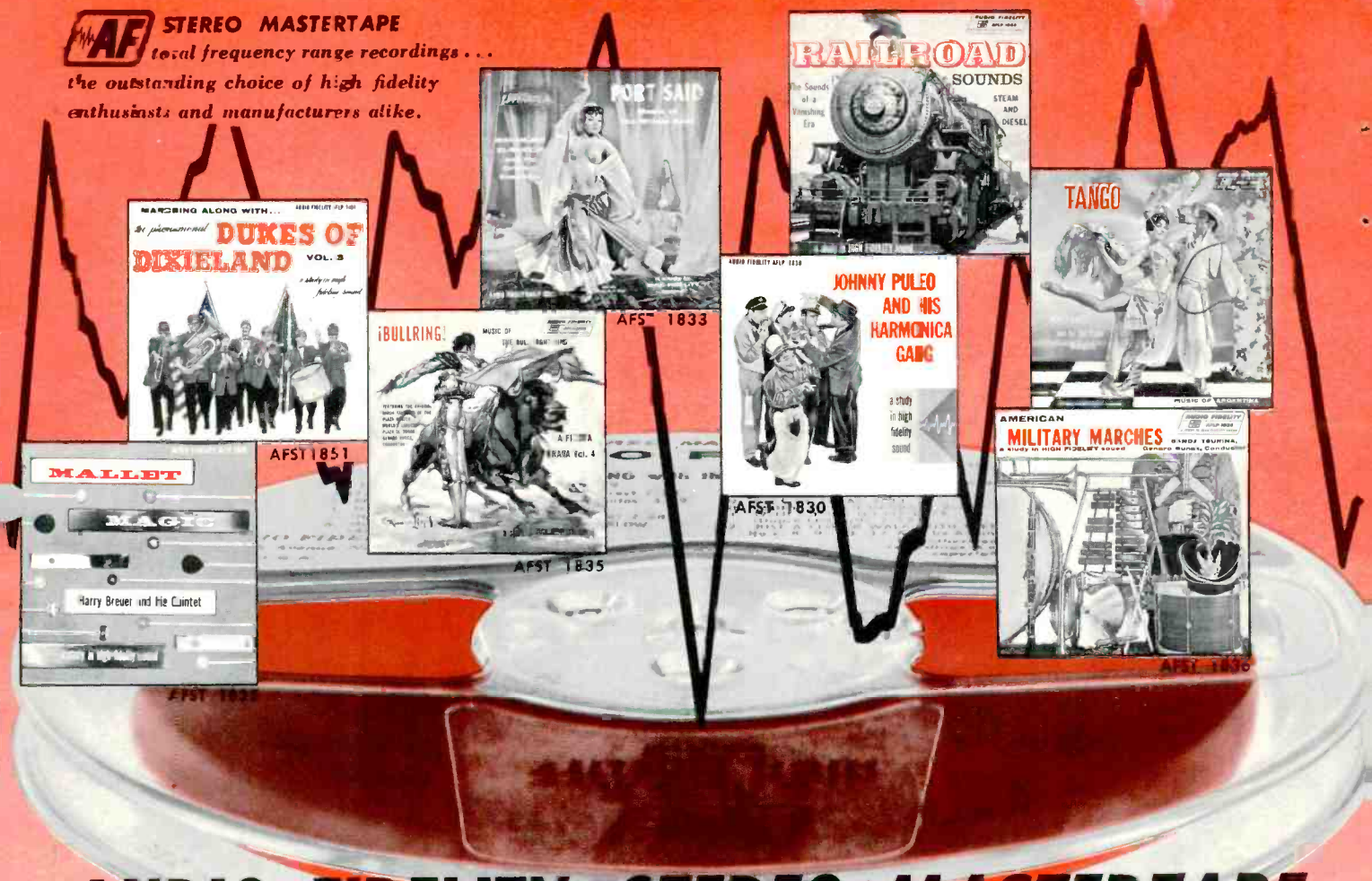

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RECORDS

(*from page 56*)

makes following the opera an interesting experience. For once—you really know what is going on.

Rimsky-Korsakoff: Le Coq d'Or (The Golden Cockerel) (complete). Ballets Russes Orch., Horvath.
Concert Hall XH 1512

The revived Concert Hall label, under Crowell-Collier management (C-C Clubs), has snared this orchestra for ballet recordings in cooperation with something called the International Ballet Guild, dedicated to the preservation of ballet and in particular the famous Diaghilev tradition. Here is the complete score of a ballet that we ordinarily hear only in the usual concert excerpts; and once more, the pleasure in the discovery of the whole music, familiar and unfamiliar, is great for home listening. Indeed, this particular bit of Rimsky goes up a lot in the estimation as one finds out how it originally was supposed to sound.

In this performance the Ballet Russes orchestra, wherever it may be, plays most danceably and with fine musicianship; the music would seem to be familiar enough to the players, as well as the dancing that goes with it. Or perhaps it is merely a well-known style, for an experienced ballet orchestra. Nice recording in the sound, big and rather close, though there is some distortion in louder parts as I hear it.

Prokofiev: Romeo and Juliet (complete ballet). Ballets Russes Orch., Bashich.
Concert Hall 2XH 1513 (2)

Here is another in the new Ballets Russes series—but, alas, it is a different kettle of fish. Prokofieff (it can be *ff* or *v*), to be sure, is in the line of great Russian ballets and out of the Diaghilev tradition; but evidently he isn't too well known by this orchestra—or maybe the music is just too hard.

Admittedly, the string parts in one of the main themes go dreadfully high; but other orchestras manage without trouble. The string playing in this performance is just plain, excruciating and there are other bloopers and falterings that mar the recording to a point where I can only wonder how it came to be issued. Sounds like a first-time run-through be a very inexperienced orchestra—which this one surely is not.

It's a lovely, sweet, warm ballet as well as a stark one in many places and, aside from the above, it gets a sympathetic treatment here. The tempi are notably different from some of the earlier concert recordings, notably by the Boston Symphony; maybe these dance players are right.

Haydn: Symphonies #92 ("Oxford"); #104 ("London"). Berlin Philharmonic, Rosbaud. **Decca DL 9959**

These two splendid profound, cheerful, wise symphonies, that caused such sensations in England in the late 1700's, are played with a good sense of the style by the well-informed Berlin Philharmonic. The subtleties of harmony, the unexpected twists of direction, the sweetness, the long-breathing melodies of the slow movements, the top-speed last movements with their sudden breaks, the solidly brilliant minuets, all these are felt and expressed. These players revere Haydn.

The orchestral sound is on the soft side, minus that almost too-crisp accuracy that Sir Thomas Beecham put into his sprightly Haydn—but this is a natural softness, out of the German musical temperament, not to be confused with slovenly or careless playing that might blur sharp lines. Sincere is the best word for this German approach.

D-G (Deutsche-Grammophon) has dropped a bit behind our present taste over here in hi-fi; after so much of the newer close-up sound, this recording seems to my present ear a bit distantly picked up. But this is strictly a matter of taste and choice. Nobody can say which is best.

Stravinsky: Le Sacre du Printemps. L'Orch. de la Suisse Romande, Ansermet. **London LL 1730**

This is marked "Hi-Fi Record of the Month"—probably last month. All the companies are going in for this now, but the months are over before we can get to talking about the records. Too late to get in on the bargain rate, but that can't be helped.

Ernest Ansermet has definite ideas about the rites of this particular spring. The music may be about the passions that stir the primitive breast, but primitives are human, too; that's the general approach here. The gentle-faced conductor with the saintly beard gives us a musical, rapid-fire but never hard or angular playing. If you want a hard-toned, "primitive" reading, try Mercury with Dorati.

(I might hint, in parentheses, that this kind approach to the Russian savages doesn't make for maximum "hi-fi" effect—since London's engineers go along with Ansermet. So much the better, I'd say, and I like the softer, more golden hi-fi of this recording, as far as the music is concerned, even if it isn't sensational as to sheer impact.)

Strauss: Domestic Symphony. Chicago Symphony, Reiner. **RCA Victor LM 2103**

A beautifully hi-fi recording, by a top Strauss player, of one of the most long-winded tone poems ever written. For the music, this treatment couldn't be bettered and, as a matter of fact, if you don't have a train to catch or something, you can just let it play. The sound effects are always interesting.

Bach: Three-Harpsichord Concerto in C; Four-Harpsichord Concerto in A Minor. Soloists, Ensemble of the Ansbach Festival, Richter. **London LL 1446**

Technically quite a remarkable record in that for the first time, as far as I can remember, the multiple harpsichords in these two works are recorded with the proper *low-level* volume-balance against the orchestra. The four of them together are much less loud than the string orchestra—as they should be.

Most recordings of harpsichord concertos mistakenly blow up the harpsichord sound via the convenient solo mike technique. With four of them, or three, the effect is positively hideous! This version makes the music sing delightfully, as Bach intended it to sing, with never a trace of heaviness or bombast.

Just goes to show that you can carry the "advantages" of mike technique too far.

2. ADVENTURES

The Union. Richard Bales; National Gallery Orchestra, Cantata Choir; Raymond Massey, Peggy Zabawa, Raymond Zabawa. Essays by Catton, Dowdey, Nevins; illustrations. **Columbia DL 244, boxed**

As inevitable as the day, this album with its gaudy gold-and-stars-and-stripes cover follows up the successful "The Confederacy" of awhile back. The idea is the same, a kind of inspirational extravaganza, the printed section full of historic pictures and essays by well known historians, the record itself (a relatively small part of the big layout!) a potpourri of Civil War songs and patriotic speeches strung together into a sort of running cantata.

It's good of its kind and will please. I found it, on the whole, pretty diffuse; it isn't really very clear in its "message." A similar words-and-pictures affair in, say, *Life* magazine, would be much more taut, more compelling, more centralized, and with not a bit less popular appeal. Still—there are 60 album-sized (*Life*-sized) pages in this book, enough to keep you busy for many a night even without the included record. (In fact, this sort of thing makes me wonder whether a "record review" is quite the proper coverage for the volume. Maybe it should go under NEW LITERATURE.)

The musical portion (on one LP) is, necessarily on the patriotic and inspirational side.

leaving the horrors of the war to the pictures. The jaunty words and their humor are clearly projected, comment on the history of the songs is provided in the book. Mr. Bales' musical arrangements are unassuming and practical, rightly leaving the various items to speak pretty much in their own terms. They were good tunes, if they do sound old fashioned now.

Nonsense Verse of Carroll and Lear. Read by Beatrice Lillie, Cyril Ritchard, Stanley Holloway. **Caedmon TC 1078**

This disc is supposed to be screamingly funny but it left me angry—and not for the reasons you might guess.

Surely it was a good idea to have three voices, for variety, and it did no harm at all to hire three well known voices either; the prognosis for good comedy might seem to be high enough. And the nonsense verse of Lewis Carroll and Edward Lear ought to be just the stuff for this particular trio.

And yet I was honestly hurt and, in a way, shocked, by the irreverence here displayed. What? Do I expect this to be a sermon? Not quite that. But what these people evidently do not see, is that these verses in their zany way are as fine, as human, as universal, as a large amount of poetry that makes more outward sense. Nonsense or no, both Lear and Carroll had a marvellous feel for the great ballad tradition of the English language, the kind of swinging, rhythmic underplaying of universal human symbolism that is the basis for the best in folk music. Does it matter that outwardly so much of this is pure fantasy in words? That is its very beauty! It should not be made fun of—it speaks for itself, exactly as does a fine ballad or folk song.

All three of these famous people, the readers, find themselves unable to resist the temptation to act. They are stage people, after all. They exaggerate; they shriek and they growl, they put on fancy airs, they ham up every last detail—where instead all should be played down, ballad-style. Under this treatment the stuff *is* nonsense here, and mainly just silly. I say that Lear and Carroll, in their ways, were top-ranking poets and demand an artistic reverence.

Perhaps it's because I was brought up on these rhymes—the Walrus and the Carpenter, the Pobble Who Had No Toes, the Jumblies, Mr. and Mrs. Discobbolos, the Dong with the Luminous Nose. Children take things like this quite seriously and they are right. Children penetrate immediately to the real beauty of such wonderful ballad-refrains as

"Far and few, far and few
Are the lands where the Jumblies live.
Their heads are green and their hands are blue
And they went to sea in a sieve."

If you had heard that, again and again, at the age of eight or so, you would never forget it.

If Lillie, Ritchard, and Holloway had simply read these things with reverence, instead of indulging in vocal sound effects and cute accents, they would have a proper out-loud impact.

Alice's Adventures in Wonderland. Read by Cyril Ritchard; music by Alec Wilder. **Riverside SDP 22 (4) boxed**

It doesn't matter a bit that Cyril Ritchard, who reads the entire volume of "Alice" here, seems to have a perpetual cold. The sound, somehow, is right for Alice's very British and very amusing adventures, which in this modern day take on a curiously old-fashioned quality, as pleasing as a lace valentine. "Alice" is full of gentle satire and of course a lot of mathematical ingenuity (as some readers may have found out in a recent issue of *Scientific American*); but though you may be aware every so often of a pointed paradox involving gamesmanship—the famous croquet match with the flamingo mallets; the contest in which everybody wins a prize, and so on—you'll just enjoy most of the stuff without any need for fancy interpretation. It really is good. And don't miss the Lobster Quadrille (especially if you do square dancing or Eng-

lish Folk Dance) as told by the weeping Mock Turtle!

Each chapter opens with a longish musical interlude by Alec Wilder in what seems to me rather tasteless and shapeless style, a bit of this and that, trailing off indeterminately. . . . Influence of TV, I suppose. There are songs, too, sung in his usual croak by Ritchard himself; the words are out of "Alice," but the music is decidedly not in the styles so clearly suggested by Carroll, who had a fairly good idea of music and liked to make fun of it. These songs are just plain uninformed, but kids will probably enjoy them just the same. The music doesn't take up much of the recorded time and it does serve to break the monotony of the speaking voice sound.

A facsimile edition of the original "Alice" is included, complete with the famous and well-remembered illustrations.

Now—let's have "Through The Looking Glass."

Frank Pettingell Presents Oscar Wilde. Spoken Arts 724

A distinguished older British actor here reads and "acts" the famous words of Oscar Wilde, and in the process gives you an idea of what a brilliant eccentric "modern" of the Eighties and Nineties was really like. Scintillating remarks, brilliantly epigrammatic and also very amusing, arch, highly affected dandyism, a way of turning back questions from the press that is positively "rapier-like" (as the press would say)—and a way, too, with story-telling that will captivate any ear, make this a really remarkably interesting disc.

Somehow, Mr. Pettingell himself seems to be just a bit old fashioned in his style of presentation. Maybe it is on purpose; if so, he is convincing. This record doesn't bring Wilde up to date; it takes you back to Wilde's times, by the very inflection of the voice, and you feel what it was like to be a celebrity in those days.

Spoken Arts is no longer connected with Westminster. The address now is 95 Valley Road, New Rochelle, N. Y. (Dealers can order records for you from there, if you buy through your local store.)

Irish Ballads, Folksongs and Lyrics. Read by Siobhan McKenna. Spoken Arts 707

If you like the real Irish way of speaking, this is for you. No faked up stuff here. Siobhan McKenna is the lady who did Shaw's "Saint Joan" with an Irish accent RCA Victor). She talks informally here, reads in English (Irish) and in Gaelic as well—a large brace of poems by Yeats plus a batch of ballads and some other lilting modern verses by well known Irishmen. See above for Spoken Arts address.

On Bourbon Street with the Dukes of Dixieland. (vol. 4). Audio Fidelity 1860
Minstrel Time with the Dukes of Dixieland. (Vol. 5.) Audio Fidelity 1861

Volumes 4 and 5 of this series—and at last I've had a chance to listen to the music itself. I'm mightily impressed by these tremendously knowing, sophisticated, vigorous musicians.

Yes—I've heard the Dukes many times already; but every time it's been "hi-fi demonstration." Who listens to *music* in a hi-fi demonstration? Who listens to a whole piece right through, not to mention a whole side of a record? The Dukes had the privilege of introducing stereo discs—some of their material is on Audio Fidelity's now famous 45-45 platter, whipped up and released very early in the year for use in the stereo disc demonstrations. (I ran into it at the Pickering demo.) But I never even heard what they were playing; as I say, you don't listen to music under such circumstances. You listen to equipment.

Actually, I haven't even got to Vol. 5 yet, in the way that I like to *listen* to music, which means hearing it all, as presented, with repeats on those sections I particularly enjoy (or dislike). Vol. 5 is presumably hi-er in the fi than ever but Vol. 4 is terrific, even so. This is a perfect combo for hi-fi effects, with big, thumping bass, squeaky, edgy highs, tre-

mendous clarity (you can see right through the music) and velvety silence for a jet-black background.

What gets me, though, is the sheer musical understanding of these boys. Do they know their stuff! The Dixieland itself is maybe not exactly progressive jazz; but it is wholly modern. This kind of music may stand still and be old fashioned in the outward harmony and style—but it gets thicker and more cogent, more concentrated, the longer it stays around. Nobody in the early Dixieland days could have conceived of quite the sort of dead-serious, sardonic, humorous texture found in this music. It's as thick as Bach, as dynamic as Beethoven, as witty as Lead Belly. And you never know what's coming next.

My favorite parts are—of course—those which take off bits of the classics, sort of en route. *Saints,* on the familiar tune, introduces members of the band one at a time, plays solid variations with bits of Tschaikowsky, the Flight of the Bumble Bee, ends up with a wonderfully hard-boiled take-off on what I gather is "sissy" progressive jazz—boy, what a commentary! You could never express it in words like that.

Another item, *Chimes Blues,* bursts into classic counterpoint on a set of bells that will ring up the Nutcracker Suite for you—then ends with a flying pass at a Bach Invention (Two-Part Invention in F Major) on the way out. All as casual as you please. Still another takes us through an oldtime jazz-accompanied funeral.

In the fifth volume the Dukes turn their sardonic attention to such minstrel items of black-face as *Swanee River, Old Kentucky Home, Wait 'til the Sun Shines, Nellie,* not to mention Alexander's famous band and *Dixie* itself. Man, what they won't do to these simple-minded classics! Better give them a try.

Catch the Brass Ring! Carrousel at Coney Island. **Mirrosonic SP 6001**

First issue in a new hi-fi catalogue, a brace of mechanical pieces from the "repertory" of a carrousel that, at least in some of the numbers here, is obviously in business and going 'round and 'round. The first side has the usual potpourri collections of this and that wheezy popular tune. The second offers the "classics," or at least it has whole pieces lasting a complete LP band each.

Nice fi and all that . . . but what amused me most was the "Light Cavalry Overture" of von Suppé. Just as the cavalry begins to get going, the kids hop onto the mechanical horses and one shouts "giddyap"—obviously not in reference to the music. More kids, police cars cruising by in the background, general city-type noises, give this recording plenty of nice atmosphere. A big bell goes CLANG when the machine is about to start turning.

The mechanism is in much better tune than most of the automatics we've heard. Makes it less exciting, in a way, though more authentic. Quite a highbrow carrousel organ on the whole, this one.

John Langstaff Sings American and English Folk Songs and Ballads. Nancy Woodbridge at the piano. **Tradition TLP 1009.**

Interesting! John Langstaff here represents the old pre-phonograph school of folk song, when the music was "collected and arranged" by field workers who took it down on paper in notes and then set art-form piano accompaniments to the somewhat simplified tunes. (It is not possible to write down authentic folk song in ordinary notation without omitting all sorts of shadings, ornaments, trills, slides, off-color pitches and the like.)

Langstaff sings with a trained voice of power and expressiveness, as of the concert stage. He is highly musical and, of their sort, his renditions can't be beat. Some are unaccompanied—like the originals, but with trained voice—others have piano accompaniments of great beauty, by such as Cecil Sharp and Vaughan Williams. The whole thing is a million miles removed from today's folk music performance, which is modelled (for good or bad) upon the actual sound of the music in the field, rather than on the printed note. A lovely record, even so.

Elektra New Folk Sampler. Various Artists. **Elektra SMP-2.**

If you like popular folk music in hi-fi, this sampler is well worth noting. I mention it not only because of the fi, and because a number of the items appeal to me (others don't particularly—matter of taste—) but because here each song is complete, or if there has been editing done, the job is neat and there are no fade-outs in mid-stream. The music varies from Jean Ritchie in Kentucky Mountain songs to Songs of Montmartre, in French with Suzanne Robert. Haiti, Nova Scotia, Israel and the Erie Canal are by-stops.

Recorder Music of Six Centuries. Recorder Consort of the Musicians' Workshop. **Classic CE 1018.** (719 10th Av., New York.)

No—this isn't a collection of tape recorders making Musique Concrete, as the French call it! Those who have tried the wooden flutes that look like chair legs will want this record as quick as it can be had—these are good players, in ensembles up to four in various sizes, plus percussion, and the recording itself is excellent, both as to cleanness and, notably, for excellent miking with a grand, big liveness that makes the recorder sound sing. You'd be amazed what a good recorder player can do musically. My only complaint: a slight rigidity of tempo. Too much time-beating.

3. ALL SORTS OF ORGANS

Organ Music by Liszt, vol. 1: Vars. on "Weinen, Klagen, Sorgen, Zagen"; Evocation a la Chapelle Sixtine. Richard Elsasser, organ of John Hays Hammond Museum, Gloucester. **M-G-M E3576**

Organ Music by Liszt, vol. 2: Fantasy and Fugue on "Ad Nos, Ad Salutarem Undam"; Prelude and Fugue on B.A.C.H. Richard Elsasser. **M-G-M E3577**

This is the very acme of long-winded, lion-roaring Nineteenth century music and you'd think it might be pretty dull for us pure-bred classicists, so used to the new "Baroque" organs and their concise Seventeenth century music. Instead, I found these records quite exciting, if very long-winded. I had the time, and didn't mind taking it.

Elsasser is a convincing player of Romantic music, as very few organists today are. He gets over the "message" of these enormous works without strain and without apology; they rant and roar as they should and they spread out immoderately over vast stretches of LP without any hurry-up at all. (I also liked the Elsasser César Franck playing, on M-G-M.)

Each of these works last a half hour or so. You can look at the discs and see the great climaxes (the biggest, of course, at the endings), the inevitable long quiet passages where practically nothing is audible at all, the great build-ups and build-downs. That's the way Romantic music goes, on the organ as elsewhere.

What is interesting, aside from the sheer power of the music itself—given plenty of leisure on your part—is the remarkable way in which the big organ of this mid-century time had been modified to sound like an orchestra. Romantic music is essentially unsuited to the organ's natural abilities, which are best for sounds that are arranged in flat planes of color and loudness. Great climaxes aren't easy, because you can't just blow harder and use more muscle; you must create an artificial build-up by gradually adding pipes, by opening up the swell boxes, and so on. Swooning emotional tunes are equally hard for the organ—it runs via a mechanical bellows after all and each individual pipe "just blows," dead-pan, so to speak.

But in line with the general interests of that day, organs were built to rant and roar, to swoon and to emote, and in central Europe Liszt and Mendelssohn were two great exponents of the instrument's newly Romantic powers. There was much invoking of the spirit of old Bach, of course—most of this

music does it—but the music itself is about as Bach-like as Tschaikowsky.

Try Liszt's high-tension, almost atonally built fugue on B.A.C.H. as compared with Bach's own. Interesting.

The Gloucester organ has something called a Dynamic Accentor that comes out of loudspeakers. I suppose organists of a pure breed will frown, and electronic engineers will be intrigued. All I can say is, this music comes *entirely* from a loudspeaker, my own, and I really can't tell where the Accentor accents and where it doesn't. The whole thing sounds good to me. Blow you out of the house, if you want.

(See also two more volumes.)

Bach: The Art of Fugue. Helmut Walcha, organ of Church of St. Laurens, Alkmaar, Holland. **Archive ARC 3082/83**

Just before I came back from Europe in September, 1956. I was browsing around a small cheese-market town outside of Amsterdam, Holland, and found myself inside the local church edifice, with organ. I usually just look at organs—few of theme were ever playing—but this organ was actually being put to work as we wandered about the church and I suddenly realized that the four or five notes the organist was repeating, over and over again (he couldn't get one chord right in his fingering) were familiar. Turned out to be a passage in Bach's Art of Fugue and Herr Walcha was practicing for this very recording.

Funny—I never heard more than those few notes, on the spot. and I didn't think they were very convincing; but now, a couple of thousand miles or more away, I get to hear the rest of the music. Such is recording.

This great last piece of Bach's is a monumental series of musical edifices built upon one utterly simple short tune and its upside-down mirror image, plus assorted elaborations of these. It has everything and, curiously, is quite listenable and not hard to make sense out of. After all, the tune is the same all the way through—with extra ideas grafted onto it for increasing contrast and tension.

The two discs are available separately but I wouldn't advise getting just one of them—unless, maybe, the second one. The first will leave you in mid-stream, minus climax. The final peroration is the beginning of the great last fugue in which four themes are combined. one of them being B A C H (B^b, A, C, B in English)—the old man never got to finish it. Too bad that Walcha brings it to a precise close instead of playing the trailing connecting passage that was actually the final thing Bach wrote on the work. Played that way, the end, broken off in the middle of a phrase, is a real emotional shock.

You won't find any big bass here but there are some very nice colors and a few passages which because of their very potent overtone coloration make excellent intermodulation tests for pickup and system response. But the real purpose of the discs is musical and Herr Walcha, a bit didactic, nevertheless gets over the gradual sense of a great structure building up to a powerful climax of expression. This is an extra to his series of all the organ works of Bach; the music was written for no exact instrument but is clearly very much at home on the organ.

The Electronic Organ Wizardry of Mark Laub. (Baldwin, Conn. Hammond, Lowrey, Thomas, Wurlitzer.) **Golden Crest CR 3029**

I'm not an electronic organ fan, nor a "Tea for Two" fan, but I did get one mild surprise from this disc—my favorite piece turned out to be one played on the Hammond, which I *thought* was the electronic organ I would like least. Just goes to show. . . .

As a matter of fact, the comparison is pretty much meaningless, for each arrangement here is different, each represents just one of hundreds of possible uses for the given organ. Experts will be able to pick out particular stops they like, judge the usefulness of combinations, and so on, but the general listener will simply find here a record of Mark Laub playing "the" electronic organ.

Superb recording of its kind, as with most Golden Crest records. Æ

LETTERS

(*from page 6*)

pickups. This will protect the disc purchasers from making this mistake, and will save the dealer, distributor, and record manufacturer from the inevitable stream of complaints that will ensue if the point be made not quite clear.

D. H. TOLLER-BOND, Gen Mgr.,
London Records, Inc.,
539 West 25th St.,
New York 1, N. Y.

(Further experience with such stereo discs as we have been able to get our hands on indicates that even if vertical compliance is high, quality is not what we would expect from a good LP monaural disc. ED.)

SIR:

I was interested in your published letter (*Mr. Carlson's letter to Fairchild dealers and distributors, December issue*) explaining the two types of stereophonic records. So far, all stereophonic sound (a redundance we will have to live with, I suppose, like "AC current") has left me unimpressed, for unlike the original binaural sound with earphones, it is only a compromise. However, Mr. Canby has well covered that and we shall all experiment, I am sure. I would like to avoid tape. So far, monaurally, by paying attention to cartridge, arm, circuit, and speaker housing and placing, I manage to get more realistic musical sounds from discs than others seem to me to do with tape. By the way, I still use your old losser and feedback equalizer circuits, and the preamp is indistinguishable from a recent commercial model I borrowed recently for an AB test.

Anyway, in the letter, two things occurred to me and I hope you will elucidate them, preferably with diagrams, in an issue soon. In the London method, what happens to the vertical component produced by the pinch effect; is not this quite audible? In the Westrex method, how can a standard LP stylus, accustomed to track laterally, with only unintended vertical motion, follow what must be a very complicated lateral and vertical design without producing a hash? Is not either method so complicated, relatively, that it can never be as clean as a monaural disc and stylus?

EDWARD H. BENNETT, Jr.,
80 E. Jackson Blvd.,
Chicago 4, Ill.

(The "pinch" effect would certainly produce a vertical component, but our guess is that the Westrex system will be adopted, so the question is an academic one with respect to the London system. However, there must also be a pinch effect even with the Westrex system. Time only will tell how objectionable this effect will be. As suggested in the preceding letter, it is a certainty that a stylus must have considerable freedom in both vertical and lateral directions. We have heard some very fine reproduction from stereo discs, and are hopeful that they will become still better as the industry racks up more experience with them. ED.) Æ

CHARLES A. ROBERTSON*

Dukes of Dixieland: Minstrel Time, Vol. 5
Audio Fidelity AFLP1861

CENTERED ON A MINSTREL THEME, the latest volume by the Dukes of Dixieland presents them in an engaging renewal of Stephen Foster melodies and other early favorites. They maintain the youthful vitality and drive which made their previous work so attractive, and impart the strong dynamic qualities so essential to satisfying sound. Their clean-cut playing contributes to a distinctive separation of instruments that is ideal for stereo, resulting in the selection of a portion of the third disc in their series as a companion piece to some of Sidney Frey's essay on steam and diesel locomotives on the first stereo disc circulated outside the laboratories.

For a part of the story of the recording techniques employed so effectively with the Dukes and a preview of things to come, Johnny Bubbers was interviewed during one of his hurried visits to the New York offices of the B & C Recording Company. When not occupied in recording studios, he devotes most of his attention to the pressing plant in Westbury, L. I., where discs for Audio Fidelity and other companies are manufactured. The problems of the main office in regard to sales and customer relations are usually left in the hands of his partner Walter T. Colquitt, another practicing engineer who went to New Orleans for the railroad sounds.

It was occasioned by the arrival of a prototype model of the Fairchild stereo cartridge and arm. This item was then the only means available, at a price in the neighborhood of $250, for playing a stereo disc, and Bubbers welcomed it with the remark: "Now not only do we know what we are working toward, but we are beginning to get some of the equipment needed to do the job. The adoption of the Westrex system has clarified the whole matter of stereo sound. While considerable work must be done before mass production is a reality, the remaining steps will involve engineering methods already perfected. Some manufacturers may take the opportunity to introduce certain refinements in their equipment, but the team at Westrex is responsible for the inventive stroke that provided the key for another dimension to sound on records. In experimenting along the same lines as Sugden in England, they hit upon the idea of giving a new angle to the old hill-and-dale cut. From such twists of fortune came the theory of gravity and, for all anyone knows, the wheel."

A quick glance at the pickup, which had taken the better part of an afternoon to install, showed that the terms "vertical cut" and "lateral cut' will soon become a part of the vocabulary of every audio fan. For it is connected to a three-position switch with these two channels on either side of a center marking for stereo. They provide a much handier frame of reference for everyone, including reviewers, than anything yet devised to distinguish the channels on stereo tape. "Actually only a two-position switch is needed," Bubbers explained. "It would serve to remove the noise a stereo cartridge might pick up when used monaurally, but the experimenter will probably want all three for purposes of comparison, as well as switches to reverse the speakers both in position and phasing."

When played in a workroom with conditions approximating those found in many high fidelity shops, the stereo disc performed in a way to justify the brightest predictions for it. The bass viol had a living resonance and the trumpet had both presence and depth. "The railroad side presented more problems than Mr. Frey anticipated," Bubbers commented. "He tried to make it in Chicago in zero weather and the microphones froze. Working in New Orleans under field conditions, he found it difficult to check balance and overloading in the open. He spent twenty-four hours making twenty reels of tape, but the result is a good test for stereo discs in the way of decibels and directional factors.

"The mastering was done by Westrex and in a sense it is a laboratory prototype, one of the many which must be made in this transition period. I feel that it is further forward than LP when it was introduced. Played monaurally it is down about 8 db from stereo. Future discs will measure about 3 db down, though to the ear the difference may seem greater due to the sound reinforcement of stereo. As the lateral cut carries the monaural sound, it may need to be slightly wider. Its correct relationship to the lateral cut still must be worked out. The crossover at 800 cps is too high, but that is not important now as these are matters of equalization and balance and can be quickly solved when we have the equipment.

"I do feel it important to learn as soon as possible if the correct techniques are being used in the studio on tapes made and set aside for stereo discs. Until now it was impossible to be certain if mike placements suited to tape would serve as well for a compatible disc. This is a problem for the individual engineer and is not easily worked out in the laboratory. I think there will be a short period of rapid improvement as they find the best techniques, followed by a gradual levelling off at about the time there is a mass market for the discs. Audio Fidelity and the small companies must keep abreast of the latest developments or fall by the wayside. They are fortunate in being able to move more quickly than the large companies, but the sooner 'ground rules' are set up on stereo the better it will be for all concerned.

"Scully is producing an attachment to cut variable depth in addition to the variable width already incorporated in his lathe. It should be ready about the time we take delivery on our Westrex cutter, one of the second run of twenty manufactured by the company and priced at $4,250. The first run of five went to the majors at a cost of $6,000, but I understand most of the orders for the second run came from independents.

"Those persons who have examined the writing engraved in the area of the runout grooves may have noticed that the railroad side was cut with 4-mil grooves at 155 lines, and the Dukes at 3 mils and 225 lines. They may have thought this was done because of the greater amount of decibels on the railroad side. Actually it was done to see how the groove size would affect the molding, and a variable cut will need further tests. I am most closely concerned with the problems of mastering and pressing. We are getting better plastic all the time and only the best will satisfy the requirements of stereo. If there is any trend I have noticed in my time in the business, it is that the cheaper product is getting worse in this respect and the quality record continues to improve. To me this is more essential than the need for greater vertical compliance in the cartridge. Most of today's good cartridges have sufficient compliance and will not damage the grooves on tough plastic. The record you just listened to has been played more than twenty-five times. Makers of stereo cartridges are likely to stress improved vertical linkage and it is not likely to be a problem. Some users will want to mount both a stereo and a monaural pickup."

Like many an audio engineer, Bubbers began as a radio amateur and operated station W2OHH. He still holds his ham license and call letters. While in high school, he started to work for station WOV at the age of seventeen. During the eight years spent there and four years with WLIB, he studied electrical engineering nights at New York University. He gained his bachelor degree in 1953 and shortly afterward formed the recording service with Colquitt, who was then managing another studio. "Walter keeps ahead of me

* *732 The Parkway, Mamaroneck, N. Y.*

in the high fidelity field," Bubbers said. "He is always adding to his home equipment and went into stereo tape as soon as possible. But my experience goes back to the days before FM when I experimented in improving the response of AM tuners. Our first customers were institutional and included Reynolds Metal and 20th-Century Fox. We made audio-visual aids for Amherst, Oberlin, and other colleges and for many high schools. We now press for Esoteric and Dawn, and for companies in Cuba and the British West Indies.

"When we opened the pressing plant in 1955, I soon became wrapped up in it and found I was devoting ninety per cent of my time to its manifold problems. What there was in the way of standardization was mechanical, determined by the manufacturers of equipment, and I quickly realized the practical worth of my degree. It gave a broader scope to my ideas for adaptations and the knowledge to carry them out. There is a great need for an industry-wide exchange of information and improved plastics. Standards vary from plant to plant and quality control will always be a problem. We are getting better plastic, but it can vary in spite of the same label. Hank Pearson, our plant manager, takes some of the weight off my shoulders. Both stereo and the trend toward a smaller stylus make good plastic imperative. The Fairchild has a 0.7-mil stylus and it will be more noisy than a 1-mil stylus on a poor pressing."

Sidney Frey became a client when they produced The Investigator, which became a best seller thanks to Jack Gould of the New York Times. The relationship became a close one, and as Bubbers explained: "It came about through the need for two pairs of ears on a recording date. This is understandable to anyone who has returned to a studio and tried to complete a record after a change in the weather. Sometimes it is necessary to dry out the studio, but the bass viol still may sound dead and the drums soggy. One person struggling to achieve a balance soon loses faith in his own ears. We learned that my experience with pressings was of value in the studio. Some wave forms are more difficult to press than others and they can be avoided by slight changes in balance. Also a French horn may seem all right in the studio, but by the time it reaches the record it can sound like a trombone. No one man hears everything and more than one reaction is often needed. We have come to respect each other's opinion.

"We are working with the new Electro-Voice 667 microphone and think the theory behind it is good, though we are just getting acquainted with it. So far I find that, like the Telefunken U47, it permits close miking without blasting. But there is less proximity effect and the remote control factor is excellent.

"As to Mr. Frey, he has a tremendous amount of drive and a fund of invention. He has a perspective of his own which enables him to see things as no one has seen them before. No one else recognized the possibilities of the Port Said record. It took me a long time to warm up to it," Bubbers admitted, 'but now I, and a lot of other people, feel its excitement."

Ten days elapsed before it was possible to visit the new offices of Audio Fidelity and talk to its head in his soundproof listening den. With acoustically treated walls, it serves as a demonstration room and a private retreat for the editing of tape. After reviewing some of the events attendant on the first stereo disc and the excitement engendered by it, Sidney Frey plunged into the most controversial point raised by its circulation. "We have been criticized as being premature," he said, "but I am not one to agree that such developments should be hidden in the laboratories. The hard core of audio enthusiasts has swollen considerably in the past ten years. I think it was their putting together components to play the first LP's that made the mass market for the LP and high fidelity; in fact, many of them go back to the early days of radio. If given something to work with while they perfect their home systems, I think they will do the same thing for stereo. We may make a mistake or so in our early releases, but I believe these are people willing to share them with us. I am always glad to hear from them and value their reactions, because their acceptance will make the stereo disc succeed."

In a brief survey of his belief in the prospects for the new development, he remarked, "Engineering progress makes the stereo disc in its present stage far superior to early LP's. As soon as I am satisfied that we are making the best use of our new equipment, I intend to have a release for the general public. The experimenters will find a way to play it. I imagine you have heard the story of how one of them* made his own prototype from a G.E. cartridge. But since you talked to Johnny, we received a model from Electro-Voice. Made of ceramic, it is designed to sell for about $20, depending upon the stylus. Pickering has shown a prototype and, by the time a record is ready, other cartridges should be available or well on the way.

"I know demonstrations of our first disc have surprised and pleased people of some experience. What shortcomings it has can be eliminated, most of them almost immediately. Its distribution to interested members of the industry came on the spur of the moment. I am anxious to know how it would sound and Johnny wanted to see how it would mold as part of a regular run. He neglected to tell his inspectors what was coming up, and he tells me they greeted the odd groove with considerable amazement. When we heard the results, it was decided to make up a limited number of copies for the record and high fidelity industry."

The response was nothing short of overwhelming and in the brief span of three weeks roughly seven hundred requests had been filled. "We are beginning to get some reactions," Frey revealed, "and they are highly complimentary, in regard to both the quality of sound and to our taking the initiative in making them available as a service to the industry. Several cartridge manufacturers say they are using them to demonstrate their prototypes to distributors. To get back to Johnny Bubbers and Walter Colquitt, they are a great help. By working closely together, we man-

* AUDIO's editor.

age to keep ahead of the latest developments. Mention should be made of Johnny's musical background. He studied violin for eight years and has an excellent ear."

To recapture the flavor of the minstrel show, the Dukes convey a lively spirit of gaiety and good humor on *Dinah, Alexander's Ragtime Band, Swanee, Dixie,* and *Alabamy Bound.* For ballads of sentiment, an important ingredient in the blend which made this form of entertainment so beloved, they turn to *Wait 'Till the Sun Shines Nellie, Old Kentucky Home, Jeannie,* and *Swanee River.* By way of bonus, they add such straight dixieland fare as *Georgia Camp Meeting, Ida,* and *Bill Bailey.* The Assuntos, father and sons, are in their usual good form. In addition to picking the banjo in a manner characteristic of the period, Jac shares trombone chores with son Fred. Frank provides jaunty vocals and the ensemble sound of the Dukes continues to improve under his trumpet lead.

Mose Allison: Local Color Prestige 7121

The remarkable insight into the sources of the blues shown by Mose Allison in his *Back Country Suite,* a homespun recounting in ten parts of the memories of a Mississippi boyhood, won him a critical acclaim not often enjoyed by a new jazz artist. Written over a period of seven years, the five sketches contained in *Local Color* are more loosely connected and allow his observant eye to roam beyond the blues to other bits of pure Americana. The two most recent are contrasting compositional entities dated 1957, full of the native strength which stems from well-remembered events, and able to give assurance that his talents are even greater than indicated by his earlier work. *Carnival* pictures the annual visit of the tent show to a small town. In the use of ragtime and the sound of a marching band, it finds a parallel only in the piano sonatas of Charles Ives. There is the same ability to translate everyday sounds and impressions into musical terms, the uncanny ear, and the love of oldtime things. Both communicate with the directness of a story by Mark Twain, but Allison's terms are those of the working jazz pianist and he never abandons a beat or the need to swing.

Parchman Farm is a lament Alan Lomax might have recorded on a trip to a state prison. That it is arranged so Allison's vocal carries both the pathos and humor of a man who explains "and all I did is shoot my wife," without losing the sense of authenticity, is nothing short of miraculous.

A private mood of contemplations is conveyed by *Crepuscular Air,* and an ancient dealer in herbs, charms and spells is depicted in *Mojo Woman.* The final piece has the festive air of a visit to *Town.* Among the unrelated numbers are *I'll Never Be Free* and Ellington's *Don't Ever Say Goodbye.* He sings again on Percy Mayfield's *Lost Mind,* and plays a muted trumpet solo, in keeping with his piano style, on *Trouble In Mind.* Another Allison original is the mocking *Ain't You A Mess.* Nick Stabulas on drums and Addison Farmer on bass conduct themselves as though they were enjoying every minute spent in the studio.

The 2nd Annual Herald Tribune Fresh Air Fund Jazz Concert

Some of the atmosphere of conviviality and general goodwill present October 21, 1957, at this concert, is preserved on an on-the-spot recording designed for limited circulation, but available to those wanting to make a contribution of three dollars to a worthy cause. The absence of a liner is compensated by the commentary of Benny Goodman, who introduces the artists and lists their non-musical affiliations. These touch upon Madison Avenue, or some of its extensions, where the members of the four unusual groups toil for a living. Bearing such unlikely designations as "The Many Splendored Stompers," and "The Oldest

Established Permanent Floating Dixieland Jazz Band," they operate with undiminished vigor—may they someday divert some of it to promoting a regular jazz program on television.

The moderns find release in "The Far Out Fabulous Five Plus One," and "The Executive Sweetee Five Minus One" is on hand to accompany vocalist Helen Ward. Her rendition of *The Ad Agency Blues*, with its reference to Batten, Barton, Durstine and Osborn, Inc., deserves a more permanent setting. Leslie Leiber, in one of his rare recorded appearances, plays *After You've Gone* on his hot tin whistle. Goodman collectors, admirers of Helen Ward, or searchers for the out-of-the-ordinary disc will want it. The sound suffers from the occasion, but Gotham Recording offers an excellent pressing. Copies can be ordered from Thaine Engle, Room 906, RCA Building, 1250 Sixth Ave., New York City.

Gil Evans And Ten **Prestige 7120**

One of the pioneers among the arrangers who are bringing unusual instruments in new voicings to jazz, Gil Evans is resuming recording activity after a hiatus of eight years. During that time his work, first with the Claude Thornhill orchestra and then for the Miles Davis nonet of 1950, has served as a model and major influence on modern jazz orchestrators. In heading a studio group of ten men in a set of his own arrangements, he steps into an additional role to make his recording debut as pianist. It places him in a closer association with the musicians and allows him to operate as part of the rhythm section in the manner of Ellington or Basie, whose economical and direct style he esteems as a pattern. He maintains a rich, full unison sound by use of French horn and bass trombone, complemented by bassoon and alto sax for a light shading to the darker-hued coloration, in a concert-like framework for the soloists.

The subtle tonal quality is varied further by the distribution of the lead parts among Steve Lacy, a young advocate of the soprano sax, the trombonist Jimmy Cleveland and two Thornhill graduates on trumpet—Louis Mucci and Jake Koven. Like many of the innovators of the 1940's, Evans seems intent now on the coordination of developments which once stood by themselves into a more lasting expression of vital and emotional musical ideas. His setting for *Ella Speed*, a traditional tune once sung by Leadbelly, is timeless in its feeling. On *Jambangle*, his own composition on a boogie-woogie theme, he has Lacy assume the vibrato of Sidney Bechet. *Just One Of Those Things* is another study in the contrasting uses of the soprano sax as Lacy follows a solo in his usual cool style with a hot, climatic flight.

Nobody's Heart and *If You Could See Me Now* feature mellow, unhurried readings by Cleveland. *Remember* and Leonard Bernstein's *Big Stuff* offer solos by Paul Chambers, but alto saxist Lee Konitz is heard only in a supporting role. As a result of this album, and the one for Columbia headed by Miles Davis on flugelhorn, the creative writing of Evans should reach a wide audience. Poor sound obscured much of the delicacy of his scoring for Thornhill, but Rudy Van Gelder gives attention to such details on this recording.

Lee Morgan: The Cooker **Blue Note 1578**

Rapidly growing out of his classification as a new star on trumpet, Lee Morgan joins a newer star on baritone sax for this session. With more than twice the number of years of band experience behind him, Pepper Adams has yet to enjoy as much solo exposure on records as Morgan has acquired in the brief time since he left his native Philadelphia. As the baritone men will always be outnumbered by the trumpeters, a fresh talent on that instrument is always welcome. The lateness of his arrival on the scene is explained by ten years spent as a member of the Detroit school which serves as a training center for so many musicians. From his scholarly appearance, like that of an Oxford don, and the ferocity of his attack, he can be classed as one of the angry young men of jazz. His full tone is used to extract the utmost from his horn in intense, heated statements or the flowing line of a more pensive mood.

A Night In Tunisia, his showpiece with the

Dizzy Gillespie band, allows Morgan to demonstrate his great facility in knotty technical passages, as do *Heavy Dipper* and *Just One Of Those Things*, the two fast numbers. But the test of his growing maturity comes on a tender *Lover Man*, and a moving interpretation of the minor-setting of *New-Ma*. Drummer Philly Joe Jones sets the pace, aided by pianist Bobby Timmons and Paul Chambers on bass.

Bobby Jasper: Tenor And Flute
Riverside RLP12-240

A young, Belgian-born flutist and tenor man, Bobby Hasper led his own quintet in Paris from 1954 to '56, gaining a considerable reputation in France, before coming to this country last year. Since then his technical proficiency has broadened through an association with the J. J. Johnson group, and an influx of fresh ideas has given a warmth and depth to his intonation. In his choice of colleagues for this LP, he is fortunate in the selection of a pianist whose ability as a composer brings two originals to the session. George Wallington is the writer of the moody *Before Dawn*, and the melodic *Sweet Blanche*, one of the vehicles for flute, the other being the standard *My Old Flame*. By way of temperament and inclination, he is well fitted to put Jasper through his paces on both instruments.

Idrees Sulieman on trumpet expands the quartet to a quintet on his sunny blues *Doublemint*, and Jasper's robust *Seven Up*. In these and *Dawn*, he reveals the source of some of the influences brought to bear on the latest European to join the East Coast School of musicians. Bassist Wilbur Little and drummer Elvin Jones complete the rhythm section.

Lou Donaldson: Swing And Soul
Blue Note 1566

In choosing to essay a solo role, Lou Donaldson expands his group to a quintet by the addition of Ray Barretto on conga drums. By increasing the ranks of the rhythm section of pianist Herman Foster, Peck Morrison on bass and drummer Dave Bailey, he is permitted a repertoire of greater variety. It extends to the Latin theme of *Herman's Mambo*, provides an unusual coloration to the ballad *I Won't Cry Anymore*, gives a pulsing undertone to the blues *Peck Time*, and allows a drum conversation in the swinging *Groove Junction*.

Donaldson carries on the Parker heritage on the alto sax, but taps only its warmer vein to evolve a style of his own, in the awareness that soul is a necessary part of jazz. That he is bringing it to a bright polish is evident on *Dorothy* and *There Will Never Be Another You*. Blind since birth, Foster's specialty is an organlike chording, particularly when punctuating *Grits and Gravy* and the other blues, which gives a deep-rooted sound.

After Hours **Prestige LP7118**

Thad Jones and Frank Wess, two members of the Count Basie band, join a versatile rhythm section in a session which is aptly styled by the album title. The playing is of the relaxed and recreational sort favored by musicians in the early morning hours after a night on the stand. The lines by pianist Mal Waldron provide for an examination of the numerous facets of the blues. He presents them in effective statements as a firm base for the soloists. In enlarging upon them to suit their fancy, they incline to the subtle and tender moods of an idiom too often used only to express the more obvious emotions.

Generally classed as one of the brassier trumpet men, Jones can make a clarionlike declamation of the most sticky ballad. Here he uses a mute to subdue his horn to an introspective pitch and constructs choruses which are all the more passionate for their restrained power. Its telling effect is pronounced in the opening bars of the slow *Empty Street*, where Wess adds a perceptive flute obbligato. Wess plays tenor sax on the rapid *Steamin'*, a happy opener, and the Basie-oriented *Count One*. He returns to flute on *Blue Jelly* for exchanges with Jones and Kenny Burrell, who again demonstrates his ability to illuminate the blues and to step back from solo spot to resume the duties of a rhythm guitarist. This adroitness, combined with good taste, is held in common with bassist Paul Chambers. Art Taylor fills out the section on drums.

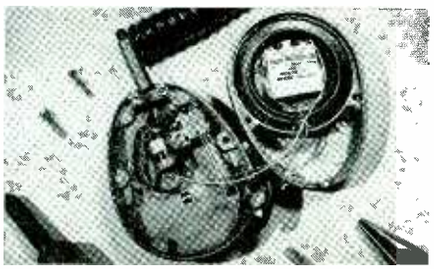
(*Continued on page 84*)

NEW PRODUCTS

● **Pilot Stereo Preamp-Control Amplifier.** Model SM-244 is a complete stereo amplifying system with self-contained bi-channel preamp and two power amplifiers rated at 14 watts each with less than 1.0 per cent distortion. Inputs are provided for stereo FM-AM broadcasts, stereo tape, stereo discs, microphones and auxiliary devices. There is a separate output for

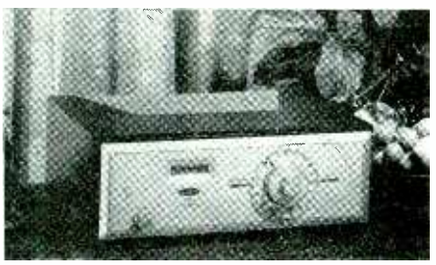
making stereo tape recordings. A balance control is supplied for adjusting the relative level of the two channels. Other panel controls are bass, treble, volume, loudness, and input channel switching. The SM-244 is handsomely housed in a brushed-brass-and-burgundy metal enclosure which will enhance even the most tasteful surroundings. Pilot Radio Corporation, 37-06 36th St., Long Island City 1, N. Y. **C-7**

● **Microphone Conversion Kit.** With this kit carbon microphones can be quickly converted into more reliable transistorized magnetic microphones. Developed to improve the transmission quality of mobile radio transmitters, the conversion equip-



ment consists of a small transistor preamplifier and a magnetic microphone cartridge, both of which are mounted in the original microphone housing in place of the carbon unit which is removed. Conversion takes only 15 minutes. Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. **C-8**

● **Improved Scott Tuner.** The new Model 311-C FM tuner offers a number of distinct advances over the original Model 311. Sensitivity of the new unit is 2 microvolts for 20 db quieting which makes it one of the most sensitive in its price class. Extreme selectivity is achieved through use of Scott's exclusive wide-band design, with adjacent-channel interference reduced to a practical minimum. The circuit features two-megacycle wide-band detectors,

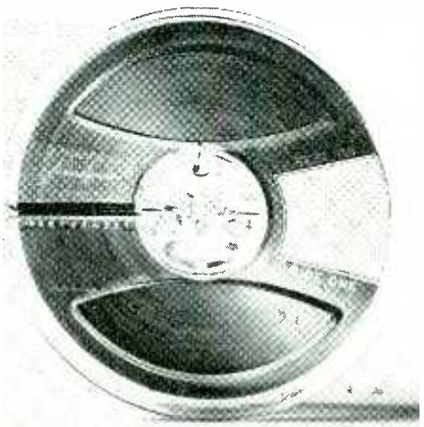


two stages of limiting, and 80 db rejection of spurious cross-modulation response. Maximum audio output is 4 volts for 75-kc deviation. Low-impedance output permits use of connecting cable up to 70 feet in length. Equipped for multiplex, the 311-C has a separate tape output for off-the-air recording. H. H. Scott has prepared a complete technical bulletin on the 311-C. For a copy of this bulletin, and for a complete Scott catalog, write to H. H. Scott, Inc., 385 Putnam Ave., Cambridge, Mass. **C-9**

● **Portable Anechoic Chambers.** Available with low-frequency cut-off points as low as 140 cps, portable AN-ECK-OIC chambers are designed for testing microphones,

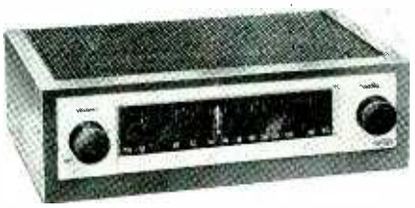
hearing aids, loudspeakers and various other acoustic devices. They are also effective in the study of noise sources in small electrical, electronic and mechanical equipment. These portable units incorporate essentially the same structural features as full-size chambers. Sound absorption is accomplished by wire-enclosed matted wedge-shaped units mounted on the walls, ceiling, floor and door of the chamber. Provisions are made for external electrical connections. Manufactured by The Eckel Corporation, P.O. Box 226, Cambridge 38, Mass. Requests for information must be written on company letterhead. **C-10**

● **Improved 7-Inch Tape Reel.** Constructed with a unique V-slot for quick threading, this new Sonoramic reel is also equipped



with permanent selection-finder numbers molded into the flange. The reel is made of opaque gray plastic to match the permanent plastic container for Sonoramic tapes. Ample space is provided for program identification. For further information, write to Ferrodynamics Corporation, Lodi, N. J. **C-11**

● **Eico FM Tuner.** Many characteristics of professional equipment are inherent in the Eico Model HFT-90 FM Tuner, available in both kit and wired form. The pre-wired pre-aligned "front end" makes it practical for even the most experienced novice to assemble the tuner with assurance of getting complete satisfaction. Exact center-of-channel tuning is provided by the Eico "eyetronic" traveling neon indicator. Other performance features include fly-wheel

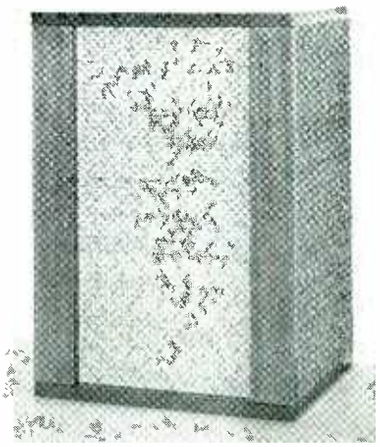


tuning, automatic gain control, and broad-band ratio detector. Extremely flexible design permits easy console installation with adaptability to different thicknesses of panel. Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y. **C-12**

● **Racon 100-Watt Horn.** This new cobra-type horn is designed for use in public address systems requiring high-power speech reproduction with maximum concentration of sound in the horizontal plane. It consists of a two-piece aluminum

casting of straight horn design, exponentially flared for maximum transfer of energy. Cut-off frequency is 250 cps. The dual throat is designed to accept two standard-thread driver units with aggregate power handling capacity up to 100 watts. Dispersion is 120 deg. horizontal and 40 deg. vertical. Racon Electric Co., Inc., 1261 Broadway, New York 1, N. Y. **C-13**

● **Klipsch Model H Speaker.** Newest member of the Klipsch line of speaker systems is the Model H, the only non-corner system manufactured by the company. Being small in size, the Model H is deliberately limited to about 100 cps at the bass end to



retain freedom from distortion in the middle and upper ranges. It is applicable wherever a small speaker may be used, and is designed for use in conjunction with other Klipsch systems. Details of the Klipsch method of obtaining 3-channel stereo from 2-channel source material, together with data on the new Model H, are available from Klipsch and Associates, Hope, Arkansas. **C-14**

● **Wrist-Watch Crystal Microphone.** Ingeniously camouflaged and worn exactly like a real wrist watch, this new microphone is ideal for investigative work of all kinds as well as for making "candid" recordings. The watch case is handsomely styled in chrome plate and the hands and numerals are finished in gold. The thin, flexible, light-colored cable is 6½ feet long and may be run up the coat sleeve to a concealed portable recorder. Tiny perfora-

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HAROLD LAWRENCE*

Unsmiling Cherub—a portrait of Luigi Cherubini

IN REVIEWING A NEW RECORDING of Cherubini's Symphony in D, a record critic recently stated that he could not understand what Beethoven saw in the "dry-as-dust" Italian. The writer's impatience over Beethoven's musical judgment is exceeded only by his ignorance of the facts. For when Beethoven spoke of Cherubini as Europe's leading composer, he was specifically referring to the latter's dramatic music. Pleasant though it may be, no one has ever claimed that Cherubini's only symphony could even remotely be classed with his operatic production.

Yet the picture of Cherubini (1760–1842) as a sterile academician still prevails, though recognition of his true musical value is at last slowly emerging. This rebirth of interest in Cherubini coincided with the advent of the long playing record. In 1950 Arturo Toscanini revived the magnificent *Requiem in C Minor;* Maria Callas performed the title role in *Medea* in 1953 after its absence from the operatic stage of nearly half a century; and in New York, Eileen Farrell evoked a similarly enthusiastic response for her interpretation of the same role in 1956.

Despite these signs of a Cherubini revival, the majority of musicians and writers on music cling to the timeworn impressions. They are not entirely to blame, however, for Cherubini's personal idiosyncracies, the musical and political developments that took place during his lifetime, and a younger composer's well publicized attacks, all conspired to relegate Cherubini's major contributions as a composer to the background.

Of Cherubini's early years we know very little beyond the facts of his whereabouts and his compositions. Born in Florence, he began his musical studies at the age of six, was sponsored by the grand duke of Tuscany who sent him to Bologna to study with Giuseppe Sarti, one of Italy's leading operatic composers. Young Cherubini became one of Sarti's "ghosts," turning out secondary arias and recitatives for his teacher's operas. He also acquired a solid groundwork in choral writing. With this invaluable training behind him, Cherubini produced his first opera—under his own name—in 1782. In his twenty-fifth year he traveled to London, where the Prince of Wales became his admirer and patron. In 1786 Cherubini visited Paris and was so taken with the capital's stimulating intellectual and artistic climate that, after a brief trip to Turin, he settled in France for the rest of his life. The decade 1790–1800 witnessed the production of Cherubini's greatest stage works: *Lodoïska, Médée* and *Les Deux Journées.*

Those who are only acquainted with the portraits of Cherubini as an old man would scarcely recognize the composer at this time in his career. "It was a happy era for him," wrote a contemporary musician, "Success flattered him. . . . The world liked him and he liked the world. He was for the moment the rage, and was lionized." Between 1788–1792, when Cherubini was director of the Italian Opera Theatre founded by Marie Antoinette's hairdresser, Léonard, a magazine of the day reported that he "had the happy art of winning the singers over to his views by a suavity of manner and a conciliatory mode of address."

Graceful, poised, charming—this was the Cherubini admired by royalty in three countries. Even the French Revolution and the Reign of Terror did not basically alter his situation. The guillotine drew crowds during the day, but at night the theatres were full. During this turbulent period, Parisians supported no less than twenty-five theatres, and Cherubini's operas were warmly acclaimed. *Lodoïska,* for example, was staged two hundred times in a single year.

The turning point in Cherubini's fortunes, and in his personality development, was the emergence of Napoleon. The First Consul plainly disliked Cherubini, prefering the lighter music of Zingarelli and Paisiello. Cherubini, by the same token, was Europe's leading stage composer and was hardly inclined to flatter the ego of a Corsican general. From the start, Napoleon, placed obstacles in the path of Cherubini's career and eventually helped to break the latter's spirit.

Disheartened by the lack of official recognition, Cherubini virtually gave up composition between 1806–8. To the profound

". . . the price of irritability?"
(Sketch of Cherubini by Horace Vernet)
Courtesy Bibliotheque du Conservatoire de Paris.

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regret of his pupils and friends, he took up botanical studies and spent his days painting flowers on playing cards. His only major concession to Napoleon's tastes (the opera *Pygmalion*) failed to please either the dictator or the public.

During the next dozen years, Cherubini devoted his main creative energies to instrumental and liturgical music. In 1821 he was made director of the Paris Conservatoire. Apart from the opera, *Ali Baba* (1833), he was to write no further music for the stage. And since the theatre was still the place where composers made their mark in Paris, Cherubini's absence estranged him from the public. The intervening years brought to the fore those qualities which were later to dominate his character.

The Paris Conservatoire may have been a government institution, but to Cherubini, who was its director for 20 years, it was his "house." And as master of the house, he was a stern disciplinarian. He dearly loved punctuality, and enforced a quasi-military régime over students and professors alike. To be less than neat was, in Cherubini's eyes, a cardinal sin. Ever since his apprentice years with Sarti, he had kept up the practice of copying out the works of older composers. "There is always something to learn," he said. His calligraphy rivalled the printed score. If a drop of ink fell on his manuscript, he cut out the offending blot and replaced it with another piece of paper, as perfectly fitted as the strands of a restored canvas painting.

One of the first "reforms" instituted by Cherubini on taking over his duties in the Conservatoire was to abolish the common entrance for students of both sexes. Henceforth girls were to enter by the door on the Rue Bergère, and boys by the door in the Faubourg Poissonière. One morning, a young composer named Hector Berlioz, "ignorant of the moral decree . . . entered by the door in the Rue Bergère, the feminine door," as he wrote of the incident, "when a servant, stopping me in the middle of the court, wished to make me go out, to return to the same point where I was now (in the library), by entering at the masculine gate. I considered this so ridiculous that I sent the livery Argus about his business, and pursued my way. . . . For a quarter of an hour I was absorbed in reading *Alceste*, not thinking any more about this incident, when Cherubini, followed by my denouncer, entered the reading-room, his countenance more cadaverous, his hair more erect, his eyes more malicious, his step more abrupt than usual . . ." After locating Berlioz, Cherubini tried to expel the disobediant young man, shouting at him in Italian-accented French (which Berlioz, incidentally, mimicked ludicrously).

In his *Memoirs*, Berlioz reported fully on several more skirmishes with Cherubini. Other incidents seemed to confirm Berlioz's opinion of the older composer. Informed of the death of the oboe player, Brod, in 1839, Cherubini's only comment was: "Petit son" (Small tone). Cherubini made it a principle never to lend anyone his umbrella for fear that it would not be returned. One day, he was walking along a boulevard when it began to rain. Someone recognized the composer and offered him his place in his carriage. Cherubini agreed to get in. But when the stranger asked him for the loan of his umbrella, Cherubini flatly refused, and drove off.

A less elegant Italian version of Phineas Fogg, Cherubini had his handkerchiefs consecutively numbered for the days of the week. When a friend gave him the wrong handkerchief on his deathbed, Cherubini flew into a rage.

Inflexible in his personal life, Cherubini applied the same approach to his pedagogic

JAZZ

(*from page 75*)

Pedro Garcia: Tropical Cruise
Audio Fidelity AFLP1841

In setting a course for romantic southern ports, Pedro Garcia and his Del Prado orchestra chart their way by means of the native rhythms of the points of call. Under the spell of the Caribbean, *Night and Day* emerges in the glamorous guise of a bolero. For the rhumba, they depend upon *Amor y Mas Amor*, and the samba is represented by *Baiao en Africa*, *Carinoso*, and *Noche en Bahia*. The lone cha-cha-cha is *No Nenita No*. The compelling sway of the bolero is conveyed by *Adios Arequita Linda* and Grenet's primitive *Drume Negrita*. Other boleros are *Hechizo*, *Dios No Lo Quiera*, and *Sabra Dios*. The full sound is recorded with care and the rhythms are warranted to persuade the Alec Guinness type on the cover to leave the protective shell of his beach chair.

Abbey Lincoln: That's Him
Riverside RLP12-251
Keely Smith: I Wish You Love
Capitol T914

A popular singer of some success, Abbey Lincoln, in realizing an ambition to "do a jazz date, with some good musicians," seems to have run into something more than she anticipated in the way of a supporting group. In the main, it consists of men who would not ordinarily deign to work behind a vocalist, and the qualities they bring to the studio are scarcely those to which she is accustomed. Sonny Rollins, the most significant of the moderns on tenor sax, makes his first recorded appearance in such a context, and it becomes a memorable occasion by virtue of his true creative fervor. Kenny Dorham shows a fine lyric strain on trumpet, and Max Roach drums with restraint and good taste. The able bassist is Paul Chambers, and Wynton Kelly, who as pianist is entrusted with correlating the various inventive flights, comports himself well.

Desire and good intentions do not make a jazz singer, but she starts by stripping her style of the gimmicks of the popular artist. What is left is an intense personal expression, and a keen sense of phrase and measure, which are given breadth and scope by the superb backing. Her material is well chosen, from Gershwin's *Porgy* to the title tune by Kurt Weill. Included are the seldom heard *Strong Man*, and Phil Moore's *Tender as a Rose*, sung unaccompanied. Also the standards *My Man*, *Happiness Is Just a Thing Called Joe*, and a driving *I Must Have That Man*. Billie Holiday's *Don't Explain* points up a parallel, although there is no copying of style, as this is a session similar to those which started her on the way. In this respect, it makes an immediate contribution by its combining of unique talents to chart a course necessary to the next important jazz vocalist. It also gives Miss Lincoln a lap on her competitors.

Keely Smith shows natural propensities toward becoming a good jazz singer when accompanied by her husband Louis Prima. But Hollywood has discovered her and with a movie contract there must be a popular buildup. To eleven old and new love songs arranged by Nelson Riddle, who leads the lush studio orchestra, she brings the warm glow of her earlier work.

A Date With Jimmy Smith, Vol. 2
Blue Note 1548

The second part of the session which pairs Jimmy Smith and his Hammond organ with an instrumental quintet goes on the credit side of the ledger for Lou Donaldson. His poignant alto sax on Ellington's *I Let a Song Go Out Of My Heart*, and the ballad *I'm Getting Sentimental Over You*, sets the mood for the others to follow. It lasts until Hank Mobley brings his tenor sax into play on an up-tempo *Groovy Date*, an enthusiastic swinger with solos for all to give expression to their sentiments about this unusual date. Smith again displays some intriguing uses of the electronic organ, and drummer Art Blakey proves his versatility by adapting to the odd combination. The Ellington tune fills one side and includes a solo by guitarist Eddie McFadden. Æ

TAPE RECORDER EQUALIZATION

(*from page 30*)

which deserve mention, although they do not change the essentials.

1. As indicated in *Fig.* 2, bass boost is provided predominantly in playback and treble boost predominantly in record by tape recorders that conform to the NARTB standard. This practice minimizes distortion by preventing tape overload when recording middle and low frequencies, where distortion is most apt to occur; and it minimizes noise by avoiding unnecessary treble boost in the playback amplifier, which is a high-gain affair inasmuch as playback head output is but a few millivolts. However, moderate-price machines often use "half-and-half" equalization; that is, they use equal amounts of bass boost in record and playback, and equal amounts of treble boost in both functions. As a result, playback bass boost essentially has a 3-db-per-octave instead of 6-db-per-octave slope, and recorded flux declines at a rate greater than 6 db per octave (greater to the extent of playback treble boost, exeluding any such boost intended to overcome playback head losses). *Fig.* 5 illustrates half-and-half equalization. The net result is still a 6-db-per-octave declining slope, which is compensated by the 6-db-per-octave rising slope of the playback head. A major disadvantage of the pattern of equalization in *Fig.* 5, apart from the choice of turnover frequency, is that the signal-to-noise ratio deteriorates because of the decline in recorded flux at high frequencies and the compensating treble boost in the playback amplifier. Another disadvantage is that the increase in recorded flux at low frequencies heightens the danger of distortion at these frequencies due to tape overload when recording.

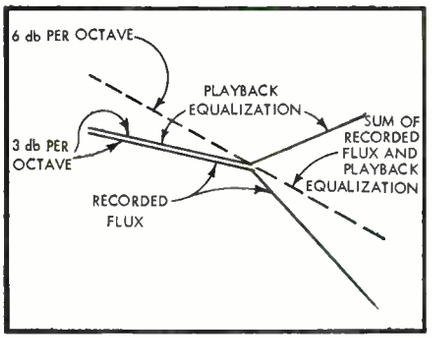

Fig. 5. Combination of "half-and-half" equalization often used in inexpensive tape recorders to provide over-all flat response without changing amplifier equalization between the record and playback modes.

2. No mention has been made of record and playback head losses due to eddy currents and hysteresis—so-called "iron" losses. These losses increase with frequency. In a modern high-quality head they are kept to minimum, perhaps 1 db or less at 15,000 cps, so that essentially they can be ignored. However, if the losses are appreciable, the NARTB standard requires that in the case of the record head they be compensated by treble boost in the record amplifier, and that in the case of the playback head they be compensated by treble boost in the playback amplifier.

3. The various figures have assumed flat response from 20 to 15,000 cps. Actually, this is seldom achieved, particularly at 7.5 ips. At the very low end, the efficiency of the heads decreases. At the high end, to the extent that treble boost is used in the playback amplifier to compensate for playback-head losses (gap width, eddy currents, hysteresis), there is a corresponding increase in reproduced tape hiss and playback amplifier noise. Consequently, perfectly flat response to 15,000 cps is seldom sought at 7.5 ips; often not even at 15 ips. The practical possibilities are reflected in the NARTB standard, which permits response to be 4 db down at 50 and 15,000 cps.

4. Some of the curves in *Fig.* 2 are idealized. Thus the response of the playback head is not as smooth as shown at (E) in *Fig.* 2 and does not conform precisely to a 6-db-per-octave/throughout the middle and low ranges. The record equalization and recorded flux and other resulting curves are drawn to correspond exactly to the theoretically desired variations of response with frequency, although practical circuitry usually does not achieve this degree of precision. As a result, the record-playback response is not truly flat over the bulk of the audio range, allowing for the permissible decline to 4 db down at 50 and 15,000 cps. Instead, over-all response contains some bumps and hollows. However, in top-quality tape recorders these deviations are kept within ±1 db of a smooth line, while other, also excellent, machines maintain response within ±2 db. Even ±3 db variation is considered quite creditable. Æ

AN AUTO AUDIO SYSTEM

(*from page 23*)

from the tuning unit and discarded, as they will no longer be required.

The next step is the selection of locations for parts which are being added to the tuner. Included in this category are V_2, the two tone-control potentiometers, and the 6-terminal tube socket into which will be plugged the 6-conductor cable leading to the amplifier-power supply. The locations of all these added parts are non-critical and they may be spotted wherever space permits.

After these components have been mounted, the wiring shown in *Fig.* 3 should be accomplished. It is advisable to complete and test all parts of the auto audio system and align the tuner unit before replacing the tuner unit on the dash.

The size of the chassis selected for the amplifier-power supply will depend largely upon the size of the power and output transformers. A $7 \times 12 \times 3$ in. chassis will be found adequate, even when bulky transformers are used. Since the amplifier-power supply will be mounted in the trunk where it may be damaged by coming into contact with luggage if suitable precautions are not observed, it is suggested that a cover be constructed of perforated metal to protect all parts exposed on the top of the chassis. A heavy-gauge chassis bottom plate should also be used. This plate should extend an inch or two beyond each end of the chassis to provide space for the rubber shock mounts and bolts used to attach the chassis to the automobile.

Layout of parts in the amplifier-power supply follows conventional practice, with the power supply components at one end of the chassis and the amplifier components at the other end.

To facilitate installation, removal, testing and servicing, all cabling connecting components of the system should be terminated by suitable plugs. Receptacles for these plugs must be located in both the tuner unit chassis and the amplifier-power supply chassis. Three cables are used as follows:

1. Five-conductor cable from tuner unit to amplifier-power supply. In most cases it will be convenient to run this cable under the floor mats and underneath the rear seat into the trunk. Plug connections are shown in Table II.

TABLE II

Prong number	Function	size Wire
1	ON-OFF to relay	#12
2	signal	#18
3	B+ to tuner unit	#18
4, 5	B+ ground (connect as shown to reduce IR drop at tube socket)	#10
6	feedback from output transformer	#18

The conductors in this cable should be cabled together by friction tape or lacing twine.

2. Two-conductor cable from output transformers to speakers. It is suggested that an 8-prong plug be used to avoid the possibility of plugging the

speaker plug into the 6-prong receptacle and vice versa. #18 wire is suitable for this cable.

3. Single-conductor cable from the battery (actually the starter relay) to amplifier-power supply. #10 wire should be used. This cable will carry 10 amperes, so the plug terminating it at the amplifier-power supply must have ample current handling capabilities. An ordinary household appliance two-prong plug, with prongs wired together as shown in *Fig. 7* will serve nicely.

In addition to the cables already listed, a short heavy flexible copper grounding strap must run from the amplifier-power supply chassis to a convenient nearby ground on the automobile chassis.

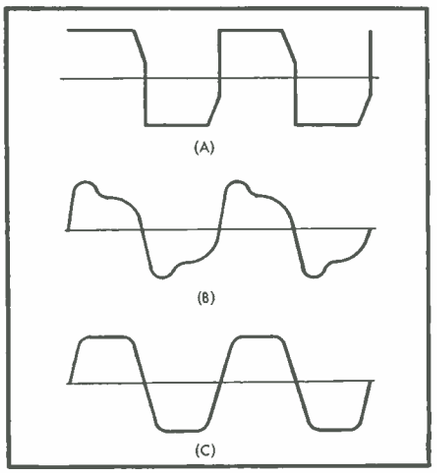

Fig. 7. Wave forms across primary of power transformer with various values of buffer capacitor. (A) Capacitance correct; (B) too low; and (C) too high.

It will be noted that two different grounds are shown in *Fig. 2* and *Fig. 6*. In *Fig. 2*, the two grounds are connected together and become a single ground, but in *Fig. 6* they must be kept separate. Such an arrangement is necessary to avoid modulating the signal with the vibrator wave form, which occurs if a single ground is used.

The vibrator contact points will burn and erode rapidly if the buffer capacitor, C_{44}, is of incorrect value. After construction is complete, an oscilloscope should be connected across the primary of the power transformer so that the wave form can be examined. The wave form shown in (A) of *Fig. 7* will be obtained when the proper buffer is used. A capacitor rated at .006 μf at 1600 volts is a good value for the initial test. (B) and (C) of *Fig. 7* show the wave form to be expected if the capacitance is too low or too high.

The values of the resistors shown in *Fig. 2* are not critical. A tolerance of ±10 per cent is permissible. However, some effort should be made to use balanced pairs in the push-pull portions of the circuit. Sufficiently accurate balance can be assured by purchasing three resistors for each pair, then selecting the two which give the best match. In the case of R_{31} and R_{32}, the latter should be approximately 5 per cent larger than the former. Matching of tubes is unnecessary.

It is essential that a good quality output transformer be used. This is the most important single component in the entire system. Satisfactory results cannot be expected with an inferior transformer. The author used a UTC LS55 transformer which has a 5000-ohm primary winding tapped at 3000 ohms. By turning the primary winding inside out, (i.e., attaching the plates of the output tubes to the terminals marked "B+" and attaching B+ to the terminals marked "Plates,") the 3000-ohm winding can be used to supply the screens, thus achieving the Ultra-Linear circuitry. Since the 6V6 tubes require a plate-to-plate impedance of 10,000 ohms and the LS55

has a nominal rating of only 5000 ohms, a change must be made in rated impedance of the secondary winding so that the correct load will be reflected to the output tubes. Under these conditions, the correct output tap may be found by merely multiplying the rated output impedance by the fraction 10,000/5000, or 2. Thus, for example, if a 16-ohm speaker is used, it should be connected to the 8-ohm output taps, since the 8-ohm output will "look" like 2 × 8, or 16 ohms. The Acrosound TO-310 output transformer should also prove entirely satisfactory, provided a corrective factor of 10,000/8000 is used in computing the output impedance of the secondary. The Chicago Transformer Co. (Stancor) A-8073 has a primary rated at 10,000 and hence may be employed as shown by the manufacturer.

Feedback capacitor C_{34} must be selected experimentally. The normal speaker load should be attached to the output transformer secondary while testing to determine the optimum value of C_{34}. Square waves of 2000 to 20,000 cps should be applied to the grid of V_2, care being taken to adjust the level of the signal so that the output tubes are operated well below the point at which they are overdriven. Use different values of C_{34} until a compromise value which provides best all-around performance has been determined.

Modifications

The use of the audio system described herein in conjunction with automobile record players will no doubt occur to readers who happen to have such an accessory. No experiments were made to adapt the amplifier for this purpose, but it should require only relatively simple modifications.

The pickup cartridge used in automobile record players (Chrysler Corp.'s "Highway Hi-Fi") is a special ceramic type made by Shure Bros. The output is about 2 volts when working into a load resistance of 3 megohms. No compensation is necessary. Since a signal of .075 volts at the grid of V_2 will produce 10 watts output and the volume control, R_9, is a 3-megohm potentiometer, it is merely a matter of installing a suitable switch to permit R_9 to be switched into the record player pickup circuit. The tuning-unit portions of the system should be inactivated at the same time by cutting off plate supply.

A few changes will be required in the amplifier-power supply for care which are equipped with 12-volt electrical systems (record players are available only for 12-volt systems). The power transformer should have two 12-volt secondaries instead of the two 6-volt secondaries specified. Current capacity of these windings need be only 4 amperes rather than the 8-ampere windings in the 6-volt transformer. The output tube heaters should be attached in series or, alternatively, 12V6 tubes may be used. A 12SN7-GTA should be substituted for the 6SN7-GTA. Finally, the switching relay and vibrator should both be 12-volt units. Total current consumption of the 12-volt version will be about half of the requirements of the 6-volt model.

Conclusion

The audio amplifier and associated components described in this article are simple, easy to build, stable, and self-balancing. The improvements achieved by the "auto audio system" over a conventional auto radio are so great they have to be heard to be believed. Probably the principal difficulty any reader would have in building and installing the system would be the expense of the parts. A good output transformer will cost about $16, and the more expensive ones twice that amount. The power transformer will cost $8 to $10. Speakers will cost $3 each, plus an additional dollar each for individual grill covering. A heavy-duty vibrator cannot be obtained for much less than $4.50. These

parts account for the major individual costs, but the builder will still have to put another $10 to $15 for tubes, resistors, relays, chassis, and so on. This all sums up to a total of $60 to $70. However, dealers' list prices on auto radios vary from $60 to as much as $160, and such radios invariably have inferior audio systems. When these facts are considered, the cost of $70 for a really first-class amplifier and speaker system may not seem excessive, particularly to those who use their radios frequently.

The author wishes to express his appreciation to the Radio Corp. of America for authority to reproduce *Fig.* 1, and to AUDIO magazine for authority to reproduce *Fig.* 4 and to use the tone-control circuitry shown in *Figs.* 2 and 3. Dr. Peter Goldmark of the CBS Laboratories kindly supplied data on the pickup cartridge used in the Chrysler Corp. Automobile record player.

PARTS LIST

C_1–C_{16} *incl.*	Part of tuning unit
C_{17}, C_{18}	100 μμf, ceramic
C_{19}	0.1 μf, paper, 200 v.
C_{20}	Part of tuning unit
C_{21}, C_{25}	0.1 μf, paper, 400 v.
C_{22}, C_{27}	Part of tuning unit
C_{28}, C_{29}	40-40/450, electrolytic
C_{30}	75 μμf, ceramic
C_{31}	500 μμf, ceramic
C_{32}	.003 μf, ceramic
C_{33}	.02 μf, ceramic
C_{34}	See text
C_{35}, C_{37}	0.1 μf, paper, 600 v.
C_{38}, C_{39}	100-100/50, electrolytic
C_{40}, C_{42}	250 μμf, ceramic
C_{41}, C_{43}	0.5 μf, paper, 200 v.
C_{44}	See text
C_{45}	80/450, electrolytic
C_{46}, C_{47}, C_{48}	80-40-20/450, electrolytic
C_{49}, C_{50}	.01 μf, paper, 600 v.
F_1	20-amp. fuse
L_1, L_2, L_3	r.f. chokes, 55 turns #12 enameled wire on 1-inch form, close wound
L_4	2.5-mh r.f. choke
L_5	10 Hy, 50-ma Filter choke
Rel	6.3-volt horn or headlight relay
R_1–R_6 *incl.*	Part of tuning unit
R_7	47,000 ohms, ½ watt
R_8, R_{10}, R_{35}, R_{36}	0.27 megohms, ½ watt
R_9	3.0-megohm potentiometer, audio taper
R_{11}	0.82 megohms, ½ watt
R_{12}	1200 ohms, ½ watt
R_{13}, R_{14}	Part of tuning unit
R_{15}	27,000 ohms, ½ watt
R_{16}	1.0 megohm, ½ watt
R_{17}	5600 ohms, ½ watt
R_{18}, R_{29}, R_{30}	47,000 ohms, 1 watt
R_{19}	22,000 ohms, 1 watt
R_{21}, R_{24}	0.18 megohms, ½ watt
R_{20}	2.0-megohm potentiometer, audio taper
R_{22}	1.0-megohm potentiometer, audio taper
R_{23}	15,000 ohms, ½ watt
R_{25}	$6750/\sqrt{Z_{vc}}$
R_{26}	680 ohms, ½ watt
R_{27}, R_{28}, R_{37}, R_{38}	1000 ohms, ½ watt
R_{31}	1.0 megohm, ½ watt
R_{32}	1.1 megohms, ½ watt
R_{33}, R_{34}	0.27 megohm, 1 watt
R_{39}, R_{40}	390 ohms, 2 watts
R_{41}, R_{42}	68 ohms, ½ watt
R_{43}	22 ohms, 1 watt
R_{44}	820 ohms, 2 watts
R_{45}	1000 ohms, 2 watts
Sel_1	200-ma selenium rectifier doubler (Federal #1009 or equivalent)
T_1	Output transformer, Ultra-Linear circuit 10,000 ohms plate-to-plate (UTC LS555 modified as per text, Acrosound TO-310 modified as per text, Stancor A-8073, or equivalent)
T_2	Vibrator transformer, 117-volt primary, two 6.3-volt, 8-amp secondaries
Vib	Heavy-duty 6.3-volt vibrator (Radiart 5715 or equivalent) Æ

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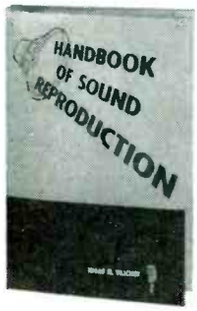

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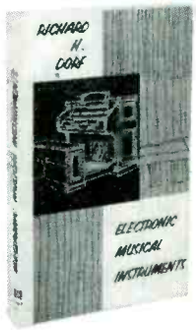

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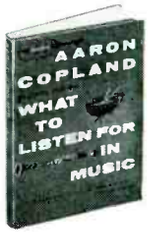

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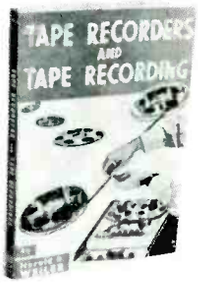

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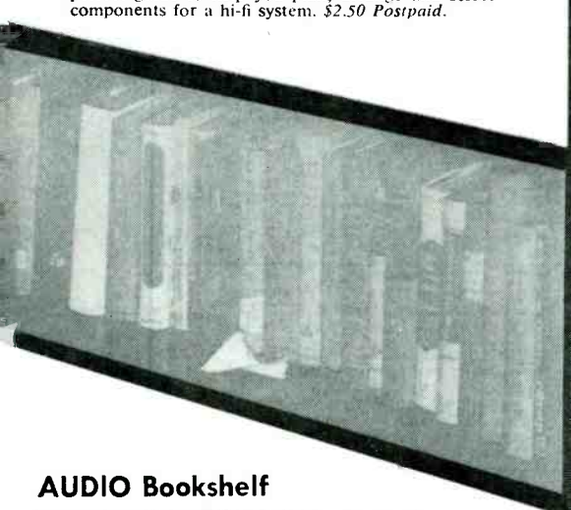

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HIGH-POWER AUDIO AMPLIFIER

(*from page 38*)

in parallel with the filter capacitor, C, this 475 volts also appears across this capacitor. If the capacitor is rated at 500 volts, it will not break down.

Next, assume the same circuit as at (C) in *Fig.* 6; this time the load resistor, R_l, is omitted. Since there is no completed d.c. circuit, no d.c. current flows; no flowing current means no voltage drop across R_t and R_p. Therefore the entire 550 volts appears across the filter capacitor, C, the open circuit for d.c. This 550 volts can easily damage a capacitor rated at 500 volts if kept there for a long period of time or applied frequently.

This is exactly what happens when there is no separately heated cathode in the rectifier tube.

A rectifier with a filament type cathode, such as the 5Y3G or the 5U4GB conducts at the moment the amplifier is turned on. The output tubes have not had the time to heat their cathodes so as to start conducting. Since there is no current being drawn from the high-voltage power supply for the first half to three-quarters of a minute, (while the output-tube cathodes are warming up) there is no current flowing through the power supply and rectifier tube. No flowing current means no voltage drop in the rectifier tube and power transformer (*Fig.* 6). All the high voltage then appears across the electrolytic capacitor, and this may damage it.

The solution to this problem is to prevent the rectifier from heating up fast and setting up a high voltage before the output tubes start conducting. A slow-heating, separate cathode will provide this necessary time delay to protect the electrolytic capacitors, while the output tube cathodes are heating up. This will prevent the initial excess voltage surge, protecting the capacitor.

Tubes like the 5V4G provide this feature. However, for higher current applications, as in high power amplifiers, either two 5V4G's are necessary or the European GZ-34 made by Mullard and Amperex, may be used.

Mechanical Considerations

There are several layout factors which must be carefully considered for a successful and durable amplifier.

The internal volume of tubes such as the EL-34 is small. It thus needs a large ventilating area outside of the tube bulb to conduct away the excess heat. Tube manufacturers claim that the tube life of this (and any other tube) is an inverse function of the bulb temperature. They recommend that the maximum bulb temperature of 250° C should not be exceeded. (The bulbs of the tubes used in two EICO units were measured with Tempilac and did not exceed 230° C. under any enclosed conditions.)

To accomplish this, Mullard recommends as a rough approximation a distance of 40 millimeters or 1 9/16 in. between two tube bulbs and 30 millimeters or 1⅜ in. between any tube bulb and any other component mounted on the chassis. These temperature specs should be carefully observed when using these or any other output tubes, although the distances between different types may vary. A good rule-of-thumb is one bulb diameter of space between tubes. However, this can vary considerably as in the case of the 6L6GB, 6550 and EL-84.

Power transformers should not be mounted close to the hot tubes. Although the transformer itself may have a low temperature, being placed too close to these tubes can raise the ambient temperature to such a degree that when added to the transformer's own temperature rise, the insulation can break down.

Another important consideration for a successful amplifier is the electrolytic capacitor. These components must run cool. At high temperatures (above 85° C. in some cases and above 65° C. in most instances) these capacitors may become excessively leaky. They may short out entirely, or ruin the rectifier tube. Electrolytic capacitors should not be mounted near hot components such as power output tubes and power transformers.

Ventilating slits or holes between and around hot tubes and transformers is a good method for cooling the components. These slits will provide a chimney effect, affording excellent ventilation. The bottom plate on the chassis should have similar holes and be raised from the actual mounting shelf to permit cool air to rise into the chassis. If a protective cover is used, this too should have enough open spaces to provide good ventilation. It should, however, be noted that good ventilation is no substitute for proper spacing of components. Æ

PHONO REPRODUCER

(from page 42)

equalizer will depend not only on the material of the record but on whether it is lateral or vertical cut. For the 9A reproducer, therefore, an adjustable equalizer was desirable, and one was developed under the direction of E. T. Mottram. It is known as the 171A repeating coil, controlled by the KS-10066 switch. It serves not only as an adjustable equalizer but as a means of matching the impedance of the reproducer to the input of an amplifying system, which may be 30, 250, 500, or 600 ohms. The equalizer characteristics desired are selected by a rotary-type switch, which is also used to interchange the reproducer connections for vertical or lateral reproduction. These units, the 9A reproducer, the 5A arm, the KS-10066 switch, and the 171A repeating coil form what is known as the reproducing group.

The response of the 9A reproducer, shown in *Fig.* 3, is essentially flat up to nearly 10,000 cps for both types of records. Most lateral-cut records are recorded at a slightly higher level than vertical records because they are intended for acoustic reproduction. To compensate for this difference in level the 9A reproducer is designed to have greater sensitivity for vertical records and the output volume is thus made approximately the same for both. This 9A reproducer, which has performed excellently both for lateral and vertical service in commercial fields, meets all of the varied requirements of present-time phonograph reproduction. Æ

Industry Notes . . .

Joseph N. Benjamin, vice-president of Pilot Radio Corporation, has been elected president of the **Institute of High Fidelity Manufacturers, Inc.**, succeeding George Silber, president of Rek-O-Kut Company, who has headed the Institute since it was founded three years ago. Other officers elected are: Saul Marantz, Marantz Company, Inc., vice-president; Leonard Carduner, British Industries Corporation, secretary; Milton Thalberg, Audiogersh Corporation, treasurer. Directors elected to a two-year term are: Avery Fisher, Fisher Radio Corporation; Bernard Cirlin, Stephens Trusonic, Inc.; Sidney Harman, Harman-Kardon, Inc.; and Mr. Silber.

Rigo Enterprises, Inc., is planning a year-round campaign built around the firm's hi-fi shows in various cities. Rigo will provide local newspapers which support the shows with a continuing supply of feature material to be used before and after the local shows, according to Henry Goldsmith, Rigo president.

A lavish new plant designed especially for the manufacture of magnetic recording tape has been announced by Hazard E. Reeves, president of **Reeves Soundcraft Corporation.** Located in Danbury, Conn., the new plant will have many unique design features, among which are air-sealed dust-free areas for the manufacture of instrumentation tapes, new automation devices, and a production plan which reduces material handling by as

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much as 60 per cent. Production capacity of the plant on a single-shift basis is equal to the entire amount of tape manufactured by the industry in 1956. Scheduled for completion in mid 1958, the new plant and its facilities will represent an investment of over one million dollars.

An engineering and discussion session devoted entirely to stereo disc recording will be held during the national convention of the **Institute of Radio Engineers,** March 24-27, at the New York Coliseum and the Waldorf-Astoria hotel. Also included in the extensive program of technical papers are several on audio, amplifier, and tuner developments. Other sessions of interest to audio engineers will be devoted to semi-conductor devices.

The fourth **High Fidelity Show** to be held in Washington, D.C., is slated for March 14-16 at the Shoreham hotel. The show committee, headed by M. Rogers, president of the Good Music Station, Inc., cancelled the show last year due to lack of exhibition facilities. Admission is being increased from 50 to 90 cents. Other committee members are Charles W. Lineau and Gene Rosen, manufacturer representatives; Earl Campbell, president, Campbell Music Co., and William Shrader, president of Shrader Sound Studios. The show will occupy 55 rooms.

Growth and development of **ORRadio Industries, Inc.,** has led to the establishment of two new divisions. The two sections will be headed by James D. Grady, Jr., as manager of the Instrumentation Tape Division, and Robert D. Browning as manager of the Audio Products Division. "The creation of these two divisions results from ORRadio's current growth and its plans for future expansion," stated William H. Barnett, vice-president in charge of manufacturing. While ORRadio's sound recording tape is marketed under the **Irish** brand name, instrumentation tape and Videotape are handled exclusively by Ampex Corporation under the Ampex brand name.

Industry People..

Maurice Meshboum, well-known commercial artist who pioneered the high-fidelity movement in the Windy City area, is now president of the Chicago Cinema Club, the oldest incorporated amateur cinema club in the United States.

Thomas B. Aldrich and **Stanley Neufeld** have been appointed industrial sales manager and national jobber sales manager, respectively, for Rockbar Corp., American distributor for British-made Collaro record changers and Goodmans speakers. Mr. Aldrich was formerly sales and advertising manager for Presto Recording Corporation, and Mr. Neufeld has been assistant sales manager at Rockbar.

Glen C. Tillack has been appointed to the new post of sales operations manager of Kierulff Sound Corporation and its affiliates, Bushnell Sound Corporation and Valley Sound Corporation.

Pentron Corporation has named **Morton M. Tillman** as sales manager of its new Pentron Premier Division.

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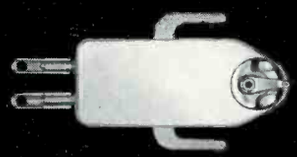

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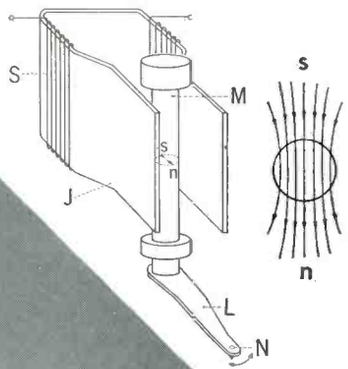

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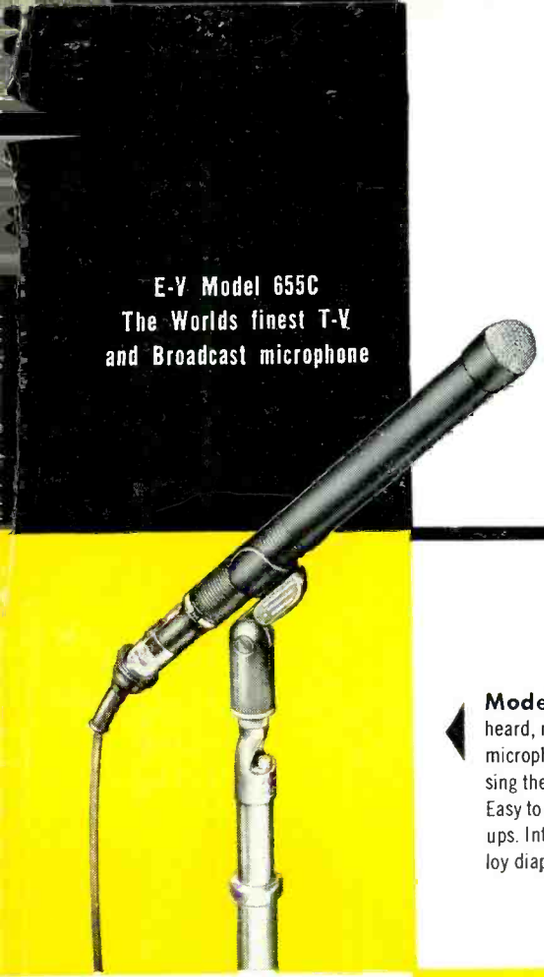

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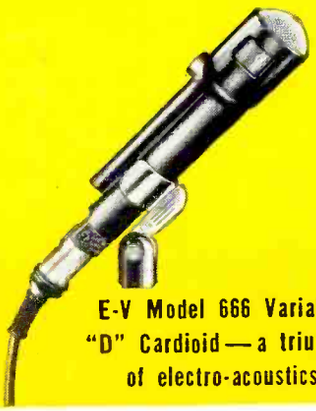

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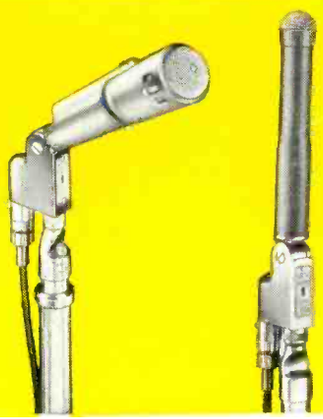

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