AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

APRIL, 1956

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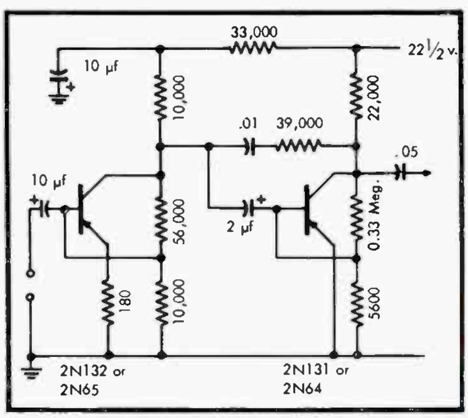

Increasing interest in the use of transistors, particularly in low-level circuits, makes this article with all its detail especially valuable. See Transistor Preamps, page 31.

Studio-Type construction is key to flexibility in this author's system. See page 23.

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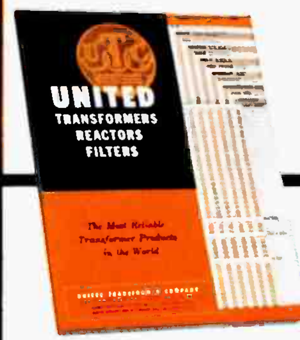

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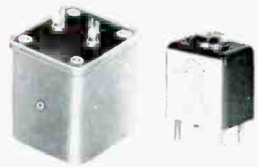

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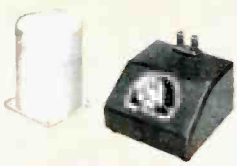

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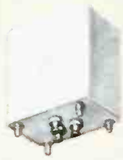

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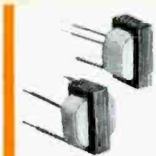

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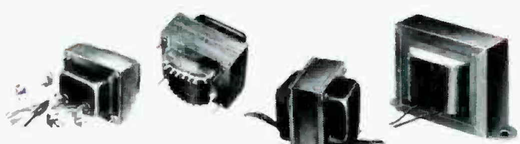

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THE BRITISH INDUSTRIES

Sounding Board

A message to the Quality-minded Consumer .....

Claims..... Claims !

It must be very confusing to the consumer to read the claims of different manufacturers. It's a bit confusing to us.

Thumbing through one of the publications devoted to our field, I recently came upon no fewer than seven Turntables of one kind or another being offered to the audiophile. *Not one* of these acknowledged in any way that it was even *possible* for any other Turntable to be superior, or better value for the money! A recent edition of the New York Times carried a Sound Studio's advertisement showing *four* record changers (in the same advertisement, no less) and each one of these four stated quite calmly that it was simply the *best made!* The cheapest, the most shoddily constructed, make the same claims, in vague, non-specific terms, as the finest!

I almost yearn for the automobile-type salesmanship, which makes the strongest possible claims for a six-cylinder Ford, but at least has the decency and good taste not to claim that it is every bit as good as the Lincoln Continental. Each has its place in the market, but they are *two separate places!*

No such modesty, however, hampers the record-player maker! Thus, one manufacturer blandly undertakes to "objectively" evaluate a Turntable versus an Automatic Changer but neglects to point out the small fact that he only makes *one* of the two! Well, if I were to be influenced on the choice of a blue suit versus a black suit, I would like my information to come from a manufacturer who made *both*. That *might* make the analysis somewhat objective!

The Sounding Board

The Sounding Board

I notice that some manufacturers are showing "rumble" figures in their advertisements . . . just figures, that's all. Any competent engineer will confirm that these are utterly valueless, if not intentionally misleading, unless they are distinctly related to a given test. How was the test made? How was the turntable mounted? Which amplifier was used? At what frequency was the test made? Which independent laboratory, if any, conducted the test? Was the unit tested taken from inventory or was it a specially selected unit? . . . these are but a few of the questions which could very well be asked.

Yet—despite all the confusion surrounding these products, there *are* reliable yardsticks available to the equipment buyer:

First, there is the length of time the manufacturer's products have been accepted on the market. Here, GARRARD stands alone. It has been acknowledged the leader in the field for nearly 35 years. No come-lately are we, trying to climb aboard a band wagon. On the contrary, we are proud that we are one of the pioneers of the industry.

Second, there is the basic reputation of the manufacturer. Here again GARRARD stands alone, because our products are known throughout the world as just about the best that can be made. No compromise is made with quality. No mass-production methods are employed. That, of course, is the reason why Garrard Changers and Transcription Turntables are not always in stock at your Sound Studio, for delivery *that very day*. We are catching up with the demand, but not at the expense of quality control.

I suppose the correct phrase to employ in considering this question is "Caveat Emptor". You don't (or shouldn't have to) buy a Record Changer or Turntable very often; why not get the best when you do?

Leonard Carduner

Leonard Carduner is President of British Industries Corporation, Port Washington, New York. BIC is an American company which offers you the finest of audio equipment . . . fully guaranteed, with service and spare parts available throughout the country.

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APRIL, 1956 VOL. 40, No. 4
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AUDIO

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CONTENTS

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AUDIO PATENTS

RICHARD H. DORF*

THE TECHNIQUE of using a coil to cover a room with electromagnetic waves at audio frequencies, and then picking them up with portable receiving equipment, is well known. Its uses are numerous—from cueing in television studios to simultaneous translations at the United Nations. So far as this writer knows, however, just about all of these systems require electrical gear of one sort or another. Some have abbreviated equivalents of ordinary radio receivers which pick up, detect, and amplify radio-frequency signals; others have hearing-aid-type systems which amplify audio picked up inductively.

Victor Albert Foot, a British inventor, has come up with a magnetic sound transmission system which requires no electronism—no tubes, no resistors, capacitors, or, in fact, anything but one or two specially built earphones. The patent covering this (a U. S. patent) is 2,721,896 and no assignment of it is noted.

The system begins with an audio amplifier which feeds a wire loop strung around the room, of which more details later. The wire, one or more turns, is strung around the walls, floor, or ceiling in such a way that amplifier output causes a magnetic field to be set up in the room.

The special headphones used for reception are shown in the two drawings of Fig. 1. (A) is a cutaway side view and (B) a cutaway front view. We reproduce here the actual drawings from the patent specification, contrary to our usual practice, simply because this is probably the clearest way to show what is largely a mechanical invention. When we refer to the part symbols, look at them in both drawings to give yourself a clear idea of what exists.

The symbol C^1 indicates the earphone as a whole, which, at least from the outside, greatly resembles a standard one. There is a casing *D* with a cover *E* which carries a conical diaphragm *F*. The center of the diaphragm *F* is secured to a reed-like armature *G* which at its outer end (see the front view) is fastened rigidly to the casing *D*.

The reed *G* is directly over—but not touching—the gap between a pair of pole pieces *H*. These pole pieces are composed of a highly permeable material (one which carries magnetic flux very easily) and extend in opposite directions from the armature. They are shown here emerging from the case and are about the only visible features (from the outside) which would make the earphone look abnormal when it is in use.

The pole pieces *H* are bridged by a permanent magnet. In (B) of *Fig.* 1 the permanent-magnet arrangement is shown as the magnet itself *J* and two soft-iron pole pieces J^1; but a C-shaped magnet might be used instead.

When the phones are worn, they are adjusted so that the normal direction in which the pole pieces run is in line with the flux produced by the transmitting loop. This means, of course, that if the wires run around a baseboard, say, the pole pieces would be vertical. The pole pieces, being so very permeable (material not specified), collect and concentrate the magnetic flux in their vicinity. A good deal of flux, therefore, passes through the air gap between the two pole pieces and, of course, through the reed-like armature *G*. This causes the armature to move and the cone attached to it to push air, so that the sound is reproduced. The permanent magnet functions in the normal way to superimpose some steady flux and prevent reversal of the force exerted on the armature.

Contrary to usual practice, the cover *E* of the earphone is held by the headband (it is usually the case which is held), and the cover and case are held together in such a way that the case, and with it the pole pieces *H*, can be turned about the axis of the diaphragm to orient the pole pieces exactly in line with the magnetic flux in the room. This allows adjustment for maximum signal and also gives a sort of volume control.

If the permanent magnet offered low reluctance to varying flux it would tend to short-circuit the pole-piece gap and reduce sensitivity. The inventor suggests either using a material with low incremental permeability for the magnet (low permeability for varying flux) or using two permanent magnets, one alongside each pole pieces, with their circuit completed by leakage flux from their outer ends.

The inventor also suggests arrangements using coils to aid the sensitivity of the headphones. If interested, you can obtain a copy and read those details for 25 cents; address The Commissioner of Patents, Washington 25, D. C.

(*Continued on page 69*)

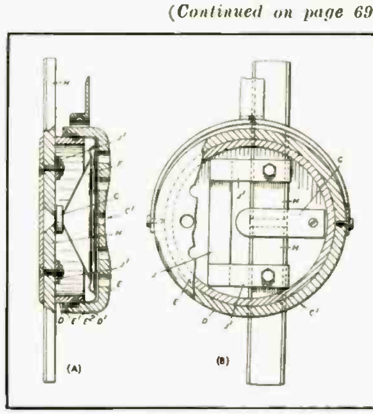

Fig. 1

* *255 W. 84th St., New York 24, N. Y.*


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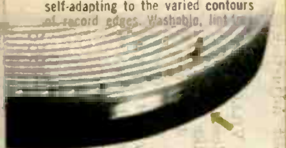


⑫ GENUINE RUBBER TRACTION MAT
Exclusive raised outside tread is self-adapting to the varied contours of record edges. Washable, lint-free.

HEAVY STEEL PRECISION TURNTABLE
A full inch high . . . and recessed into unit plate. Improves shielding of motor, and eliminates hum caused by stray magnetic fields. Flywheel action, so that voltage changes are not reflected in record reproduction.

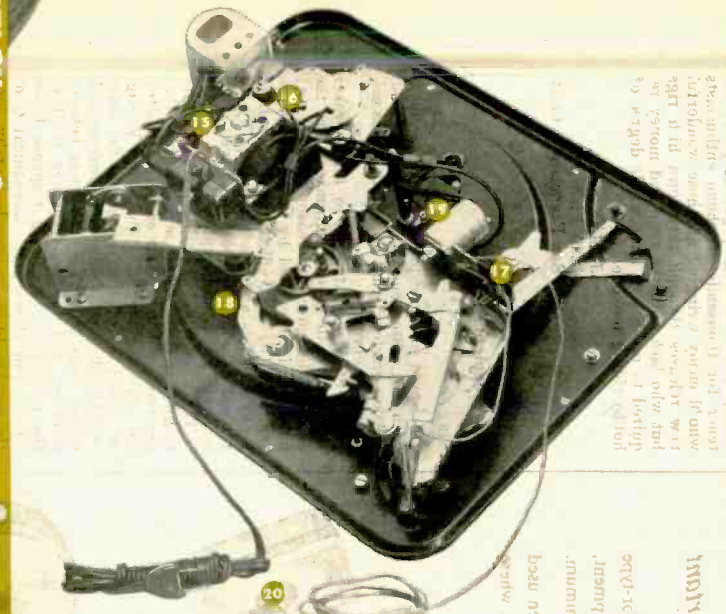
⑬ SILENT, FREE-WHEELING BALL-BEARING TURNTABLE MOUNT
Meticulously engineered to prevent wow and friction. Bearings are sintered bronze, expertly burnished to size . . . and revolve freely and smoothly in an exclusive Garrard non-metallic cage, eliminating noisy metal-to-metal contact, and binding found in the usual steel cup races.

RC 98 · RC 88 · RC 121

⑮ 4-POLE SHADED "INDUCTION-SURGE" MOTORS
Heavy duty . . . engineered and built entirely in Garrard plants. The smoothest, quietest, most powerful and up-to-date type available in record playing equipment, and the best Garrard has yet constructed as regards freedom from vibration and rumble. No hum, even when used with sensitive pickups. Constant speed maintained.
Self-aligning Oilite bearings top and bottom.

EXCLUSIVE, DYNAMICALLY-BALANCED MOTOR ARMATURES
Individually weighted by special Garrard equipment, to insure perfect speed, without vibration. The only rotors of which we have cognizance, balanced in this manner.

RC 98 · RC 88 · RC 121



⑲ NEW-TYPE SHIELDED CONDENSOR-RESISTOR NETWORK
Pioneered by Garrard, this feature eliminates the startling "plop" noise through speaker when changer shuts off at end of last record.

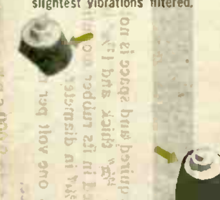
⑳ COMPLETE U-L APPROVED WIRING
Ready for Plug-In!
Changer comes with full 6 ft. U.L.-approved electrical line cord, and with pickup cable, terminating in standard jack. Fits into any system of high fidelity components, without soldering or tools for connecting.

RC 98 · RC 88 · RC 121

⑭ STEEL "MONO-BUILT" UNIT PLATE
Permanently true; affords husky, rigid support for entire mechanism.

EXCLUSIVE "SNAP MOUNT" SPRINGS
Permits instantaneous mounting of changer unit; may be levelled from the top, by a simple turn with a screwdriver.

⑯ 4 LIVE RUBBER CONI-POISE MOTOR MOUNTS
Floating power! Motor completely isolated and damped from rest of unit by exclusive tension compression shock absorbers. Even the slightest vibrations filtered.



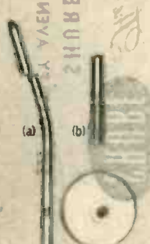
⑰ REINFORCED, AUTOMATIC MUTING SWITCH
New, heavy-duty design . . . requires no servicing. Eliminates sound through speaker during record-change cycle. Continuity of music undisturbed by extraneous noises.

RC 98 · RC 88 · RC 121

⑱ WATCH-LIKE CONSTRUCTION
The hallmark of Garrard engineering! All levers machined to close tolerances and fully adjustable . . . easy, inexpensive to service. Bronze bearings at all moving points for longer life! Precision-ground gears perfectly meshed to insure constant, smooth action through years of service.

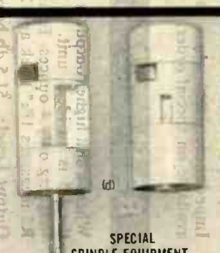
RC 98 · RC 88 · RC 121

SERVICE AND REPLACEMENT PARTS
Garrard changers hold their pre-eminent position in the American market by virtue of the finest service and parts facilities available in the Industry . . . the guarantee and facilities of the B.I.C. Group. This policy protects owners of all Garrard equipment . . . old models, current models, and newest models. You may purchase any Garrard equipment with complete confidence.



INTERCHANGEABLE SPINDLES
Easily inserted and instantly removable. Designed to afford greatest possible protection to records.

STANDARD SPINDLE EQUIPMENT
(supplied with RC88 and RC98)
(a) Garrard "bent" one-piece spindle for standard center holes. Heavily chromium-plated, and polished to mirror finish . . . perfectly smooth as a spindle should be. No moving parts to nick or enlarge center holes.
(b) Manual "single play" spindle.
(c) Manual 45 rpm adaptor.



SPECIAL SPINDLE EQUIPMENT
(d) Special Garrard automatic spindles for 45 rpm records. Revolving collar prevents wear on center hole.
(supplied with RC98
Optional with RC88 and RC121)

SIMPLI-MIX OPERATION
In the RC121, records of any standard diameter (12", 10", or 7" . . . or mixed, bottom to top in this order) may be loaded on the fixed spindle at one time and the overarm placed in position. The changer then operates automatically, with the tone arm dropping in correct positions. 45 rpm records are played using clip-in adaptors, or with optional automatic spindle.

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LETTERS

Criticism

Sir:

Harold Lawrence's piece on critics is the fairest ever to hit print. It might be added that the function of the record critic, like that of many another kind of writer today, is to entertain. Your own Mr. Canby, for example, does a bang-up job as proxy listener for thousands of phono enthusiasts who'd enjoy wringing all those wonderful new releases through their own hi-fi rigs but who lack both the time and money required to make such an enviable degree of hobby-riding possible.

J. M. Kucera,
1280 Pine St.,
San Francisco 9, Calif.

Disagreement

Sir:

I would like to express my disagreement with Mr. Stephens comments on loudspeaker efficiency that appeared in this column in February.

Mr. Stephens attempts to link speaker inefficiency to poor performance in the form of hangover by reasoning that (a) hangover is prevented by magnetic damping, and (b) that efficient speakers have heavy magnets and good damping; by inference, inefficient speakers have small magnets and poor damping.

The weight and material of the speaker magnet is only one of many factors that determine efficiency. Our own AR-1 woofer, for example, using a 3.3-lb. Alnico V magnet and 6 lbs. of Armco iron, has far lower over-all efficiency than many speakers with 6.8-oz. slugs. The choice here was between efficiency and the low-frequency limit of the pass-band; sacrificing response below 50 cps and allowing the mechanical *Q* of the speaker to be increased—thereby, incidentally, introducing hangover—would have allowed the efficiency to be significantly increased.

If one applies the efficiency rating of a speaker to the low bass portion of the sound spectrum as well as to the mid-band spectrum, the picture is likely to change quite a bit. We at Acoustic Research were interested to note that the Audio League (Pleasantville, N. Y.) reported in issue No. 11 that the absolute efficiency of the AR-1, at 25 cps, exceeded that of a justly famous speaker system rated as having 50 times the over-all efficiency of the AR-1.

Speaker efficiency, or the lack of it, cannot be taken as an index of quality, any more than the output voltage of a phonograph pickup (representing *its* efficiency as a transducer) can be taken as an index of pickup quality. I consider that it is as useless to compare loudspeakers without making some adjustment for equal sound level as it would be to compare different phonograph cartridges without adjusting amplifier gain.

Edgar M. Villchur,
Acoustic Research, Inc.,
25 Thorndike St.,
Cambridge 41, Mass.

(That ought to be sufficient fuel to continue this controversy. It would appear that efficiency can not be rated at any one frequency, but should perhaps be integrated over the entire audio spectrum. Ed.)

ABOUT MUSIC

HAROLD LAWRENCE*

By Any Other Name

ASK THE CLASSICAL sales manager of a large record company which of the following Mozart symphonies are likely to outsell the others: Nos. 38, 39, 40, and 41, and without even checking his sales figures he will tell you: Nos. 38 and 41. He will also inform you the Beethoven's Violin Sonata, Op. 24, stands a better chance of attracting sales than Op. 30 no. 2, always assuming that the interpreters are the same or of comparable quality. What makes him so certain? There seems no clear-cut musical reason for placing No. 41 above No. 40, or 38 above 39. As for the Beethoven sonatas, they are vastly different in conception; the first is a lyrical work of classic proportions, the second a forceful , impassioned expression. Both are prime examples of the composer's violin literature. The answer to this baffling stare of affairs can be summed up in one word: "title." Mozart's 38th and 41st are named "Prague" and "Jupiter," respectively; Beethoven's Op. 24 is called "Spring."

In the society of musical compositions, the untitled piece is often lost in the shuffle. With nothing to identify itself but a dull opus number or key signature, it is outshone by its more colorfully labelled counterparts. There are exceptions, of course. A few that come to mind are Beethoven's Fifth, the Brahms Symphonies, and Mozart's piano concertos. Nevertheless, in sales and popularity, titled music generally leads the field.

The predilection for titles flowered in the nineteenth century but actually dates back to the Renaissance and the birth of modern instrumental music. Elizabethan keyboard pieces were given such fanciful titles as *My Lady Carey's Dompe*, *His Humour*, *The King's Juell*, and *The New Sa-Hoo*. Later, in France, court composers devised an enigmatic language of their own to clothe their miniature pieces with an aura of mystery. This piquant nomenclature rubbed off on François Couperin in his harpsichord works. Here are a few examples: *La Zénobie, Les Fastes de la grande et ancienne Mxnxstrxdxsx, Le tic-toc-choc, Les Culbutes Jxcxbxnxs*, and *La Petite Pince-sans-rire*. Your knowledge of French will get you nowhere with these, by the way. Other Couperin pieces, however, were authentic miniature tone poems whose names seem to have preceded rather than followed the music's creation. Even such a nonsensical designation as *Le tic-toc-choc* is not as remote as one would think from the character of the piece with its light staccato effects and sparkling wit.

Couperin's contemporaries in Central Europe regarded the art of the French *clavecinistes* as too unsubstantial for their serious tastes. The frills and ornaments, unconcern for weighty and sober construction, and brevity were foreign to their ears. Solidity was the primary quality they sought to express. Titles were therefore strictly functional: partita, sonata, concerto grosso, sinfonia, toccata, fugue, etc.

The late 18th century composers, in their preoccupation with classic forms and the development of the orchestra gave little thought to descriptive titles. The terms symphony, sonata, serenade, divertimento, and concerto were therefore seldom qualified wtih picturesque phrases. The public, however, bestowed titles left and right to its favorite works. The symphonies and quartets of Haydn are a case in point. Symphony No. 96 in D is subtitled, "Miracle," because of an incident that took place at the première. According to a contemporary report, "Part of the audience pressed forward to look at the popular musician at close range, leaving a vacant space in the concert room. Hardly had they moved when a chandelier crashed down upon this empty spot. There were cries of 'A miracle, a miracle,' because no one was killed or hurt by the accident." The quartets have been assigned such colorful names as "The Razor," "The Frog," "The Joke," "The Lark," "The Sunrise" and "A Dream."

Carrying the circumstantial principle to a logical conclusion, why not call Schumann's Symphony No. 1 (as one English critic put it) *The Rusty Pen* Symphony, since it was written with a rusty pen which Schumann picked up on Beethoven's grave during a trip to Vienna?

With the dawn of romanticism, trivial associations of this sort gave way to words or phrases that would embody the heart and soul of a composition. Thus, the *Pathétique* and *Appassionata* Sonatas and the *Eroica* and *Pastoral* Symphonies. As the 19th century progressed, critics and music lovers thought they saw a "program" not only in a ballade or symphonic poem, but in many a piece of abstract music. Countless "stories" of the great symphonies appeared. The publishers eagerly catered to public tastes; to enhance the sales potential of a new edition, they would often provide subtitles of their own. Of the nine Beethoven piano sonatas with tag names, only three ("Pathétique," "Les Adieux" and "Hammerklavier") were given by the composer. The "Moonlight" Sonata, for example, got its name from a critic who compared the first movement with shimmering beauty of Lake Lucerne, a lake Beethoven had never seen. The "Tempest" Sonata grew out of a question a friend asked Beethoven about the meaning of the work. Beethoven, in what must have been a hasty reply, said, "Read Shakespeare's *Tempest*." It is more than likely that the composer had not yet read the play himself. Had he done so, he would never have linked it with the sonata.

Nearly a century after Beethoven, a Frenchman named Erik Satie anticipated friends and critics by providing virtually all his piano pieces with not only titles,

* *26 West Ninth Street, New York 11, N. Y.*

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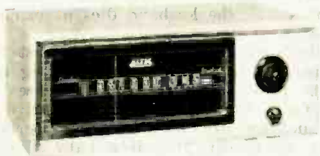

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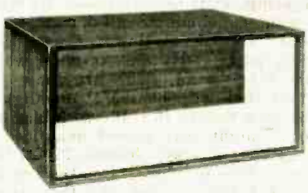

901B Melodist
Record Reproducer

utilizing exceptional Altec 339B amplifier • finest English-made 3-speed changer • magnetic pickup • three inputs: one low level, two high level • powerful enough to drive any size speaker; comprises a complete music system • finest record reproducer-amplifier-preamplifier available • Mahogany or blond hardwood cabinet* . . . $237.00

415A biflex Speaker

guaranteed frequency response 30-14,000 cycles • 15" cone using multiple concentric compliances • outstanding efficiency • extremely low distortion • smoothest speaker response at an economy price . . . $60.00

**All Altec furniture-finish cabinets bear the seal of the Fine Hardwoods Association*

GUARANTEED PERFORMANCE
With Altec Lansing High Fidelity Components

The exclusive Altec Lansing Performance Guarantee is your assurance that every Altec home music component you buy will meet or exceed its published technical specifications. This guarantee is made possible by the engineering integrity, proud craftsmanship, and product testing that goes into every Altec Lansing component. In addition to quality performance Altec offers beautiful, smartly designed cabinets that bear the Fine Hardwoods Association Seal. When you check the specifications on Altec equipment, remember that these are conservative figures that will be exceeded in actual performance.

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but "programs" for his essentially abstract conceptions. In the first movement of *Chapitres tournés en tous sens* (Chapters Turned Every-Which-Way) entitled, "She Who Talks Too Much," he wrote the following 'narration': ". . . signs of the impatience of the poor husband . . . Let me speak! . . . I'd like a hat of heavy Mahogany . . . Mrs. Thing has a bone umbrella . . . Miss What's-Her-Name married a man as dry as a canary . . . Well, listen to me! . . . the concièrge has a pain in his ribs . . . the husband dies of exhaustion."

Satie's art was a reaction against the "music illustrators." He was poking fun at the prosaic realism of such scores as "Sinfonia Domestica" which charted a day in the life of a typical German bourgeois family, including baby's noisy awakening, the bath, playing with the child, parents' argument, and yes, a love scene too.

Brahms frowned upon program music of any kind. To him the noblest musical expression was to be found in the classic vein. It would have warmed his heart to know that posterity would not provide more than a handful of his works with nicknames.

Like Brahms, the purist would certainly like to abolish all titles not assigned by the composer to his own music. He might even want to eliminate all but the most necessary formal heading for each composition, particularly for abstract works. On the other hand, there are those who maintain that without the "Moonlight," Beethoven's Sonata in C Sharp Minor, Op. 27 no. 2, might have passed unnoticed by the majority of music lovers. Titles, they say, serve two purposes: (a) they're fine for quick reference, and (b) they arouse interest and pave the way for a more receptive audition. After all, even the non-objective modern painter invents poetic names for his latest efforts.

Every once in a while the controversy flares up again. A music critic writes an article, his readers send urgent letters pro and con to the editor, and soon other critics become embroiled in the dispute—a storm in a teacup. What was that Shakespeare said about a rose?

COMING EVENTS

April 10–12—Radio Electronic Component Manufacturers Federation Show, Grosvenor House, London, England.

April 13–15—The London Audio Fair 1956, Washington Hotel, Curzon St., London, England.

April 16, 18, 19—Broadcast Engineering Conference, in conjunction with the 34th annual Convention of the National Association of Radio and Television Broadcasters. Conrad Hilton Hotel, Chicago.

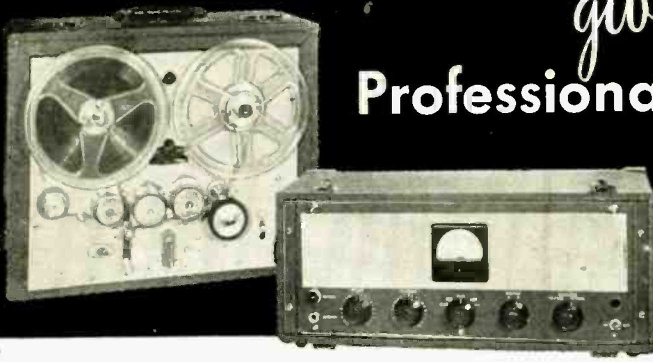
April 23–24—New England Radio-Electronics Meeting, "Stocktaking of Electronic Progress." Sheraton-Plaza Hotel, Boston, Mass.

April 29–May 4—79th Convention of the Society of Motion Picture and Television Engineers, Hotel Statler, New York City.

April 23–May 6—British Industries Fair, Earls' Court, London, England.

(Continued on page 83)

Only the PRESTO SR-27 Tape Recorder *gives such* Professional Performance *at such a popular price!*



The top performance features of the finest PRESTO units are yours in this 2-unit combination—R-27 tape recorder and A-920B amplifier. *Check the features of the recording unit:* 3-motor drive; separated record, erase and playback heads; fast forward and rewind. There's no take-up reel clutch or idler pulley. *Compare the features of the companion amplifier:* 10 watt output at 16 ohms, self-contained power supply, separate preamps and VU meter and *two* playback speakers. You can monitor the tape during recording. This professional performer is yours for just $588 complete.

PRESTO *Pirouette* T-18 TURNTABLE

. . . finest low-priced professional turntable has world-famous flick shift—one sideway flick selects any speed.

There is no finer, smoother-running or easier-to-operate instrument for control room, studio or hi-fi system than the *Pirouette* T-18—the PRESTO achievement that sets a new high in turntable design. You select any speed—33⅓, 45 or 78 rpm—with a sideway flick of the exclusive PRESTO 3-speed shift. You engage the proper idler for the speed you want with one motion. There are no bothersome arms or shift cams. And check the extras you get: extra heavy-weight wide-beveled table, deep-well bearing, sleek styling in telephone black and brushed chrome. . . . Net price $66.00. With hysteresis motor . . . Net price $117.00.

Watch for the NEW PRESTO K-11 DISC RECORDER

. . . improved professional version of PRESTO's all-time favorite K-10—incorporates revolutionary T-18 turntable . . . Net price $396.00

K-11 is the smart new disc recorder you can fit into your sound system—or use as an on-location recorder. It's featherweight with a completely new pick-up arm, fully encased hi-fi speaker, smart new panel design with push button controls and the dependable PRESTO cutting head. You get excellent broadcast-quality fidelity. For those times when a disc recorder is preferable, the K-11 is your best bet. Cuts discs up to 13¼ inches in diameter. Three-speed operation. *With hysteresis motor* . . . Net price $145.00.

PRESTO RECORDING CORPORATION
PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Instantaneous Recording Service, 42 Lombard St., Toronto

WORLD'S FOREMOST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

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Extra playing time?

At economy price? Famous *acetate-backed* "Scotch" Brand Extra Play Magnetic Tape 190 also offers 50% more recording time—as much as found on 1½ reels of standard tape. New, high-potency oxide coating assures recordings of increased frequency range. New economy price saves you 28%.

Economy?

The favorite tape of sound engineers, the world over, famous "Scotch" Brand Magnetic Tape 111 cuts tape wear in half, thanks to exclusive silicon lubrication. Tape glides smoothly over recording heads to give flawless sound reproduction time after time. Buy it now at a special new low price!

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want magnetic tape?

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New "Scotch" Brand High Output Magnetic Tape 120 guarantees greater dynamic range recordings . . . with harmonic distortion reduced to a minimum. 133% more output permits brilliant sound reproduction. A must for hi fi fans. Also available with Polyester backing at slight extra cost.

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New "Scotch" Brand Extra Play Magnetic Tape 150 is made to take even hardest wear—thanks to its tough, durable "Mylar"* plastic backing. In addition to super-strength, new 150 Tape offers 50% more recording time on a standard-size reel, and famous "Scotch" Brand recording quality.

*"*Mylar*" *is a registered DuPont trademark.*

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SCOTCH
BRAND
Magnetic Tapes

London Letter

RICHARD ARBIB*

AUDIO IN ENGLAND should receive a great impetus by the presentation of the first British Audio Show. This will be occupying three floors of the Hotel Washington in London by about the time you read this Letter. Although there are three exhibitions or shows held in England each year in which audio equipment is exhibited this is the first attempt to have an Exhibition which has the title "Audio Fair" and which has quite frankly been patterned upon those which have been such a sweeping success in the United States.

Previously the show which was devoted most exclusively to audio equipment has been the annual exhibition of the British Sound Recording Association but whilst this has been an interesting exhibition it has been on a comparatively small scale and it is hoped that the new Audio Fair will attract 10,000 or more visitors. Of course, these numbers cannot compare with the Radio Show which has more than a quarter of a million patrons every year. As the London Audio Show will follow immediately after the British Radio Components Show, it is likely to be patronized by a number of visitors from Overseas.

If this Audio Show becomes an annual event, it will fulfill one very useful purpose in providing a focal point each year for Audio equipment manufacturers to present their new products. During the past few months there has been little new in this field for even some of the items I have described in previous Letters have not yet reached the production stage, but no doubt these will be seen by the public for the first time at the Audio Fair.

New Tape Recorders

In the field of tape recorders there are only really three new pieces of equipment of interest to the audio enthusiast and probably the most interesting of these is the new Ferrograph 66 which is a complete unit of a tape deck, amplifier, and preamplifier, built in such a way that if a hole 15" × 16" is cut in a board the unit can drop in complete. It incorporates switches

* *Multicore Solders, Ltd., Hemel Hempstead, Herts., England.*

Close-up of the steel drawer in which are contained the tape recorder, amplifiers, tuner unit, crossover network, and a felt-lined recess for a microphone. On the right can be seen the transcription turntable and pickup.

so that a pick-up, microphone and tuner can be permanently connected and this can virtually form the heart of a small high-fidelity installation and the more ambitious user can connect to it a larger amplifier taking the output from the Ferrograph before it reaches the output stage. This machine is available in two forms, with tape speeds of 7½ and 15 ips or 3¾ and 7½ ips, and I am advised that the first deliveries were made to the United States. One particular advantage of this machine is that as it uses 8¼-in. reels; 1 hour 10 minutes playing time can be obtained at 7½ ips without changing a reel and 2 hours 20 minutes on both tracks of one reel.

Another new model made by an old established British tape recorder manufacturer is the Simon S.P. 2 which incorporates a 10-watt amplifier and is stated to have a frequency response of 50–12,000 cps ± 3 db. This is a self-contained model which can be carried about reasonably easily.

Specto, Ltd., who have previously confined their activities largely to home cinema projectors, are now producing two tape recorders both of which incorporate the Rudman Darlington tape deck which has a variable speed control. Whether or not this idea of a variable speed control is a good one is a debatable matter but it must have very intriguing possibilities for high fidelity enthusiasts wishing to dub tapes and vary speeds.

One of the models produced by Specto is a stereophonic one designed for reproducing the H.M.V. and Columbia stereosonic tapes. It is rumoured that in the near future, E.M.I. will have at last produced a high-quality tape recorder and reproducer for home use. This has been promised for nearly two years.

Both E.M.I. and "Scotch-Boy" are now producing "long-play" tape and despite the present economic position, there is still a brisk demand for amplifiers of the well known companies such as Quad, Leak, Pye, Pamphonic, Trix, R.C.A., Rogers, and Tannoy.

Although sales of high fidelity equipment are still good, it is surprising that during the last six months the demand for radio-gramophone combinations has been much depressed despite the fact that sales of records have exceeded all previous figures.

How to Obtain English Record Catalogues

American enthusiasts have asked me for details of catalogues of British records and it is as well to remember that probably 85 per cent of sales of records in England are achieved by the E.M.I. and Decca Groups. E.M.I. issue annually four international catalogues covering the H.M.V., Columbia Parlophone and M.G.M. marks. These catalogues cover in all 1,318 pages. Whilst they are of course available from England, it will probably be simpler for the American enthusiast to get them in the United States. H.M.V. record catalogues are available from R.C.A. Victor; Columbia are obtainable from Columbia Records Inc.; Parlophone through American Decca; and the catalogue of Angel records which now include the discs issued in England under the Columbia trade mark can be obtained from Electric & Musical Industries, Ltd., in New York.

The disc lover who would like to see one British catalogue is recommended to get the H.M.V. which includes twenty pages of details of composers including dates of their births, deaths, and nationalities, a most excellent pronunciation guide, and a glossary of musical terms.

The Decca catalogues probably contain a much larger quantity of L.P. records than E.M.I. because Decca were issuing L.P. records two years before the first E.M.I. one appeared. Copies of the Decca catalogues are obtainable from London Records, Inc., in New York. The main catalogue contains details of over 2,000 long-playing records, nearly 250 medium-playing records, about the same number of extended play 45 rpm records, and over 700 of the standard length 45 rpm records. Whilst E.M.I. issue separate catalogues for each of their marks, the Decca catalogue covers all its labels, including Brunswick, London, Felsted, Telefunken.

While both groups of companies issue monthly lists of their releases, the Decca people issue every quarter a comprehensive catalogue in a stiff backed cover covering all the records issued under their various marks during the appropriate period. Opera lovers can buy the most excellent libretti giving the original language in which an opera is recorded and an English translation side by side, and similar booklets are available for most recital records. Details of these booklets, which are quite inexpensive, are given in the appropriate catalogues.

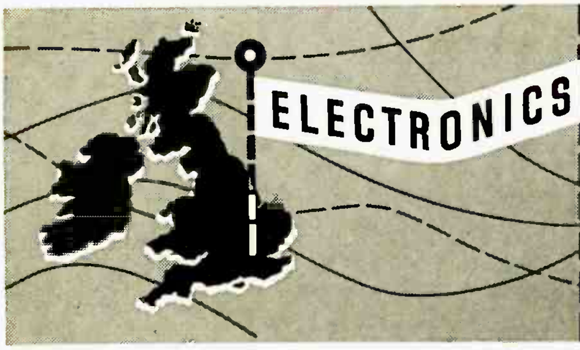
The record enthusiast who wishes to keep up to date with British record releases cannot do better than obtain copies of *The Gramophone* which is probably the oldest journal in the World which has been exclusively devoted to records. It is published monthly and costs only $3.50 a year.

High-Fidelity Home

Elaborate built-in high-fidelity installations of the kind only too well known in the United States are a comparative rarity in this Country and consequently, you may be interested in details of your correspondent's equipment which is illustrated on the cover and in a more detailed view here. Behind the grille on the left is a 14 cu. ft. sand-loaded enclosure in which is mounted a 15-in. bass speaker. Mounted above are an 8-in. and a 3-in. speaker in a simple baffle that is open at the sides and rear. The main equipment is housed in a pull-out drawer which weighs nearly 250 lbs. It comprises a tape recorder, amplifier and pre-amplifier, AM/FM tuner, recess for microphone, crossover network with adjustable potentiometers, and a sub-control panel.

This panel enables signals from the recorder or amplifier to be fed into the three-way loudspeaker system and/or the extension loudspeaker network. Signals can be fed to the recorder from the tuner or pickup or from a television receiver which is situated in another side of the room. A main switch is provided which switches off all the equipment simultaneously. On the right hand side the only part of the equipment

(Continued on page 69)



ELECTRONICS *in Britain*

The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

EF86

Another Mullard contribution to high fidelity

The Mullard EF86 audio frequency pentode is one of the most widely used high fidelity tubes in Britain today. It has been adopted by the leading British manufacturers whose sound reproducing equipment is enjoying increasing popularity in the United States and Canada.

The marked success of this tube stems from its high gain, low noise and low microphony characteristics.

By careful internal screening, and by the use of a bifilar heater, hum level has been reduced to less than 1.5μV. Over a bandwidth of 25 to 1,000c/s equivalent noise input approximates 2 μV.

When operated below 1,000c/s, internal resonances of the EF86 are virtually eliminated. Even at higher frequencies chassis and tube socket damping are usually sufficient to make vibration effects negligible.

Supplies of the EF86 are now available for replacement purposes from the companies mentioned here.

Principal Ratings

Heater	6.3V, 0.2A
Max. plate dissipation	1W
Max. screen dissipation	0.2W
Max. cathode current	6mA

Characteristics

Plate voltage	250V
Screen voltage	140V
Grid voltage	—2V
Plate current	3mA
Screen current	0.6mA
Transconductance	1800 μmhos

Base

Small button noval 9-pin

Supplies available from:—

In the U.S.A. International Electronics Corporation, Dept. A4, 81 Spring Street, N.Y.12, New York, U.S.A.

In Canada Rogers Majestic Electronics Limited, Dept. HH, 11-19 Brentcliffe Road, Toronto 17, Ontario, Canada.

Mullard

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EDITOR'S REPORT

FLEXIBILITY AND CONVENIENCE

'WAY BACK in the early days of hi-fi, we remember how most of us housed our home installations so as to look as much like a radio station's control room as possible. Lucky was the man who had either a very coöperative helpmate or sufficient intestinal fortitude to preëmpt adequate space to install a six-foot rack for amplifier, power supply, tuner, control unit, volume indicator panel, and a few rows of jacks, and who located his turntable in a two-foot-square cabinet as nearly identical as possible to those alongside the master control of the local radio station —even to lacquering the cabinet the usual gray, now almost universally called the "utility" model. Those were the "good old days."

And while we still long for the flexibility of that type of installation (and surreptitiously attempt to hide a few jacks of the telephone type—they are the only ones that can be camouflaged by flush mounting on a limed oak panel—on a cabinet that is seen by all and sundry who chance to come into our diggings) we can't help but admit that with few exceptions the permanently installed group of necessary components serves the household with a sufficiency never dreamed possible by the long-time audio fan. When we use the term "permanently installed" it must be construed in the looser sense—it will not be changed *daily*, even though it may be reorganized upon receipt of each quarterly dividend check (unless that happens to coincide with an outgoing check destined for a city on the Potomac).

The real experimenter who is always trying out a different amplifier, speaker system, tuner, pickup, or other component needs the flexibility, to be sure. We do feel that it is desirable to have facilities for substituting various components without having to move too much furniture. We like the idea of being able to "patch in" a filter, another amplifier, or different speakers whenever we get a chance to compare—the credo of the real hobbyist. One simple solution might be to install a row of jacks underneath the cabinet, perhaps set far enough back to be reasonably out of sight yet not so far as to make them completely inaccessible. Then one has the flexibility of the professional system with the acceptable appearance of a custom-made cabinet. Suggested treatment would be to have jacks for output of pickup, input to preamp, output from tuner, high level input to control unit, output from control unit, input to main amplifier, and several more pairs of jacks to accommodate amplifier outputs and speaker lines. If tape recorder, TV set, or other auxiliary inputs are being used, a pair of jacks for each would do the trick. With contacts normalled, the "system" plays just like any permanent installation; with suitable cords patched in, all kinds of combinations can be tried.

Mr. Berliner's article on a Professional Hi-Fi Home Music System reflects the thinking of one who has long worked in studios, yet not every home can be adapted to accept such an installation. There are many advantages to the professional type of construction, not the least of which is the pride of showing it off. But when listening is the prime reason for the array of equipment, the flexibility must result from some sort of compromise.

Fortunately for the industry—and even for the real hobbyist, since it provides him with a wider range of equipment to choose from—*listening* is the prime reason for most sales of hi-fi equipment. We still feel that many of the improvements that have resulted from the activities of the home experimenter have made hi-fi as important as it is today.

Just as improvements to automobiles are the result of experience at Indianapolis, Daytona, and Le Mans, so the improvements to audio equipment often get their start because of the insatiable curiosity of the experimenter and his quest for perfection. Long live the experimenter!

LOOK IN THE BOOK

Purchasers of any equipment—power lawn mower, electric razor, air conditioner, or what not—are usually exhorted by the manufacturer to read the instruction book before installing or using the product. We recently heard what we consider a classic in this regard.

Large, respected manufacturer receives record changer for evaluation. Makes tests. Rejects changer as not meeting specifications claimed with respect to rumble by as much as 15 db. Returns changer.

Changer manufacturer rechecks sample, finds it perfectly normal. Suspicion dawns. Replaces wooden shipping block wedging motor to chassis and rechecks. Figures duplicate those of manufacturer who rejected unit.

Instruction book specifically cautions user to remove block before using. But nobody read it. We think that is a real good joke. On somebody.

DEADLINES

We were so pleased with Jean Shepherd's first column on Jazz, expected confidently to continue monthly. New (to us) author not sufficiently acquainted with need for meeting deadlines. Better luck next time.

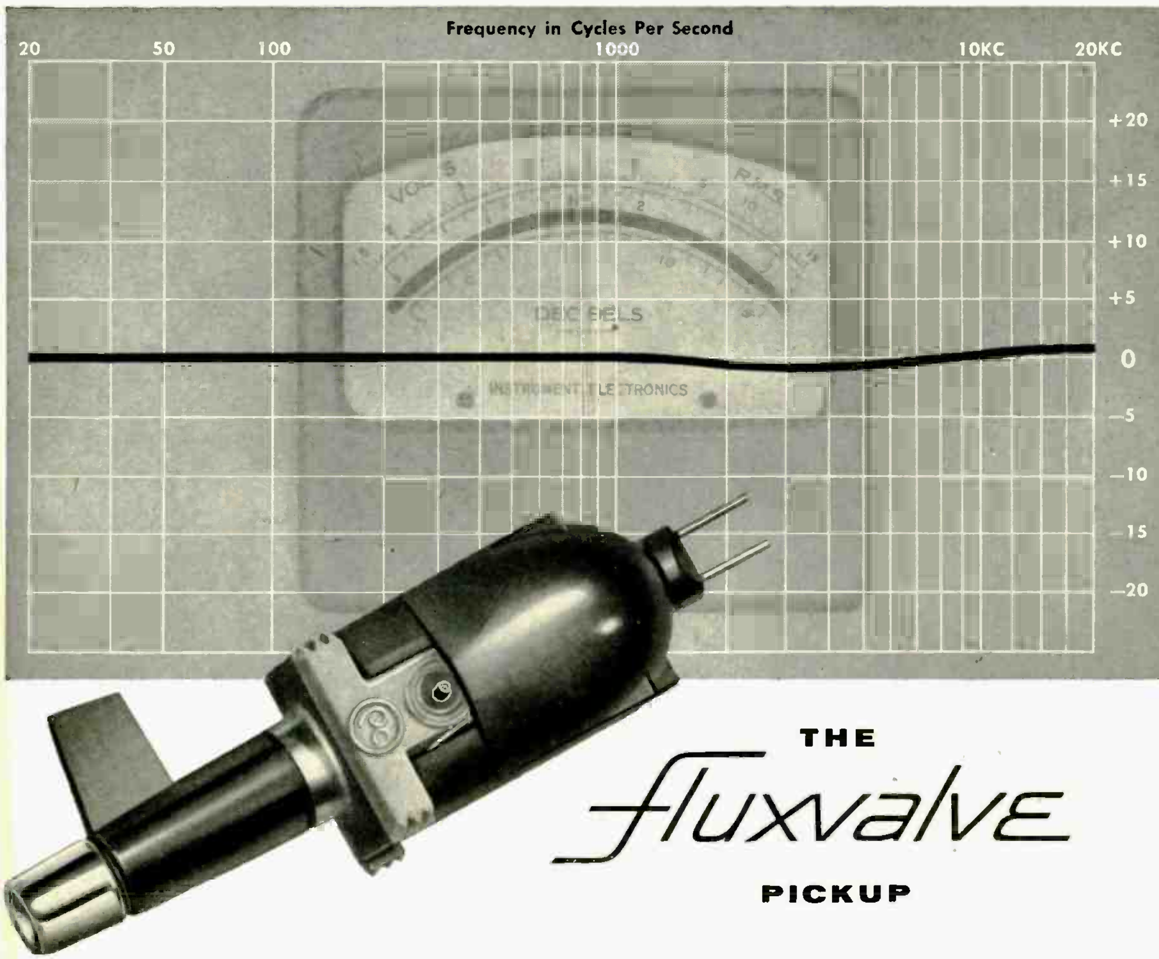
OVEROPTIMISM

Seems we erred somewhat in stating that the attendance at the Philadelphia show was around 17,000. The correct figure, we have been told by some more careful observers, should have been 8000—all paid admissions.

Our original informant seems to have caught the virus which is manifested by counting feet rather than faces—a not uncommon affliction, it appears, from some of the figures we have heard given out for shows that we have had the opportunity to observe personally.

At Last... and for the first time!

A PICKUP FOR CALIBRATING RECORDS!



THE *fluxvalve* PICKUP

Important as it is to the recording industry, the FLUXVALVE offers values never before available to thousands of record playing enthusiasts!

- *Very Wide Range (VWR)*
- *Unequalled transient response*
- *Long record and stylus life*
- *Low overall distortion*
- *Hermetically sealed*
- *Easily replaceable styli* ✲

✲ **Less than 1 mil stylus on special order**

THE FLUXVALVE PICKUP was originally developed for professional applications, particularly recording studios where accurate correlation between lacquer, master and pressings is essential, and has always been difficult. Now with the FLUXVALVE magnetic turnover pickup with which to make precise and *reproducible* record-measurements, a vital control step is simplified.

For a new listening experience, ask your dealer to demonstrate the new FLUXVALVE *. . . words cannot describe the difference . . . but you will hear it!*

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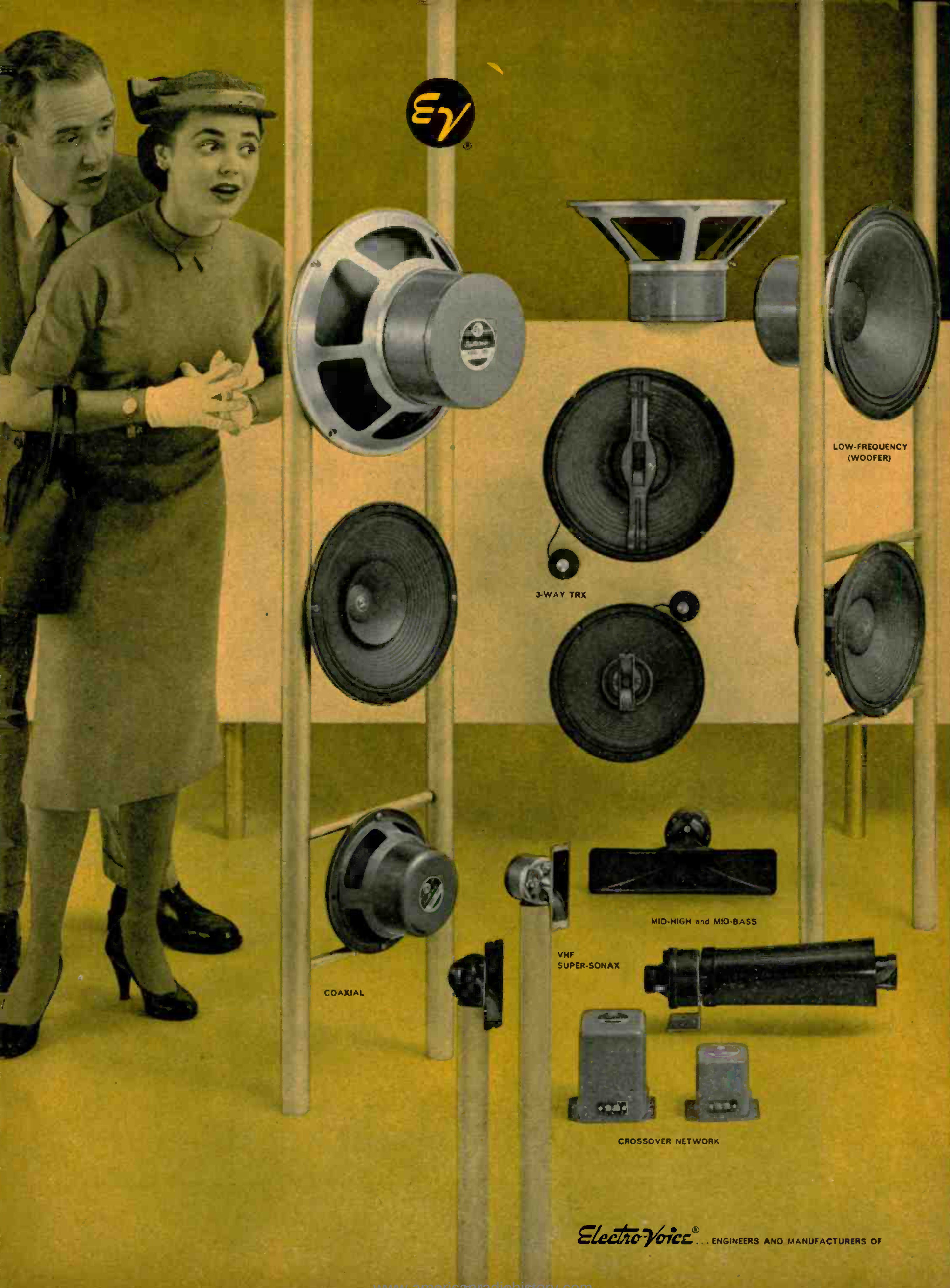

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VHF SUPER-SONAX
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Widest choice makes it easy to enjoy

TRUE HIGH FIDELITY

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Your enjoyment of high-fidelity reproduction depends largely on the efficiency of your loudspeaker system. For only with properly engineered speaker components can you obtain the range, the cleanliness of tone, the realism you want.

With today's most complete line, Electro-Voice makes it easy for you. You can start with an economical, integrated 2-way coaxial or 3-way triaxial speaker...and expand it as you desire to a multi-way system with the E-V Building-Block Plan. Or, you can choose now a complete, separate 2-way, 3-way, or 4-way speaker system which more efficiently reproduces each section of the audio spectrum.

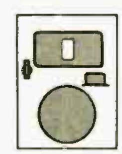
In E-V speakers, you have the advantage of heaviest, most powerful magnets, edgewise-wound voice coils, scientifically treated cones, and many other features that provide highest efficiency with the least discernible distortion.

What's more...the exclusive E-V Radax principle of high-frequency propagation... the exclusive E-V mid-range coaxial diffraction driver-horns...the exclusive E-V Super-Sonax very-high-frequency drivers...are all designed to bring high-fidelity sound reproduction even closer to perfection.

That is why your friends will recommend Electro-Voice. *Look...and listen... for your own satisfaction.*

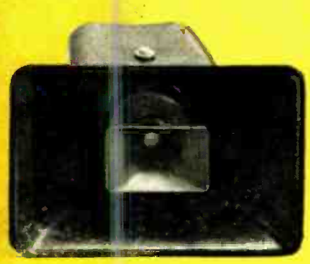
SEPARATE 2-WAY SPEAKER SYSTEM

SEPARATE 3-WAY SPEAKER SYSTEM



SEPARATE 4-WAY SPEAKER SYSTEM

MID-RANGE COAXIAL



Radax Coaxial Integrated 2-way Speakers in Economy and Super Series...in 8-inch, 12-inch, and 15-inch sizes ...from $28.50 to $78.00 net.

TRX Triaxial Integrated 3-way Speakers in Economy and Super Series...in 12-inch and 15-inch sizes ...from $59.70 to $135.00 net.

Low-Frequency Drivers (Woofers) for separate multi-way speaker systems in Economy and Super Series ...in 12-inch, 15-inch and 18-inch sizes ...from $29.70 to $90.00 net.

Mid-Range Coaxial Driver-Horns for separate multi-way speaker systems... in 12-watt and 25-watt sizes ...from $29.70 to $48.00 net.

Mid-Bass Driver-Horn Assembly for long-path indirect radiator applications ...$30.00 net.

Treble Diffraction Horns from $16.20 to $21.00 net.

High-Frequency Drivers in 25-watt and 30-watt sizes ...from $40.50 to $57.00 net.

Super-Sonax Very-High-Frequency Drivers (Super-Tweeters) in Economy and Super Units ...from $21.00 to $33.00 net.

High-Frequency Level Control for adjustment to room acoustics ...$3.60 net.

Crossover Networks for separate multi-way speaker systems ...from $8.40 to $72.00 net.

Building-Block Kits of matched components for expansion of existing economy speaker systems ...from $33.00 to $106.80 net.

All components are designed for use in your own or in E-V recommended enclosures. E-V "Do-it-Yourself" Enclosure Kits are also available.

New Catalog-Guide gives quick facts on speaker systems for high-fidelity reproduction. Send 25¢ to cover postage and handling for No. 117-A64.

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HIGH-FIDELITY SPEAKER SYSTEMS, AMPLIFIERS, TUNERS, PHONO CARTRIDGES, ENCLOSURES, DO-IT-YOURSELF KITS, MICROPHONES AND PUBLIC ADDRESS EQUIPMENT

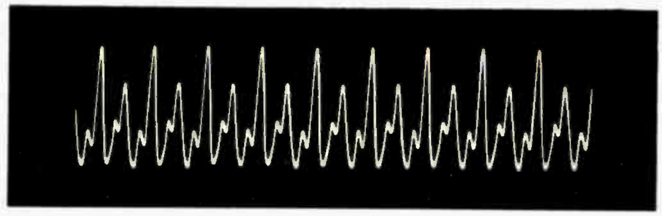
An intrstng exprmnt in spch

Some day your voice may travel by a sort of electronic "shorthand" when you telephone. Bell Laboratories scientists are experimenting with a technique in which a sample is snipped off a speech sound—just enough to identify it—and sent by wire to a receiver which rebuilds the original sound. Thus voices can be sent by means of fewer signals. More voices may economically share the wires.

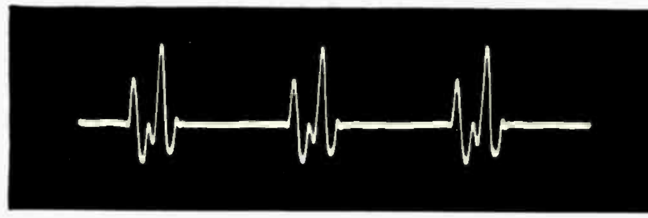
This is but one of many transmission techniques that Laboratories scientists are exploring in their search for ways to make Bell System wire and radio channels serve you more efficiently. It is another example of the Bell Telephone Laboratories research that keeps your telephone the most advanced on earth. *The oscilloscope traces at right show how the shorthand technique works.*

BELL TELEPHONE LABORATORIES

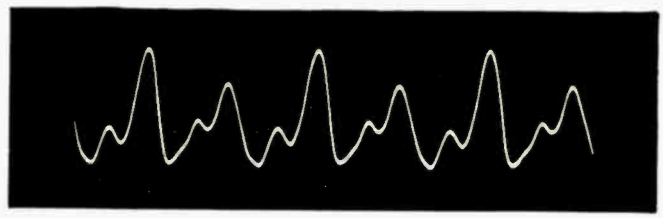
World center of communications research
Largest industrial laboratory in the United States



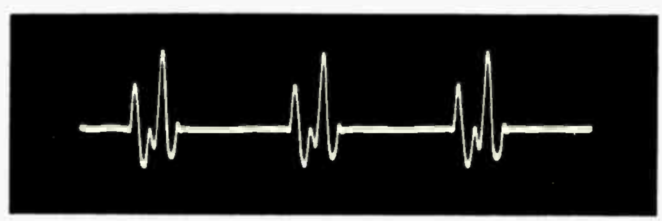
Vibrations of the sound "or" in the word "four." Pattern represents nine of the "pitch periods" which originate in puffs of air from the larynx when a word is spoken.



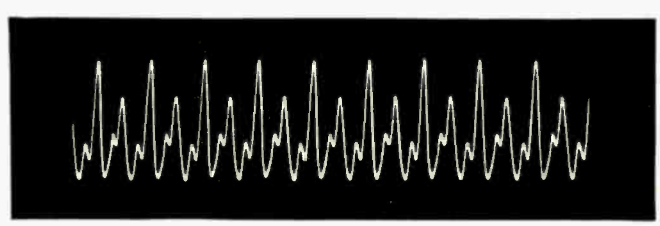
An electronic sampling of the "or" sound. One "pitch period" in three has been selected for transmission. This permits great naturalness when voice is rebuilt. Intelligible speech could be sent through a 1 in 6 sampling.



The selected samples are "stretched" for transmission. They travel in a narrower frequency band than complete sound.



Using the stretched sample as a model, the receiver restores original frequency. In all speech, sounds are intoned much longer than is needed for recognition—even by the human ear. Electronic machines perform recognition far faster than the ear.



The receiver fills in gaps between samples, recreating total original sound. Under new system, three or four voices could travel at once over a pair of wires which now carries only one—and come out clearly at the end!

A Professional Hi-Fi Home Music System

OLIVER BERLINER*

A marriage of high fidelity and broadcast audio equipment has resulted in an extensive but essentially simple home entertainment center for the advanced audiophile and tape recording enthusiast.

THE PURPOSE OF THE SYSTEM described herein is to provide high-fidelity sound reproducing facilities plus a provision for tape recording of various types of material. For ease of description the system will be separated into listening and recording facilities.

Virtually every form of audio programming available in the home is incorporated into the listening portion of the system. As a result, the following components were included: an FM/AM tuner, a three-speed record changer, and a remote-controlled television set. The tape recording requirements resolved into recording from radio or from television, and the dubbing of records to tape. For these purposes the following equipment is used: a professional tape recorder, a broadcast type mixer, a three-speed transcription-type playback turntable, a phono cueing amplifier, and a TV-sound tuner.

The needs of the installation do not stop here, for some method of coordinating this equipment is necessary. Two identical preamplifier-master audio controls serve perfectly, and added to this is a power amplifier and loudspeaker, thus completing the equipment lineup. In order to mount these components in as compact a manner as possible, the vertical mounting plan was selected and every possible item is placed in a rack, as shown in *Fig.* 1.

The location of the equipment in the rack is of some consequence, and it is placed as shown with one purpose in mind—ease of operation and easy access to critical controls. From top to bottom, the components are: master power panel, magnetic tape recorder, FM/AM tuner, Oberline TV/FM tuner, record changer, and the two master audio controls. The McIntosh 30-watt amplifier rests on the floor of the rack, behind the master audio controls. The Conrac television set and RCA loudspeaker system (*Fig.* 5) are, of course, separate. The transcription-type playback, *Fig.* 2, contains a Rek-O-Kut turntable, Fairchild pickup arm, and an Oberline cueing amplifier. The space below the amplifier houses 16-inch transcription records.

The careful observer will undoubtedly notice that there is some duplication of equipment, for there are two FM tuners and two TV tuners in the line-up. This is a matter of personal preference and convenience and is not unavoidable. The two FM tuners (one combined with AM, the other combined with TV (audio)) provide a safety in the event of failure of one of them. The two TV tuners (one with FM, and the other the television set itself) serve two purposes: one—safety; the other—to record one television program while watching another. No duplication exists in having both a record changer and a manual player, for they serve two purposes: convenience in the case of the changer; and ability to handle 16-inch transcriptions and all other discs with the ultimate in reproduction, in the case of the straight player.

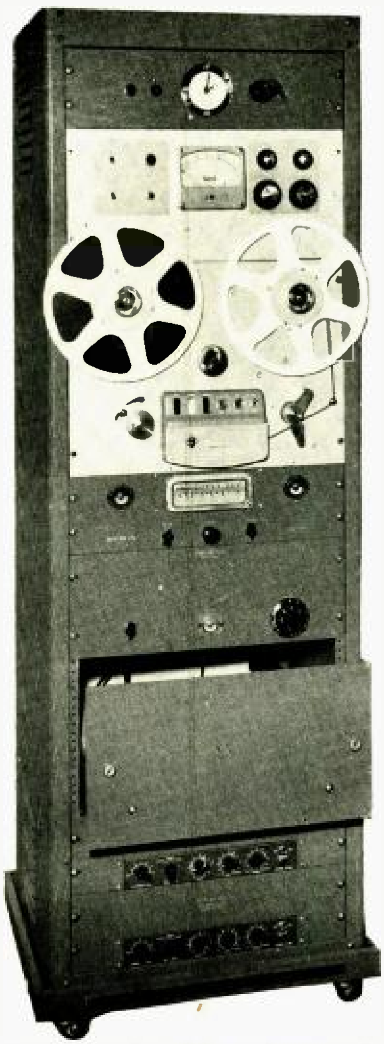


Fig. 1. Front view of the equipment rack. Locations of the various components must be carefully selected to provide ease of operation.

Figure 3 is a block diagram of the components hook-up, the solid lines represent audio circuits, while the dashed lines show power supply connections. Where power suppliers are not shown, it indicates that those units have their own self-contained power supply on the same chassis. Careful examination of the diagram indicates that the system hinges around the two master audio controls and the two-position toggle switch, S_1.

Circuit Description

Each of the master audio controls has three inputs: the TV/FM tuner, FM/AM tuner, and transcription turntable on one; the television set, tape recorder (playback output), and record changer on the second. This is by no means a haphazard arrangement, for you will notice that the input units used for both listening and recording are all connected to Control 1, whereas the units used for listening only are connected to Control 2.

When the two section toggle switch, S_1 is in the normal position, the program sources connected to Control 1 are fed to the recorder and those connected to Control 2 are fed to the monitor system. However, when S_1 is thrown to the other position, Control 1 goes directly to the monitor amplifier and Control 2 is completely out of the circuit, providing listening facility without the need of feeding through unnecessary equipment.

To make a recording, S_1 is placed in normal position, (as shown in *Fig.*3). The selector switch on Control 1 is set for the

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desired program source—AM/FM tuner, TV/FM tuner, or transcription turntable—which is fed to the program amplifier. This amplifier serves two purposes. It converts the high-impendance output of the master audio control to 600 ohms and to the proper level for driving the tape recorder; also it contains a volume indicator meter for checking recording volume level.

After passing through the recorder where they are put on tape, the signals are fed to one of the selector switch positions on Control 2. If the selector is set to pick up the tape recorder, it will send the signal on through to the monitor amplifier and loudspeaker for listening. Now here is where the versatility of the system makes itself available. As shown in the diagram, Control 2 may select either the record changer or the television set (audio) for listening, in addition to the tape-recorder output, without disturbing the other equipment. Therefore, it is possible to record a radio program, for example, while listening to records or watching television—simultaneously, and without interaction or interference between the two.

This feature is extremely handy when one has two favorite shows that he wishes to hear or watch at the same time. One may be recorded (and played back at any convenient time) while you listen to the other. Both go through the hi-fi audio system, yet do not interfere with each other. The secret, of course, is in having two master controls; and in connecting the proper program sources to each one. Remember, one control unit is used for recording and/or just plain listening; the other for listening only. With this arrangement, the program sources on Control 1 may be connected directly to the monitor, as do those on Control 2, without the necessity of going through the program amplifier and tape recorder.

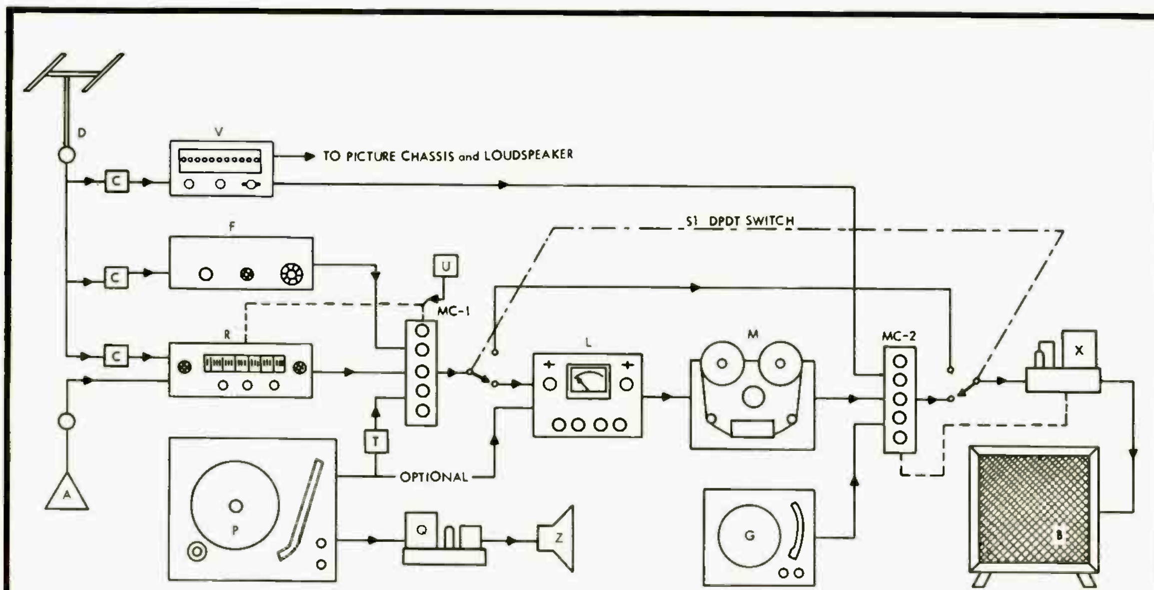
Fig. 2. Broadcast type turntable with equalizer and cueing facilities on pedestal. Mercury switch eliminates "popping" on motor starts and stops.

The master audio controls provide more than mere program source selection and gain control, for each has a set of bass and treble controls. Therefore, it is possible to compensate for deficiencies in the response of a signal being recorded, such as an AM radio broadcast or a telecast; or to adjust for room conditions or listening preferences when just listening. In addition, phono equalizers are also provided—one for the transcription turntable, the other for the record changer.

The Program Amplifier

The program amplifier (*Fig.* 6) used in this installation, was one designed for general portable use and has more facilities than are needed here. Although only one (high-level) input is actually necessary, this mixer has three, plus a master gain control. In this manner, up to three separately controlled microphones may be fed to the tape recorder and monitor when the recordist wishes to make a live tape recording at home, or in the field. Additional niceties, such as a current metering switch for self-contained tube testing; a meter on-off switch; and a master audio line on-off switch have also been incorporated into this mixer/program amplifier.

A great deal of time could be spent discussing the tape recorder and tape recording, but that is not our purpose here. Let it suffice that this unit accepts up to 10½ inch reels; operates at 15 or 17½ inches per second tape speed; has



LEGEND

A AM ANTENNA
B MAIN LOUDSPEAKER
C ANTENNA COUPLER
D TV(FM) ANTENNA
F TV(FM) TUNER
G RECORD CHANGER
L PROGRAM LINE MIXER AMPLIFIER
M TAPE RECORDER
P TRANSCRIPTION PLAYER
Q CUEING AMPLIFIER
R AM/FM TUNER
S1 RECORD/MONITOR SWITCH (SEE TEXT)
T INPUT TRANSFORMER
U TUNER and MC-1 POWER SUPPLY
V TV SET REMOTE CONTROL
X MAIN POWER AMPLIFIER
Z CUEING LOUDSPEAKER
MC-1 REC/MON MASTER CONTROL #1
MC-2 MONITOR MASTER CONTROL #2

Fig. 3. Single-line block diagram of professional hi-fi home music system. Correct hook-up of each component is essential to provide for the desired features.

separate record and playback gain controls; and has three heads so it is possible to monitor from the tape during recording.

The VU meter may be used to check erase and bias currents, and also indicate record and playback volume levels. Since the meter on the program amplifier is suitable for indicating record level, the meter on the tape-recorder may be set to indicate playback level. Thus it is possible to watch recording and playback levels simultaneously without having to switch from one to the other. With the mixer mounted on top of the rack, the meters will be in line with each other for minimum eyestrain and easy comparison.

A word about volume indication. In order that meter readings may be quickly and accurately compared, the meters should be identical in appearance and operation. Four-inch, front illuminated VU types with equal ballistics are recommended. Certain tape recorders use a vacuum tube voltmeter callibrated in volume units. The action of such a meter is different from that of the standard VU meter, and makes readings much more difficult to compare, and even inaccurate. The meter scales should also be the same, either type "A" (VU calibrations predominate) or type "B" (per cent modulation predominant); the latter is preferred by the writer.

Equipment Rack

The main equipment rack is mounted on a dolly, and may be swung around for servicing, as may the transcription turntable. This allows the equipment to be placed near the wall and eliminates the need for walking space behind. The turntable is a 12-inch model, but it has a pick-up arm capable of handling up to 16-inch transcriptions, either wide or fine groove. A four-position broadcast-type equalizer switch at the turntable may be used, if it is desired to connect the pick-up arm directly to the mixer.

Otherwise, the equalizer on Control 1, to which the arm is normally connected, is used (see *Fig.* 3). The former is handy, especially when one wishes to mix turntable with microphones in a live pick-up. A small cueing amplifier located on the shelf just below the turntable plate allows the recordist to locate any exact spot on a record without interfering with the regular recording or monitoring channels, as in standard broadcast operating practice. This may be any *good* small amplifier.

The TV/FM tuner deserves some description. It is buit around a DuMont "front end" which has been designed to tune in the FM broadcast band in addition to television channels 2 to 13. The frequency modulation band of 88 to 108 megacycles is located between television channels six and seven. Only the sound i.f. and audio stages of the television receiver were constructed with just enough audio amplification included to deliver about one volt to the input of the Master Control. A green "magic eye" tube for precise tuning was included. The circuit is shown in *Fig.* 4. The AM/FM tuner has two "magic eyes," one for the AM band and the other for FM tuning. Each tube glows only when you have selected its particular band, which also serves as an indicator for band switching.

The record changer is housed in a pull-out drawer located just below the

(*Continued on page 84*)

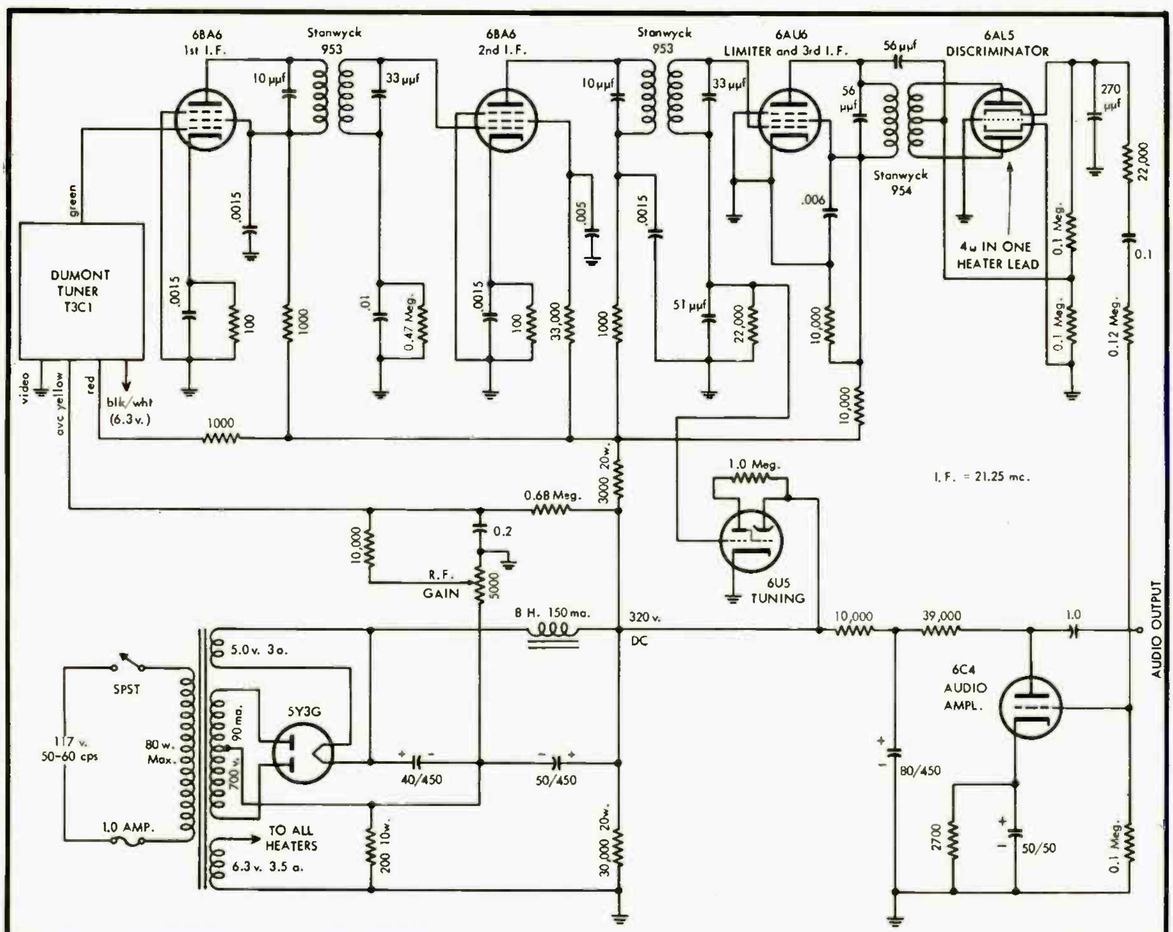


Fig. 4. Circuit of tuner capable of receiving TV (audio) and FM signals. Heart of the unit is the DuMont T3C1 "front end."

True-Fidelity Organ Reproduction

JULIAN D. HIRSCH*

Edgar Hilliar, organist at the Mt. Kisco church, during the making of one of the recordings used at the demonstration.

Description of techniques and instrumentation used in recording and playback of pipe organ performance in A-B comparison with the live sound, in the continuing search for audio perfection.

It is unusual to find two persons in complete agreement on the meaning of the term "high fidelity". Individual tastes vary so widely that it is hard to find a music system so poor that it will not meet someone's quality standards, or so excellent that it cannot be validly criticized. However, when sound is reproduced with such accuracy that it cannot be distinguished from the original, this is indeed "high fidelity". Perhaps "true-fidelity" would be a better description of such an accomplishment.

As the high fidelity industry has grown, there have been many public demonstrations in which live and recorded sound have been compared. These are frequently staged by equipment manufacturers, who are naturally interested in showing that their products are capable of functioning as parts of a true-fidelity reproducing system. Since certain musical instruments are much easier to reproduce than others, it is not surprising that the most successful and popular demonstrations have involved solo violin or cello, or small chamber groups. In Carnegie Hall last fall, Mr. G. A. Briggs achieved virtually perfect realism in reproducing the sound of a woodwind quintet, in direct comparison with the original sound. He was possibly less successful in matching the tonal quality of a pipe organ.

There are four basic characteristics of a sound which must be duplicated for true-fidelity or facsimile reproduction. These are:

a) *Frequency range.* The full frequency range of the sound source must be reproduced, without significant distortion of any kind. Reduced to essentials, this means that the entire recording and reproducing chain, from microphone to speaker, must have a flat frequency response and negligible non-linearity.

b) *Dynamic range and sound level.* The playback must create the same sound pressure at the listeners' ears as did the original sound. The reproducing system, therefore, should be capable of producing as much acoustic power as the original sound source.

c) *Spatial distribution.* The various components of the reproduced sound must originate from the same physical locations as their original counterparts. It is imperative that the microphone and loudspeaker be located as close together as possible.

d) *Acoustic environment.* In order to be played back in the room in which it was made, a recording must be as "dead" as possible. If room reverberation is audible in the recording, realism is destroyed.

Let us now consider these four requirements in relation to the reproduction of certain specific instruments.

It should be apparent that solo instruments in general are the easiest to reproduce successfully. With the exception of the pipe organ, and possibly the piano, they have relatively restricted frequency ranges. A system with a range of 40 to 12,000 cycles can do a creditable job of reproducing almost any solo instrument, whether it be string, woodwind, or brass. Since only one note at a time is being generated, problems of intermodulation distortion are minimized. A solo instrument has an acoustic output well within the capabilities of most good-quality loudspeakers and amplifiers, even at peak levels. Finally, the entire sound comes from a rather limited area, comparable in size to many practical home speaker systems.

The preceding statements apply, in lesser degree, to the reproduction of small groups of instruments. Fortunately, chamber players are usually located in a rather tightly knit group, not too much larger than most good speaker systems. Thus, by using a single microphone and speaker system, it is still possible to duplicate the spatial distribution of the sounds of a quartet or quintet with remarkable fidelity. It is usually unnecessary to resort to stereophonic recording techniques to simulate the sound of such a group.

The successful reproduction of a full symphony orchestra has yet to be accomplished. The frequency-range requirements are not too difficult to meet, although it is possible that accurate reproduction of the waveform envelopes of some massive orchestral sounds requires the systems to respond to the upper and lower limits of the audible spectrum. Due to the multiplicity of instruments, the intermodulation distortion of the entire system, from microphones to speakers, must be extremely low if the resulting sound is to be completely natural. This order of perfection, while attainable, permits no compromise with quality in any part of the system.

The enormous acoustic output of a full orchestra, together with the large size of the concert hall in which it plays, calls

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for the use of a number of speakers and a correspondingly large amplifier power output. If published data on the acoustic output of musical instruments is correct, it is unlikely that completely faithful reproduction of a full orchestra can be accomplished with a reasonable amplifier power. However, recent public demonstrations, notably the Philadelphia Soundorama, showed that 300 watts can be quite satisfactory when used with efficient loudspeakers. In fact, G. A. Briggs did a respectable job in Carnegie Hall with only 60 watts and with speakers of ordinary efficiency.

In the writer's opinion, the chief obstacle to true-fidelity orchestral reproduction has been the spatial distribution problem. On the face of it, stereophonic recording and reproduction would seem to solve this difficulty. However, the microphones used in orchestral recording are usually located in front of the orchestra and well above it. There may be valid and compelling reasons for this choice of microphone placement. There are usually even more compelling reasons why the speakers cannot be mounted in this manner.

In the playback process, it is customary to use two speakers, or groups of speakers, which cannot possibly duplicate the sound of the orchestra when fed with signals derived from microphones placed many yards away. Under ideal conditions, it may be possible to get a sound which is very much like an orchestra, but a direct comparison with the original orchestra will show up the differences in instrumental balance and spatial distribution.

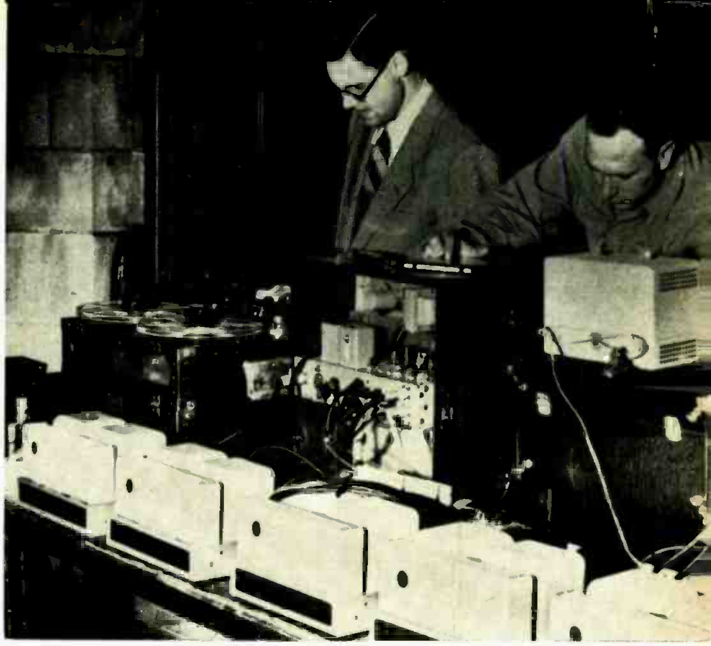

Fig. 3. Recorder and amplifier set-up. Left is John McKnight of Armed Forces Radio Service, operating the Ampex 350. Assisting him is Milton Weiss of The Audio League.

The Pipe Organ

The "King of Instruments" shares many characteristics of other solo instruments and a full orchestra, with a few additional problems peculiar to itself. In physical size, it is considerably more compact, although its pipes are frequently located in two widely spaced groups. The pipe organ spans a wider frequency range, on fundamentals, than the entire orchestra. The problem of reproducing it is complicated by the fact that its pedal notes generate tremendous acoustic power at frequencies of 32 cps or lower. Few speaker systems can generate these frequencies at appreciable levels without severe distortion. The harmonics of the upper organ fundamentals extend throughout the range of human hearing and beyond, also with considerable amplitude.

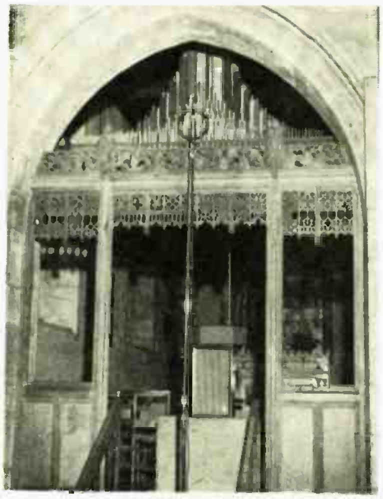

Fig. 2. Position of the Bozak and Janszen speakers under the smaller pipes of the organ. The E-V 655C microphone for recording is seen in the circle.

Although the equipment specifications for organ recording and reproduction are more severe than for orchestral recording, there are two compensating advantages. First, the physical arrangement of the pipes makes the use of two-channel stereophonic recording easy and unusually effective. Second (and not to be minimized), the organ is played by one man. Many hours of experimenting with microphone and speaker placement are necessary for demonstrations of this type, and the expense of keeping a 100-man orchestra on stand-by for such a period would be prohibitive. On the other hand, if a cooperative organist is available, it is possible to conduct a serious investigation of the recording and reproduction problem on a limited budget.

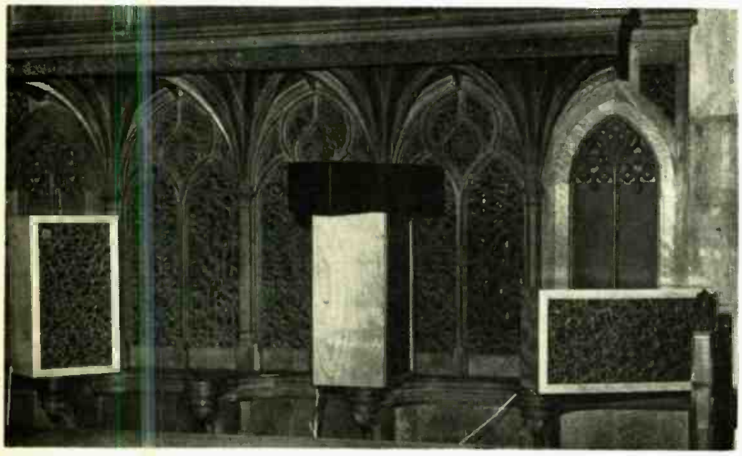

Fig. 1. Three AR-1 speakers and a Janszen electrostatic tweeter set up in front of the great organ for the public demonstration.

Events Leading to This Experiment

The Audio League, basically concerned with testing and evaluating high-fidelity components, is staffed by enthusiastic audio hobbyists. For some time we had observed the various attempts at true-fidelity sound reproduction, and had formed some definite ideas as to the most desirable techniques for accomplishing this. Independently, another audiofan, Richard W. Burden of Mount Kisco, N. Y., had been studying the same problem. He proposed, as a program for the local amateur radio club, the Harmonic Hill Radio League, to record the new

Aeolian-Skinner organ of St. Mark's Episcopal Church in Mount Kisco and reproduce it in the church itself.

Mr. Burden and The Audio League joined forces at this point and we pooled our equipment and ideas. Fortunately, we had the complete cooperation of St. Mark's Church and of Mr. Edgar Hilliar. their organist. Mr. Hilliar spent many hours working with us during our preliminary tests, and without his patience and skill the experiment could not have succeeded.

Early Trials

The Aeolian-Skinner organ at St. Mark's is a three-manual and pedal instrument, containing 38 stops, 53 ranks, and 3000 pipes. The larger pipes are located behind a wooden grillwork on the right (as one faces the altar), and the smaller pipes are in a cluster above an arch on the left side of the church.

Initially, all recording was done monaurally on Mr. Burden's Ampex 350. Two microphones were used, with electrical mixing. An Electro-Voice 655C dynamic microphone was placed as close to the treble pipes as possible, and an Altec 21C condenser microphone was placed directly in front of the great organ.

Our first problem was to select the speakers to be used in the playback. Obviously, it was desirable to use speakers capable of reproducing the entire frequency range of the organ with minimum distortion. Inasmuch as no corners were available, folded horns were out of the question. Infinite baffle systems appeared to be the only ones capable of doing the job. Several combinations of speakers of different makes were tried. Fortunately, the one which sounded most like the organ was also the smallest and lightest. We selected the Acoustic Research AR-1 system, on the basis of A-B listening comparison with the live organ.

It soon became apparent that a single AR-1, driven by a Heathkit W5M amplifier, was not capable of maching the acoustic output of the organ during any but the softest passages. The results of the first test were so promising, however, that we decided to enlarge our installation and try again. At this point, we found it necessary to seek the cooperation of a number of manufacturers and other outside agencies, since the cost of the equipment we planned to use amounted to several thousand of dollars.

For the second trial, an impressive array of equipment was on hand. Through the cooperation of the manufacturers, we had five Fairchild 275 75-watt amplifiers, four AR-1 speaker systems, a Bozak B-305, and a Janszen 1-30 electrostatic speaker. Atlantic Records, Inc. loaned us a stereo Magnecorder with two Telefunken U47M microphones. Tom Doud of Atlantic Records operated the stereo machine in this test and in the final demonstration.

Since most of the acoustic output of the organ came from the great organ, we set up three AR-1 speakers directly in front of the grillwork (see *Fig.* 1). At this point, the advantage of the AR-1's small size was brought home to us, since it would not have been possible to mount a large speaker enclosure so close to the organ pipes. The fourth AR-1, the Bozak B-305 and the Janszen tweeter were located underneath the bank of treble pipes as in *Fig.* 2. A separate amplifier was used for each speaker, with the exception of the Janszen, which was paralleled with one of the AR-1 systems. The E-V 655C microphone is visible directly in front of the pipes (in the circle). Behind the speakers is one of the Telefunken microphones used for the stereophonic recording, only the stand showing. An Altec 21C was placed as close to the organ pipes as we could get it. The Telefunken microphone used on this side was similarly located. Both Telefunken microphones were adjusted for a cardioid pattern.

Microphone Placement

Note that our microphone and speaker placement puts them close to each other and to their respective groups of organ pipes. This technique minimizes the effect of room reverberation since the recorders can be operated at low gain settings. The proximity of the speakers to the organ pipes enhances the realism of reproduction, even with a monaural system.

A considerable amount of experimenting with the exact placement of speakers and microphones was required to approximate closely the sound of the organ. After each change, Mr. Hilliar would play a short selection which was recorded and played back for comparison with the live sound. To our surprise, our major problem was excessive bass. The apparently random orientation of the speakers in *Fig.* 1 was actually the result of hours of experimentation. A valuable tool in achieving proper balance was the variable damping factor adjustment of the Fairchild amplifiers. By varying the damping factors of the individual amplifiers, we were able to tailor the bass response of the speakers to match the sound of the organ.

For some inexplicable reason, there was an apparent source of bass in a corner of the church where no organ pipes were located. To fill in this region during playback, we pointed the Bozak B-305 opposite to the other speakers, facing the corner.

As the second trial proceeded, the realism of the reproduced sound became uncanny. Frequently, we are unable to tell whether we were hearing the live or recorded sound, even when monaural recordings were played. The conviction grew upon us that what had started out to be a simple program for the local ham club was likely to be of interest to a much wider segment of the population. We decided, therefore, to hold a public demonstration, in which live, monaural, and stereophonic reproduction would be compared.

The Final Performance

The public demonstration was held on March 2. Although only a limited amount of local publicity was given to the event, over 450 people filled St. Mark's Church nearly to capacity. The equipment was essentially as described earlier, with the addition of a second Janszen 1-30 tweeter and a Fisher 50AZ amplifier (loaned by Fisher Radio Corp.) which was used to drive the Bozak speaker system. The second tweeter was placed near the great organ as shown in *Fig.* 1. *Figure* 3 shows the recorder and amplifier set-up.

Although the St. Mark's organ is a relatively low pressure instrument and consequently does not produce very high volume levels, we had some doubts about our ability to duplicate it with only 425 watts of amplifier capacity. The speakers used were all of rather low efficiency, and we could not expect to develop more than four acoustic watts of output.

Our recording and playback levels were set up as follows: Mr. Hilliar played the loudest passages to be used during the program. The recorder gains were adjusted for maximum recording level, and were not disturbed for the duration of the demonstration. While these passages were being played, the sound pressure was measured about two-thirds of the way back into the church, using a calibrated Altec 21BR150 microphone. The maximum sound pressure measured at this point was 84 db. When the test passage was played back, the playback amplifier gains were adjusted to produce the same sound level at the measuring point. Final adjustment was by ear, with less than 2 db of gain padding needed to produce identical sound levels from live, monaural, and stereophonic systems. Once set, the adjustments were not changed during the demonstration. These level settings were made with the church empty, and no readjustment was required when the audience was present. Rough measurements of power delivered to the speakers indicated that the loudest passage required 20 watts per speaker. Obviously, some clipping must have occurred in the amplifiers, even though they can deliver 150 watts instantaneous peak power. This clipping was not audible, however.

A control box was constructed which switched the amplifier inputs to the appropriate recorder outputs, and shorted all inputs when the live organ was playing. Additional contacts on the switches operated signal lights which informed the audience whether they were hearing live,

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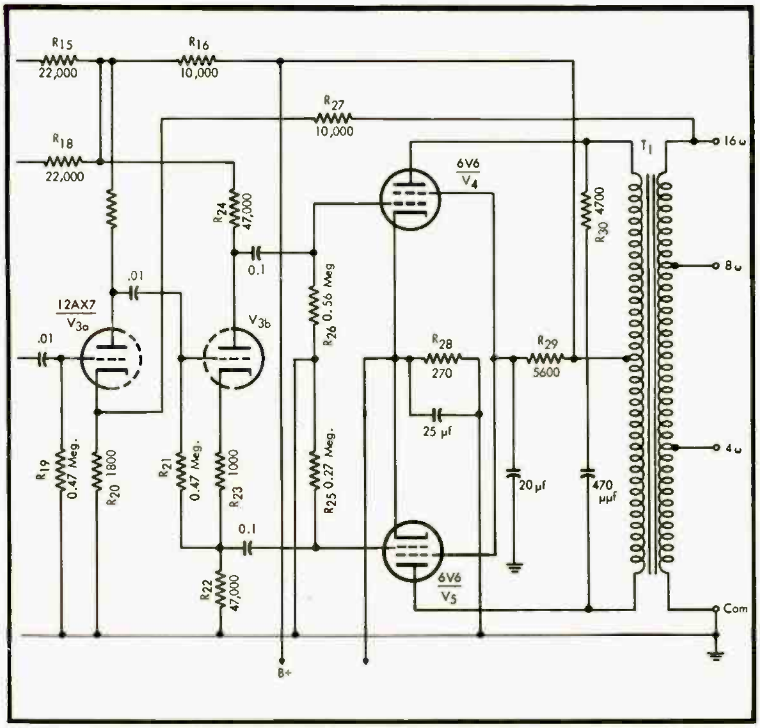

Fig. 1. Typical small power amplifier used for example worked out in the text.

Simplitronics

Electronics Simplified: Feedback Voltage

HAROLD REED*

The author believes there is still a need for electronics articles written in a down to earth manner, but not over-simplified to such an extent that the audio experimenter, hobbyist, or student is informed only that a certain arrangement of component parts and circuit design is employed because they produce certain results: and yet, not presented with mathematical analysis not understandable to the reader without clarification.

For instance, concerning feedback—the subject of this article—it is usually found that the simplified literature will state that negative feedback is used in an amplifier circuit to improve its operation and stability without giving any information concerning the feedback voltage. More advanced technical writings may state the same thing and then include mathematical equations or formulas to explain these statements without explaining the equations. Under the title Simplitronics it is proposed to present articles in this magazine to bridge the gap between these two extremes.

The reader is probably aware that feedback is the process of applying some of the output voltage of an amplifier back to the input of an earlier stage in the circuit. This is shown in *Fig.* 1 which is a schematic diagram of a straight voltage amplifier V_{3A}, phase splitter V_{3B}, and push-pull output stage V_4, V_5. This circuit arrangement is given because it is found in a number of hi-fi amplifiers and will be familiar to many readers.

The feedback resistor is R_{27}. If we simplify and redraw the portion of the circuit under consideration as shown in *Fig.* 2, we see that R_{27} and R_{20} are actually across the amplifier output and form a voltage divider, with the cathode of V_{3A} connected at the junction between R_{27} and R_{20}. The feedback voltage is the voltage drop that appears across R_{20} and is applied to the cathode of V_{3A}. The bias of V_{3A} is still determined mainly by the value of R_{20}—the shunting effect of R_{27} and the transformer secondary being very slight.

Actual measurements made on the portion of the amplifier as shown in *Fig.* 1 are as follows: with the feedback resistor R_{27} disconnected from the output winding of the transformer and a 1000-cps signal from an audio oscillator applied between the grid of V_{3A} and ground, a 0.23-volt signal from the oscillator fed to the input gave a 9-volt signal across the output transformer. See simplified schematic of (A) in *Fig.* 3. A 9-volt signal across the 16-ohm output winding is approximately 5 watts output.[1] Therefore, the voltage gain without feedback is equal to the output voltage, 9, divided by the input voltage, 0.23, or 39.

With Feedback Connected

If the feedback resistor is now connected to the 16-ohm tap of the transformer winding, it is found necessary to increase the audio oscillator signal to 1.4 volts to again obtain 9 volts of 1000-cps signal across the transformer output. Refer to (B) of *Fig.* 3.

The voltage gain, then, with feedback applied to the cathode of V_{3A} is equal to the output voltage, 9, divided by the new input voltage, 1.4 or 6.43. In other words, the voltage gain has decreased from 39 to about 6.

As it required an input of 0.23 volts without feedback and an input of 1.4 volts with feedback to obtain a constant 9 volts output, the feedback voltage must be 1.4 minus 0.23, or −1.17 volts—which is negative, and therefore opposing the original input signal.

We can now express these results by

(*Continued on page 82*)

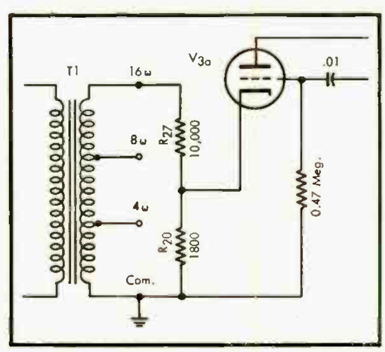

Fig. 2. Simplified arrangement of output transformer secondary and the first tube of the amplifier of Fig. 1.

* 3917 Madison St., Hyattsville, Md.

[1] Power = E^2/Z. E (voltage) is 9; Z (output impedance) is 16. Thus power is 9^2 or 81 divided by 16, which is approximately 5 watts.

AUDIOCLINIC ? ?

JOSEPH GIOVANELLI

Phono Switch "Pops"

Q. What are the best methods of suppressing the "pops" heard in a sound system when the a.c. switch of a record player is turned on or off? Donald F. Sampson, Central City, Nebraska.

A. In the better grade of record changers, the cartridge is shorted out during all portions of the cycle until the needle strikes the record surface, after which the short is removed, allowing the cartridge to feed into the amplifier in the normal way. Because of the very low impedance at the input of the amplifier at the time the motor is turned on or off, the high induced voltage around the motor windings cannot introduce too much of the unwanted "pop" sound into the system.

Excellent results may be had by wiring the motor of the record player in accordance with the schematic shown at (A) in *Fig.* 1. The capacitor, C_1, placed across the switch, S_1, effectively puts a load across the motor winding. (Because of the fairly low impedance of the a.c. line circuit, the capacitor is actually in parallel, not in series, with the motor, as will be seen from examination of the schematic.) When an inductance transfers energy into a load, the Q of that inductance is lowered. In this instance (large capacitive load), it is lowered substantially, resulting in a much smaller induced voltage which, in turn, causes almost complete elimination of the annoying "pop".

It may also be possible to combine the two methods, as shown at (B). To make this method really effective, S_1 must operate in the following sequence: When the record player is turned on, S_{1A} must close, turning the motor on; then, S_{1B} must open, permitting the pickup to feed the amplifier; when the player is turned off, S_{1B} must close, preventing the pickup from feeding the amplifier; then S_{1A} must open, turning the motor off.

If the player is a record which already has the shorting feature previously outlined, all that need be done is wire the a.c. circuit as shown at (A) in *Fig.* 1. If, however, it is a manual player or a changer lacking this feature, the schematic of (B) should be followed. Since it may be difficult to obtain a switch which will operate like S_{1A}-S_{1B}, it may be necessary to resort to using two separate switches operated in the prescribed manner; however, it might be somewhat annoying to have to fuss with two switches when your mind is on listening rather than tinkering.

Noisy Volume Controls

Q. How can I quiet noisy volume controls and switches? F. Goldman, Providence, R. I.

A. This can be done with the aid of an eyedropper and a cleaning agent such as No-Noise or Quietrol. Carbon tetrachloride may be used in place of either of these, if necessary. However, this substitution should not be made if the switches to be cleaned are of the wafer type since such switches are sometimes made of a plastic which can be attacked by the carbon tetrachloride, completely ruining the switch. Carbon tetrachloride should, in fact, be used as little as possible in cleaning electronic equipment; other agents can usually be used which will be at least as effective and which will endanger the equipment on which they are used to a far smaller extent.

Volume Controls: To quiet a noisy volume control, first remove the knob and arrange the equipment so that the shaft of the control faces up; then, with the eyedropper, pour a little of the cleaning liquid into the control at the point where the shaft enters the body. While doing this, rapidly rotate the shaft so that the cleaning agent will be spread over the entire surface of the element and slider contact. If this treatment does not produce the desired result, it should be repeated. If the second application of cleaning liquid fails, it is an indication that the control is beyond help and should be replaced.

Switches: Wafer construction usually necessitates removal of the equipment from the cabinet. To clean this type of switch, apply the cleaning agent directly to the contacts and then rotate the switch so that the liquid will be thoroughly spread over them. If it is a toggle switch that is to be cleaned, pour the liquid into it at the point where the handle enters the body, moving the handle back and forth to distribute the cleaning agent.

Decibels

Q. What is meant by the term decibel*? James Larkin, Wheeling, W. Va.*

A. A decibel is not a concrete unit like a watt or a volt. It represents a ratio of two powers. The power ratio is expressed by the formula:

$$\text{Power Ratio} = \frac{\text{Output Power}}{\text{Input Power}}$$

$$= \frac{P_2}{P_1}$$

Originally, the unit used was the bel, simply defined at the time as the $\log_{10}$ of the power ratio. It was discovered that one mile of standard telephone cable had an attenuation of 0.1 bel at a frequency of 886 cps; it therefore became more convenient to think in terms of the decibel: $10 \times \log_{10}$ of the power ratio. It was because of the ease with which logarithms may be used that the *decibel* came into use as a means of discussing these power ratios; it is far simpler to add all the logarithms in a given problem and then find the antilog in a table which exists for this purpose than it would be to do all the multiplication that would be required if the power ratios themselves were used. e.g. A system has an amplifier whose power ratio is 1000 to 1; $\log_{10} 1000 = 3$; $10 \times 3 = 30$; the amplifier thus has a gain of 30 db. The line into which it feeds attenuates it from 1.0 to .01; the log of this ratio is -2; $10 \times -2 = -20$; the line thus has a loss of 20 db. Since there is a gain of 30 db and a loss of 20 db, there is a net gain of 10 db, or a power ratio of 10 to 1.

As has been previously noted, a decibel indicates a power ratio. Sometimes, however, a piece of equipment is said to have a power output of so many db. In order for such wording to be meaningful, 0 db must be assigned a specific power level, such as 1 milliwatt, and when 1 milliwatt is the reference, it is indicated by using "dbm" instead of db. Let us say, for example, that a particular amplifier has an output of 30 dbm; $30 \div 10 = 3$, the $\log_{10}$ of the power ratio; the antilog of 3 is 1000, and so the power ratio is 1000 to 1. Since 0 dbm = 1 milliwatt = .001 watt and the output of the amplifier is 1000 times this figure, it is easily seen that the power output is 1 watt. However, it should be noted that there are at least two other reference power levels, 6 milliwatts and 12.5 milliwatts; actually, any power level can be used although these are the most popular ones. It is necessary, therefore, to know to what power level 0 db refers if the power output of a piece of equipment is to be meaningfully expressed in db.

Piezoelectric Effect

Q. What is the Piezoelectric effect? Les Salvage, Jacksonville, Fla.

A. When a crystal of a material such as Rochelle salts is bent, or stressed, a voltage appears across its faces. When the bending motion ceases, the voltage disappears; when the bending motion proceeds in the opposite direction, the voltage which appears is of opposite sign. Conversely, when an a.c. voltage is applied across its faces, the crystal will be bent in accordance with the amplitude and polarity of that voltage. This is the Piezoelectric effect. Most materials will behave in this manner to some degree; however, in the case of a metal such as steel, the impedance of the substance is so low that very little voltage will be developed; it is possible, though, to observe the presence of some voltage if the proper detector is used.

Even when a crystal of Rochelle salts (the most common material used) is at

(*Continued on page 70*)

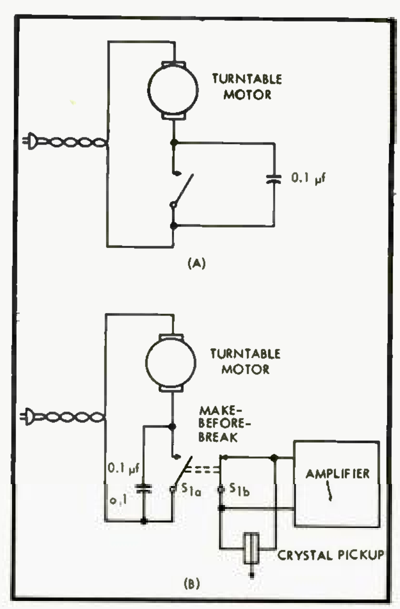

Fig. 1

Transistor Preamps

H. F. STARKE*

A discussion of practical considerations involved in the design of preamplifiers for phonograph reproduction—with their attendant low-frequency boost—and flat amplifiers for microphone applications.

Transistor preamplifiers may be classified broadly according to their various applications — in fact, it might be better to say that they *must* be so classified because (1) frequency discrimination networks are, in general, somewhat more difficult with transistors than with tubes and (2) the input resistance varies enormously with circuit configuration, operating current, and transistor alpha (α). The present account will be concerned mainly with two general types of amplifiers: those having flat responses and intended as dynamic microphone preamps or as impedance transformers, and those designed as preamps working from an inductive pickup into an otherwise flat main amplifier.

Values have been published for the new standard record curve (RIAA) to the nearest millibel.[1] A straight line between the extremes at 30 and 15,000 cps has a slope of very nearly 4 db per octave and if this line is raised a trifle it does not depart more than 1.6 db from the RIAA at any point (*Fig.* 1). Although it must be seriously doubted whether the most critical observer could distinguish between the two, the point is largely of academic interest because, as it happens, an amplifier with a slope of 4 db per octave throughout the entire band would be more difficult to design than one having RIAA response with its slight 1,000-cps flattening. This is because resistive-reactive networks are characterized by slopes of 6 db per octave—obviously too much for a nine-octave band.

In general, it is a mistake to interpose a resistive element between the transistor input and the generator for the purpose of obtaining frequency adjustment if a primary objective is that of providing the highest possible signal-to-noise ratio. The special case of a preamp designed for working from an inductive pickup, however, may be considered as a practical exception only to the extent that the designer would like to mitigate the severity of the input impedance problem at the expense of some degradation of the signal-to-noise ratio.

One form of the phono preamp is shown in *Fig.* 2 in which the following features may be recognized:

(1) No frequency networks between pickup and input.

(2) High-frequency rolloff by controlled input resistance.

(3) Low-frequency boost by means of a negative feedback loop from collector to collector. This technique is, of course, similar to the plate-to-plate loop of the vacuum-tube amplifier.

(4) Bass flattening by adjustment of the interstage blocking capacitor.

With an inductance of 0.52 Hy, the cartridge used during the development of this amplifier requires an input resistance of 6200 ohms for RIAA response when used with a vacuum-tube amplifier. This drops very little for the transistor amplifier because the d.c. resistance of the cartridge is less than 500 ohms.

If the crossover point appears to require adjustment, this can be most readily accomplished over a reasonable range by changing the operating current of the first stage. It will be noted that the base divider for this stage consists of equal values of resistance in order to keep the parallel impedance of these elements as high as possible. The adjustment of operating current should accordingly be made by changing the emitter resistor rather than the 1 to 1 ratio of the base-divider elements. If the required current change turns out to be considerable, it will be necessary to modify the load—the general objective being to maintain a collector voltage between 1.5 and 2 volts in this stage from a supply of 6 to 7 volts.

The low-frequency boosting network with a crossover of approximately 500 cps works from a source consisting of the second-stage collector load (20,000 ohms) in parallel with the output impedance of that stage, $R_c(1-\alpha)$, and works into a load made up of five impedances in parallel:

(1) First-stage output impedance.
(2) First-stage collector load.
(3) Second-stage upper base resistor.
(4) Second-stage lower base resistor.
(5) Second-stage input impedance.

* *Raytheon Manufacturing Company, Semiconductor Division, 55 Chapel St., Newton 58, Mass.*

[1] "The Proposed AES Disc Standard," (RIAA curve). *J.A.E.S.*, Jan. 1954.

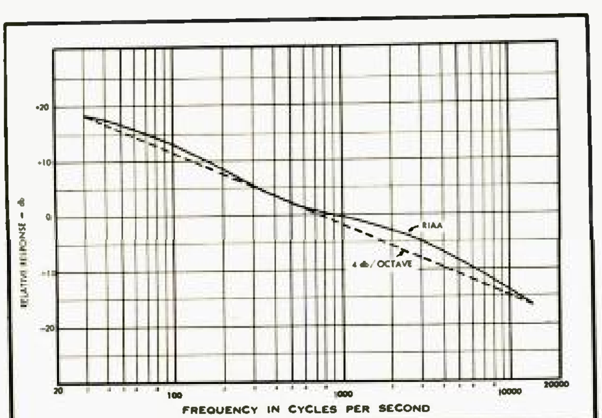

Fig. 1. RIAA playback characteristic (solid line) plotted against a straight-line response curve having a slope of 4 db per octave (dotted line).

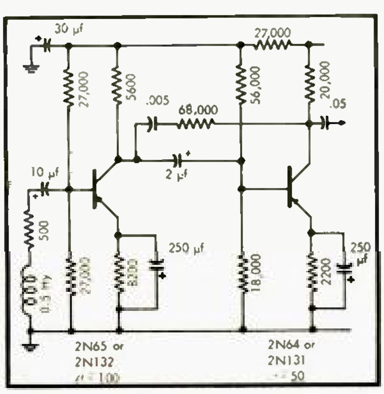

Fig. 2. Transistor phono preamp in initial stages of design.

It will therefore be recognized that this network cannot be predicted to the same exactitude that will be found in vacuum-tube circuits unless at least the alphas of the two transistors are known and their values of R_c and R_b are not too far from average for the operating current. Also, if a substantial change is made in the first-stage operating current for the purpose of correcting high-frequency rolloff, the corresponding change in first-stage output impedance will have some effect upon the low-frequency-boost network although the converse effect is much less. Both input and output impedances vary inversely with current, of course, and when the first-stage current is reduced the slopes of both high and low networks are increased. For a given change, however, the effect is more pronounced for the *LR* network because *R* in this case is a single impedance (the input impedance of the first stage) while in the other case the first-stage output impedance is only one of several impedances in parallel.

Accordingly, if the first frequency run on the completed amplifier deviates from the standard by more than an acceptable amount in one or two places, the preferred order of adjustment would be:

(1) High-frequency rolloff.
(2) Low-frequency boost.
(3) Bass flattening.

The standard calls for a 3 db flattening at 50 cps and most of this is obtained from the rather low value of interstage coupling—the remainder being due to the emitter bypasses (250 µf) which have enough impedance at this frequency to drop the gain 0.6 or 0.7 db. More or less flattening is readily obtained by altering the value of the coupling capacitor with little effect upon the rest of the curve.

Practical Considerations

Since a two-stage amplifier with phase reversals in each stage has a final output in phase with the amplifier input, the input base divider should be decoupled. The filter serves the further purpose of dropping the supply voltage to the first stage and—as used here—leaves only the second-stage collector supply at the higher voltage. An earlier version of this form of preamp used 6 volts to both stages and resulted in a design which gave adequate performance in gain, noise level, and frequency response, but which was deficient in the matter of maximum undistorted output voltage. This has been corrected in the present amplifier by raising the second-stage supply and holding the emitter resistor to a reasonable value.

It will be recognized that no particular importance attaches to the value of 22½ volts other than the fact that some may elect to use a battery in view of the low current demand and this is a value that provides 5 or 6 volts of output. On the other hand, if the supply is obtained from a 250- or 300-volt plate supply in the main (vacuum-tube) amplifier by means of a divider, there is no particular reason for setting the tap higher than 30 volts. The bleeder current in this divider should be at least four or five times the total current taken by the transistor preamp so that the voltage at the tap will not rise unduly if the preamp is switched off separately.

The 1000-cps voltage gain of this amplifier is approximately 52 db and if this is somewhat in excess of what is required, the first stage collector load may be tapped down without much effect upon over-all frequency response provided the low boost network is left at the collector.

In terms of comparative physical size, the 250 µf emitter bypasses stand out as the largest components physically, on the list. If an amplifier of this type is to be built into the pickup arm, it accordingly becomes desirable—because of both size and weight—to eliminate these capacitors. This leads to the form of preamp shown in *Fig.* 3 which uses the type of regulation circuit in which the base divider feeds from the collector instead of from the battery. Compared to the first circuit, this form has somewhat less regulation and (because of the negative feedback from collector to base) lower stage gain. The feedback also has the effect of reducing both the input and the output impedance of each stage apart from the rather low value of the resistor from base to ground. This latter can be increased only at the expense of achieving a poorer regulation factor.

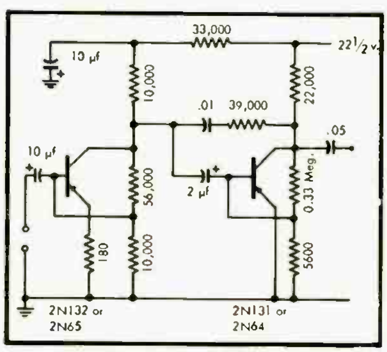

Fig. 3. Amplifier of Fig. 2 is modified to avoid use of large emitter bypass capacitors.

The over-all combination proved to have an input impedance somewhat too low for the inductive pickup with a first-stage transistor having a current gain of 50. As an alternative to increasing the impedance by reducing the operating current—a procedure discussed in connection with *Fig.* 2—a small resistor was placed in the first-stage emitter. Although either scheme appears to be workable and would probably result in approximately the same reduction in gain (other things being equal) it should be noted that the slight reduction in battery current must be balanced against maintaining or slightly improving the regulation factor.

The gain of 40 db at 1000 cps—although 12 db lower than the gain of the previous amplifier—is still adequate for the purpose. Since the second-stage collector supply is the same, the maximum output is also the same: 15 or 16 dbv. The impedance of the low-frequency-boost network is not much more than one-half that of the corresponding network of *Fig.* 2 because it works between the lower impedances resulting from the negative feedback. The 2-µf capacitor for bass flattening has sufficient effect with no augmentation from emitter bypasses—again because of lower impedance.

Adding Other Curves

For the benefit of those who would like to provide, by means of switching in other networks, a choice of frequency responses, the following practical difference between transistor and vacuum tube circuits may be noted:

Although, in general, a reactive impedance must equal the sum of the resistive impedances on either side at the crossover frequency, it is common practice in vacuum tube circuitry to disregard the source impedance (usually a plate load shunted by the plate resistance) and consider only the much higher following impedance—i.e., a grid leak shunted by the grid impedance. In direct contrast, the transistor circuit—because of the choice of circuit configuration or the use of feedback—may show a preceding impedance higher than, the same as, or lower than the following impedance and both must be taken into account.

At 15,000 cps, audio-frequency transistors will show some loss of gain due to frequency cutoff of alpha. On a flat amplifier, such as will be described in connection with dynamic microphone preamps, this can result in a response that is down 3 or 4 db at 15 or 20 kc in two stages. On the RIAA type of response, the effect may be noticeable as a convexity (facing up) of the portion of the curve between 2,000 and 15,000 cps. In brief, if the response is down by the correct amount at 15,000 cps, it will be 3 or 4 db too high at one octave lower or, conversely, if it is down by the correct amount at 7 or 8 kc, it will be 3 or 4 db too low at 15,000 cps. To determine how much alpha cutoff correction is required, it is of course in-

formative to run the curve to 20,000 cps despite the fact that the standard stops at 15,000 because—unlike the other end of the band where the 6 db/octave response due to low-frequency boost is severely modified by bass flattening—the slope of the high-frequency end of the RIAA curve is rather well defined.

The simple, low-impedance network to accomplish this correction will be discussed in connection with the flat-response amplifiers. For the present, it may be noted that the circuit of *Fig.* 3 will require less alpha cutoff correction than that of *Fig.* 2 because, as might be expected, the presence of negative feedback independent of frequency reduces the drop.

Frequency responses for these amplifiers have not been included for the simple reason that the conformity of an amplifier of this type to RIAA—or to any of the older curves for that matter—is largely either a question of patience for the individual experimenter or of tolerances to the commercial designer. It seems safe to say that the desired gain (32 to 35 db minimum) and frequency response can be obtained with transistors having common-emitter current gains of at least 30 or 35 although the preferred range would appear to be between 70 and 100. The choice between the two circuits is a matter of deciding whether or not the large emitter bypasses are too much to pay for the extra stability. In this connection it may be worth noting that the quantity S (stability factor) as now used is not particularly informative. In the first place, since a larger number denotes a more unstable circuit, the correct term would appear to be "instability factor." Of more importance, however, is the fact that, with transistors having current gains of 15 to 150 available for various purposes, the S-factor alone does not give a clear indication of circuit stability in terms of the improvement effected over the use of a unit having the same current gain in an unregulated circuit. For example, transistor A with a current gain of 100 is used in a circuit giving an S-factor of 20—an improvement ratio, obviously, of 5-1. Transistor B with a current gain of 30 is used in another circuit having constants resulting in an S-factor of 10 or an improvement of 3 to 1. But because the latter is a lower S-value, the erroneous conclusion can be made that B is the better circuit. Since the factor is intended to describe the stability of the circuit and not the stability of the transistor, it would be more informative to quote the ratio illustrated above and call it "regulation factor." In this notation unity describes, of course, an unregulated circuit and the higher numbers are the more stable circuits.

The two phono preamp circuits show values as follows: (B is the common-emitter current gain)

Figure	Stage	B	S	B/S
2	1	100	2.9	34.5
2	2	70	7.3	9.6
3	1	50	2.6	19.2
3	2	50	14.2	3.5

This matter of regulation and designing circuits for a reasonable temperature range cannot be dismissed lightly. Too many designs have appeared in the recent past showing unregulated circuits although their designers must be aware of the fact—since no one has tried to keep it secret—that transistors are temperature responsive. In the present instance, a rise of 10 or 15 degrees Centigrade would produce, on an unregulated phono preamp, a frequency response only distantly related to RIAA or any of its forebears. With rising temperature (and rising collector current) transistor impedances will drop and if the degradation of frequency response is too great to accept, the designer must improve regulation to the point where the deviations are tolerable for the temperature range over which the equipment is intended to be usable.

Flat Preamplifier

Preamps to be used with dynamic microphones and having flat responses must generally be designed for a specific application with due regard to microphone impedance, line impedance, phyical size and the input characteristics of the main amplifier. In the situation most prevalent at present, the latter will be a vacuum-tube amplifier with either a high-impedance (direct to grid) input or a line-to-grid transformer. To obtain the advantages of operating the line at a higher power level (i.e. higher than the level of the unaided microphone) and with a fairly wide choice as to impedance, it is necessary to build the transistor preamp either into the microphone case or in a small cylindrical housing which can be interposed between the cable plug and the microphone receptacle. This is practically the same, it will be noted, as saying that the transistor preamp may be regarded as an impedance transforming device which could conceivably replace the transformer now used for this purpose—the important difference being that gain may be obtained along with the transformation at little or no cost as far as signal-to-noise ratio is concerned.

For these purposes, the actual gain obtained in the input stage should be considered as secondary to obtaining the required impedance because it is always possible to add a second stage without an excessive increase to the size, weight and battery drain of the preamplifier. For example, a 50-ohm microphone will require a common base stage and if this must work into a low-impedance line (say 250 or 300 ohms) because of frequency and line capacitance considerations the stage gain will be less than 10 db since the gain of the common base connection is derived from the ratio of the load to the source.

It is a mistake to suppose that a "cathode follower" (i.e. grounded collector) type of input stage can be used for these applications as a sort of universal input device capable of working from a few tens of ohms to a few tens of kilohms with the real gain derived from the following stages. Those who think along these lines exhibit only a slavish adherence to vacuum-tube circuitry in the face of the demonstrable fact that low (and approximately equal) noise factors are possible for all three common-electrode arrangements only when impedances are matched or at least approximately so. They would like, in short, to enjoy the enormous advantages of transistors without paying the necessary (and not unreasonable) price of learning to think of the transistor as a power device.

Impedance Adjustment

Fortunately for present purposes, it is possible—as already intimated—to cover a very wide range of input impedances by the selection of transistor alpha, circuit arrangement, and operating current. The selection, furthermore, may be made to show some overlap in the transition from one circuit to another although the region of the overlap will usually favor, for one reason or another, the common emitter. A few illustrative examples may serve to clarify this point, for the benefit of those who have not hitherto given much thought to this problem.

Let us assume that the designer, in addition to the choice of circuit, has available the following:

(1) Maximum operating current: 2 ma.
(2) Minimum operating current: 50 μa.
(3) Maximum transistor beta: 90 (types 2N65 and 2N132).
(4) Minimum transistor beta: 22 (types 2N63 and 2N130).

It will be understood that these maximum and minimum beta values are not absolute but merely representative of the types indicated. Also, the beta at 50 μa will be typically about 50 per cent of the 1-ma value and the following estimates are based upon this reduction.

The minimum possible input resistance (grounded base, short-circuit load) is:

$$R_i = R_e + R_b(1-\alpha) = R_e + R_b\,\frac{1}{1+\beta}$$

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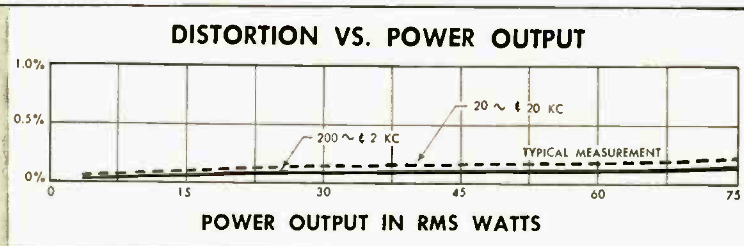

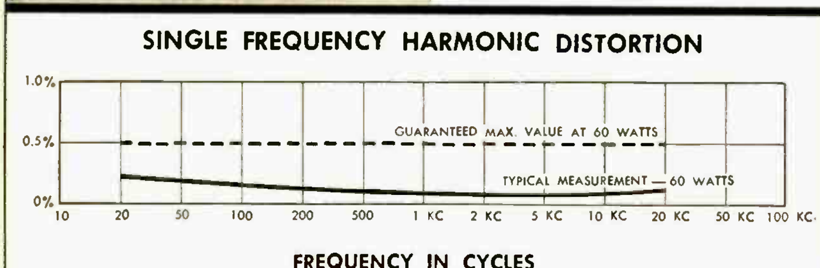

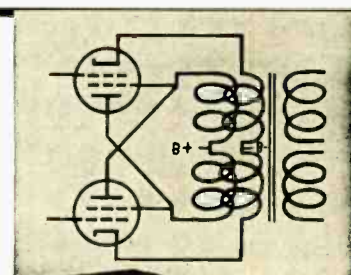

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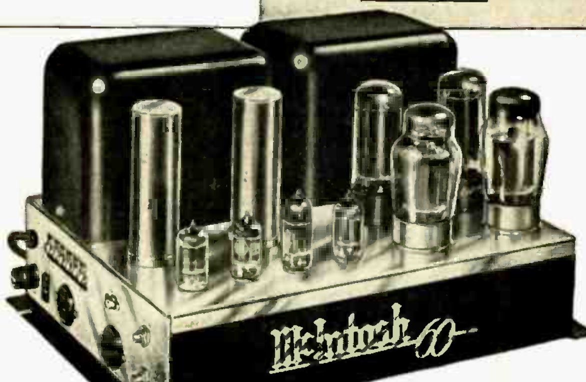

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At 2 ma:

$R_i = 12 + 400\ (.011) = 16$ ohms

For maximum with grounded base (current 50 μa, beta 11):

$R_i = 500 + 1200\ (.083) = 600$ ohms

The input resistance of the grounded emitter is:

$R_i = R_b + R_e(\beta)\ (1+\beta)$

For the minimum, the current is 2 ma and the beta 22:

$R_i = 400 + 12\ (23) = 676$ ohms

For the maximum ($I_e = 50\ \mu a$; $\beta = 45$):

$R_i = 5000 + 500\ (46) = 28{,}000$ ohms

The final values have been rounded because the R_b quoted for each case is simply the most probable value and the actual R_b may differ since this parameter, for a large number of units, has its own distribution.

The important parameters, then, for the control of input resistance are alpha (or beta) and base resistance. For either the equipment designer who must be prepared to accept a reasonable parameter dispersion or the experimenter who must perforce take his chances as to the exact values of the few units he is willing to purchase, the common emitter circuit would appear to be preferable because:

(1) The minimum R_i for a given beta and emitter current (as, for example, the 676 ohms quoted above) can be still further reduced by the use of collector-to-base feedback.

(2) This type of feedback will reduce the range of input resistance caused by a given range of transistor current gain and base resistance.

(3) Negative feedback is extremely difficult to apply to the grounded-base circuit because of its characteristically low input resistance and the severe losses in gain—lower than the grounded emitter to begin with—caused by the shunting of the load. It will be understood that we are speaking not of the case where the designer considers it no particular hardship to use 22½- and 45-volt B batteries, but of the more practical case where the desired results are obtained with a minimum of supply power.

Variation of Operating Parameters

In elaboration of the foregoing, a digression at this point may be permissible. While it is true that the phono preamp already described uses a 22-volt supply (for the output stage only) it must be recognized that this was done for one specific purpose: that of providing approximately the same maximum output voltage as may be obtained from the vacuum-tube preamp without resorting to the use of an output transformer. As far as its performance otherwise is concerned, the transistor preamp can be built with a 4-cell, 3-cell, or possibly even a 2-cell battery.

The higher voltage, as already noted, is of course available from the power supply of the main amplifier. This is also true of many other transistorized units intended to be used with vacuum-tube equipment already on hand. We are in a period of what might be called "hybridization" in which the transistor is relegated to the role of performing only those functions where it is demonstrably preferable, for one reason or another, to the vacuum tube. In many of these cases design problems would actually be simplified if the entire equipment were transistorized. Since it appears likely that some equipments now line operated will take the form of battery portables by the full exploitation of transistor capabilities, it may be recommended that designer and experimenter alike begin to channel their thinking away from 45-volt B batteries and toward low-voltage operation.

The phrase "without resorting to the use of an output transformer" which appears above has a similar explanation. High-quality transformers, in addition

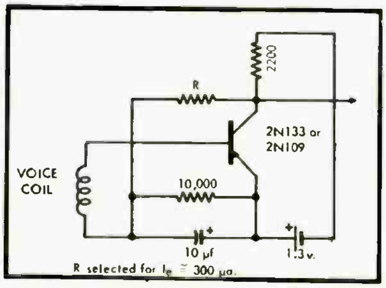


Fig. 4. Simple form of one-stage amplifier for use with dynamic microphone.

to being rather costly, are usually much larger and heavier than the rest of the components put together, including the transistors. Consequently, if the end result can be achieved without using transformers, it seems probable in the long range viewpoint that their use will decline in miniaturized applications. In fact, it may be recalled that part of the present discussion will be devoted to an examination of the feasibility of using transistors as impedance transforming devices.

To return to the main subject: Of relatively less importance is the fact that the upper limit on R_i for the common-emitter circuit can also be extended by the use of external emitter resistance feedback because these higher impedances (above 25,000 ohms) are also available with the common-collector circuit at normal operating currents and also because the emitter type of feedback gives virtually no improvement in restricting the range of input resistance. The grounded-collector input resistance is extremely sensitive to output loading and values ranging from something like 10,000 ohms to several hundred thousand ohms may be obtained with loads not in excess of 20,000 or 30,000 ohms.

"Flat" Amplifier Circuits

For the flat amplifiers we will describe first a unit intended to work from a high-quality dynamic microphone into a tape recorder. Many low- and medium-priced recorders are designed to operate from crystal microphones and consequently are not equipped with line input transformers. If the owner of such a recorder wishes to use a microphone of better quality and also to be able, on occasion, to place the microphone at some distance from the recorder (very difficult with the high-impedance crystal microphone because of line capacitance) he will find a satisfactory solution to his problem in a transistor preamp at the microphone.

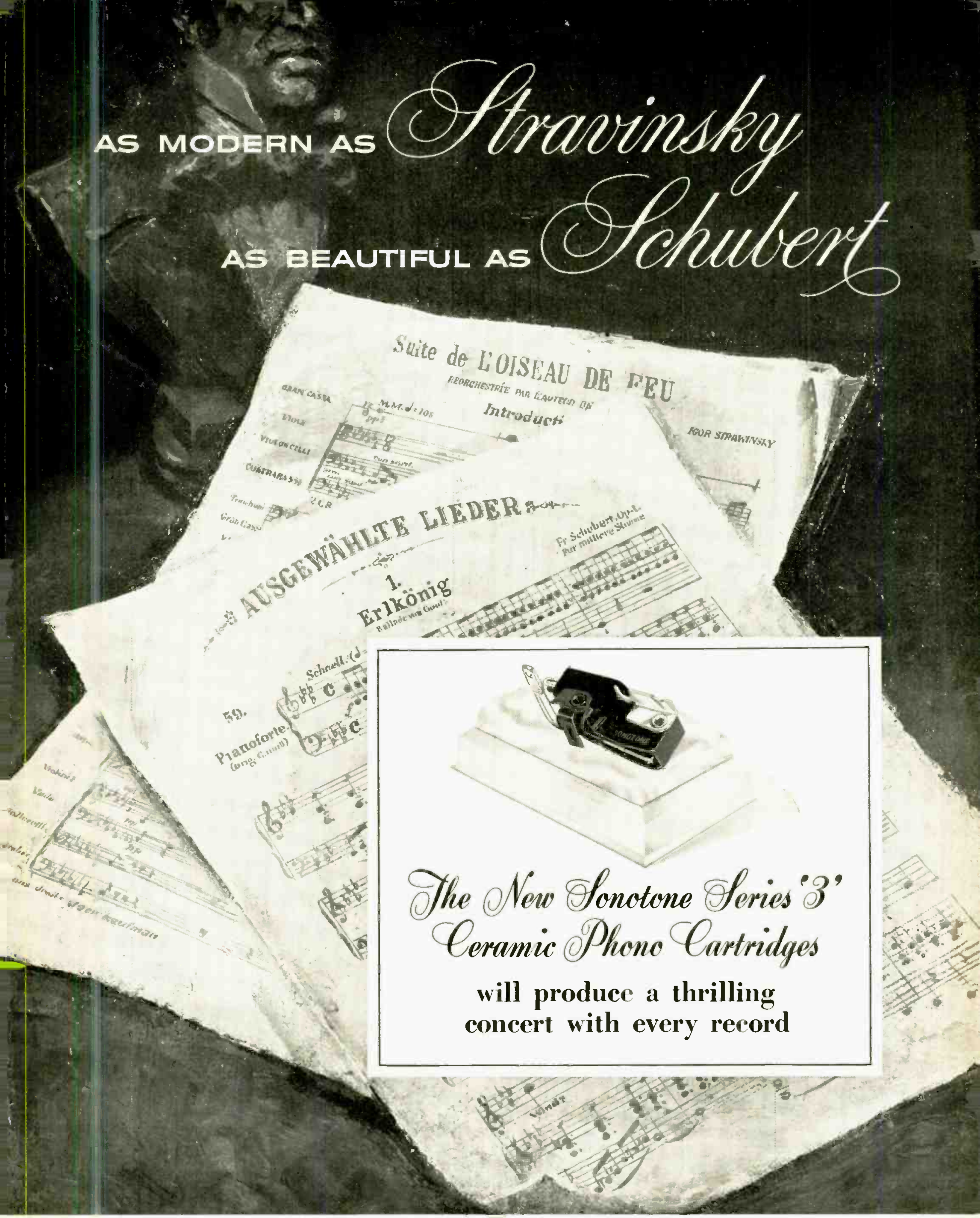
Let us assume the following factors:

Microphone impedance: 500 ohms.
Microphone power: 95 db below 1 watt/microbar.
Microphone response: down 3 db at 50 and 12,000 cps.
Amplifier input: direct to grid.
Microphone cable: 50 ft of single conductor at 70 μμf/ft.
Battery: one or two cells.

Figure 4 is typical of the simplest sort of one-stage amplifier that might be seriously considered for the purpose. With the omission of the output blocking capacitor (since this would be included with the tube-amplifier input) the circuit shows three resistors, one capacitor, one transistor, and one cell. The combination of load and collector current leaves 0.6 to 0.85 volts at the collector according to whether a mercury or a carbon cell is used. By connecting the base divider to the voice-coil return instead of directly to the base, the feedback normal to this type of regulation is made practically zero and the power gain of the stage is approximately 17 db. This does not sound very impressive (unless viewed in relation to the paucity of components) but it may be instructive to take a close look at just what we have before leaving it.

The power from the microphone, at 500 ohms, is given as −95 dbw per microbar. This is 3×10^{-10} watts for a sound pressure level of 74 db. The same microphone with a built-in transformer to raise the impedance to 25,000 ohms will deliver 5.5 millivolts to an open grid for the same pressure. The cable in this case, it should be noted, must have a capacitance no greater than approximately 525 μμf for response to 12,000 cps.

The original microphone power (3×10^{-10} watts) plus 17 db (the preamp gain) is 1.5×10^{-8} watts which is 5.75 millivolts in 2200 ohms. The maximum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tolerable capacitance across the latter is nearly 6000 μμf. The net practical comparison, then, is that we have the same voltage at the grid with this extremely simple preamp, working from the 500-ohm mike over a line more than 12 times as long, as we would have from the high-impedance mike.

With a transistor alpha of 0.975, the input resistance of this stage in the absence of feedback is approximately 3500 ohms and a mismatch of this order may yield a noise factor 1 or 2 db higher than the minimum value possible for a given transistor. To the perfectionist this may sound a trifle alarming but this particular microphone has an inherent signal-to-noise ratio of 68 db in a 74 db sound field and it is consequently of little practical importance in this particular case whether the noise factor of the transistor is 4 db or 7.

To a microphone which is down 3 db at 12,000 cps, it matters little whether or not the transistor is down 1.5 or 2 db at 20,000 cps because of frequency cutoff of alpha. There is accordingly no need for a compensating network and this is true, in general, for most preamps for dynamic microphones although this factor deserves more attention if for some special purpose considerable gain with several stages is built into the preamp.

For the second case involving a microphone preamp, let us assume that the owner of the tape recorder has a low impedance mike of 50 ohms and finds that when he tries to use it the recorder gain must be forced to the point where the quality of the resulting recordings is very dubious because of hum and microphonics—the latter being due to the tape reel motor. A similar situation can be encountered (although somewhat less annoying) if the mike is of medium (250 ohms) impedance.

We will therefore assume:

- Microphone impedance: 50 ohms.
- Microphone power: −79.4 dbm/microbar.[2]
- Microphone response: 50 to 10,000 cps.[2]
- Amplifier input: direct to grid.
- Preamp supply: one cell.
- Microphone cable: two-conductor.

Although the length and capacitance of the cable are relatively unimportant because of the very low impedance, the two-conductor cable is usually supplied to balance out hum pickup. This in turn calls for a balanced input at the amplifier and if the necessary input transformer has not been provided the only makeshift solution is to operate with an unbalanced line and reduced cable length. This difficulty disappears with the transistor preamp because the hum picked up by an unbalanced line of almost any reasonable length will be, in effect, down by an amount equal to the preamp gain.

The input impedance of 50 ohms indicates a common-base input stage with a transistor having rather high current gain (100) so that the $R_b(1-\alpha)$ portion of the input resistance may be held to 10 or 15 ohms thereby allowing an emitter resistance of 35 or 40 ohms for a current of 600 or 700 μa. *Figure* 5 shows a two-stage amplifier with a power gain of approximately 28 db and an output impedance of 2200 ohms. The corresponding output voltage for an input power of 1.15×10^{-11} watts (−79.4 dbm) is 4 millivolts or −48 dbv. This compares to −60.5 dbv (open circuit) for the same type of microphone at 35,000 ohms.

For any microphone supplied with a two-conductor cable the preamp designer is under no particular compulsion to package the cells with the preamp because the change to the unbalanced line makes the second conductor available for supplying power. Alternatively, if the designer elects to change to a single-conductor cable with the battery in or near the preamp, the switch usually supplied for grounding a single-impedance mike can be made to serve as an ON/OFF switch for the battery. If the preamp is built into a cylindrical housing plugged into the mike receptacle, the size of such a package will of course be considerably smaller than that of the housing now commonly used for the cable transformer. The diameter, in fact, need be no longer than whatever is necessary to accomodate the connectors; with a length of two or three inches according to the number and type of cells and the mechanical arrangements for their replacement.

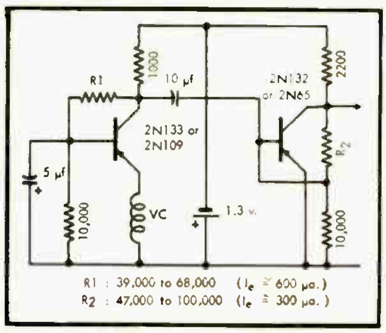

Fig. 5. Two-stage microphone amplifier with a power gain of 28 db and the comparatively low output impedance of 2200 ohms.

For the benefit of those who are unduly impressed by statements which still appear on some rating sheets for junction transistors to the effect that:

(1) The transistor should not be inserted into the socket with the power on or (2) Switching transients should be avoided; (3) Capacitor discharge surges should be avoided; (4) The socket should be designed so that, upon insertion of the transistor, the collector makes contact last—it may be noted that statements of this kind represent little more than survivals from similar statements appearing on ratings for contact types. With currently available junction types having avalanche voltages usually well in excess of 50 volts, switching tests conducted at voltages well below this value must be run into the hundreds of thousands before significant changes in major parameters may be ascribed to switching alone.

To return to *Fig.* 5: the capacitor from base to ground of the input stage may be described somewhat beyond the mere statement of its value. At first sight, it might be supposed that this value should be several hundred microfarads to avoid attenuation of low-frequency response in view of the 50-ohm input. Since such a capacitor would be by far the largest component in the preamp, it is fortunate for purposes of miniaturization that such is not the case. Although called, by precedent, a "bypass" condenser (since it bypasses the lower bias resistor) it shows up in an equivalent circuit as an impedance in series with R_b and, as such, in the common base circuit its impedance is reduced by the same factor $(1-\alpha)$ as R_b. Consequently, the effectiveness of this capacitor in relation to low-frequency cutoff is increased as if its value were multiplied by $1/(1-\alpha)$ or $(\beta+1)$.

For the marginal case where only a small amount of gain is required, the first stage alone will give a power gain of approximately 11 or 11.5 db with a corresponding voltage gain (50 ohms to 1000 ohms) of 18 or 18.5 db. With a sound pressure level of 74 db at the microphone, the preamp output in this case is −78 dbv. This gain for this stage is, of course because common-base gain must be obtained from $R_l/4R_g$ and the load has been reduced to 1000 ohms to provide the 50-ohm input with one cell. The addition of the second stage as shown results in an over-all power gain of approximately 28 db—the output voltage varying according to the value chosen for the collector load and line impedance.

Design of Microphone Preamp

Let us now assume that the microphone on hand is of the "high impedance" class. As used with dynamic microphones, this can mean anything from 20,000 to 40,000 ohms, although the value most often encountered is 25,000. We will therefore assume:

[2] Manufacturer's data on Model 556S (Shure Bros.) Cardioid.

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Microphone impedance: 25,000 ohms.
Microphone voltage (open circuit): – 60 dbv.
Microphone power (into 25,000 ohms): 10^{-11} watts/microbar.
Frequency response: 50 to 10,000 cps.
Amplifier input: direct to grid.
Microphone cable: single-conductor.

Figure 6 is representative of an amplifier adjusted to an input impedance of 25,000 ohms. Because the resistance in this case depends predominantly upon the product of β and R_e, it is necessary to obtain the major portion (say, 20,000 ohms) by operating at a rather low emitter current. Alternatively (or supplementarily) the product can be raised to the required level by increasing R_e with an external resistor. However, whether the 25,000 ohms is obtained by reducing the operating current, by increasing the external emitter resistance or by a combination of the two, the gain will be about the same for a given beta in the first stage. The actual gain realized is not of overwhelming importance because another stage will be required in any case because with a high source impedance and a low load impedance the voltage gain will be considerably less than the power gain.

For most general-purpose a.f. transistors, maximum beta occurs at an emitter current of 1.0 or 1.5 milliamperes and, although the peak is very broad on a linear current scale, the value will be down about 35 per cent at 100 μa and 50 per cent at 50 μa. As in the case of the phono preamp, in lieu of measuring R_e, R_b and β at several operating currents and computing the resulting impedance, a simpler and more direct method is the familiar one of supplying a known current signal through a resistor much larger than the expected R_i and measuring the ensuing voltage at the input. Since a 2 to 1 mismatch loses only 0.51 db in power gain and the noise factor will not worsen appreciably until the mismatch becomes gross, any value between 15,000 and 40,000 should be acceptable.

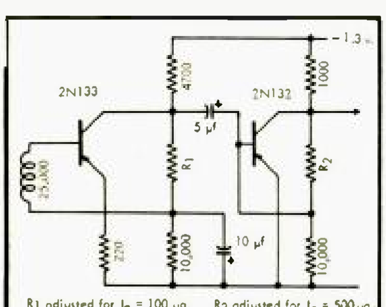

Fig. 6. Transistor microphone amplifier with an input impedance of 25,000 ohms.

With a type 2N133 having a current gain of 50 to 100 μa in the first stage and a 2N132 showing a gain of 70 at 500 μa in the second stage, the power gain is approximately 40 db, assuming average base resistance. The voltage gain (25,000 ohms to 1000 ohms) which is of greater immediate interest if the output must work into a transformerless tube input is less according to:

$$VG(\text{db}) = PG(\text{db}) + 10 \log R_L/4R_g = 26 \text{ db}$$

If some other output impedance is selected to meet some particular requirement, the second-stage current should be readjusted if possible to drop about 0.5 volts across the collector resistor. Similarly, if the first-stage current must be changed from the indicated value to meet the input impedance requirement, the collector resistor of that stage should be changed. The object in both cases is to obtain the highest possible regulation factor from the single cell without operating at a collector voltage too close to the knee of the collector characteristic.

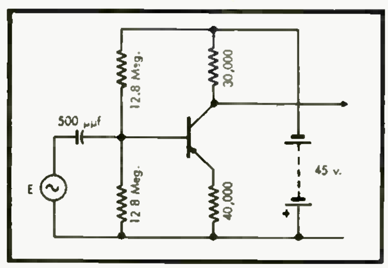

Fig. 7. Common-emitter input stage with a very high input impedance.

High-Impedance Sources

Most difficult of all is the situation where the amplifier is required to work from a high-impedance capacitive source. A good example of a particularly difficult case is that of the Western Electric 640-AA condenser microphone. This unit, with a capacitance of 50 μμf, is commonly worked into a cathode follower of at least 200 megohms for sound-pressure measurements of 20 cps with little or no correction and if used for ordinary a.f. purposes to – 3 db at 80 cps must still see 40 megohms. Since these impedances are not available with germanium transistors, we may at least examine briefly the much more common case of the 500 μμf pickup or microphone.

The common-base connection is, of course, completely useless and for either the common collector or the degenerated common emitter a major cause of the difficulty is the fact that the bass potential must be fixed by the divider which cannot be placed in the low side of the source as in some of the circuits

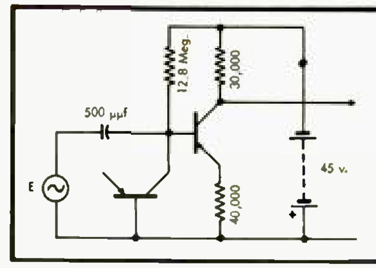

Fig. 8. Circuit of Fig. 7 modified by use of diode as lower base resistor to provide temperature compensation.

already discussed because there is no d.c. current path. In the equivalent circuit, the divider elements are in parallel with each other as well as in parallel with the input.

Although in this instance the use of an input transformer appears to be the obvious and low-cost solution, there still remains the problem of primary resonance and the necessary correction of the frequency response in subsequent stages of the amplifier. Here again the transformer may be rather large if the resonant point is made at least an octave below the lowest frequency of interest.

There appear to be only two possibilities of obtaining the required impedance (3.2 megohms for – 3 db at 100 cps) without the use of a transformer. Neither is particularly encouraging—they are included in this account only to illustrate the difficulties involved.

Figure 7 is a common-emitter input stage with a rather large emitter resistor and a 45-volt supply. The input impedance of the transistor is approximately βR_e or 6.4 megohms for $\beta = 160$ and the same impedance would be available with a common collector by taking the output from the emitter and bypassing the collector resistor. There is a practical difference in favor of the common emitter, however, because here the collector load may operate into almost any reasonable value for the following-stage input while the common collector must work into something considerably greater than 40,000 ohms to avoid excessive shunting of the emitter resistor upon which the input impedance depends.

The latter is now 3.2 megohms but the cost is almost prohibitive. The beta of 160 (at approximately 55 μa) would certainly represent some selection but even more serious is the very poor regulation factor under conditions of collector voltage and current such that a very good regulation factor is strongly indicated. The entire circuit, in fact, is scarcely better than if we had used a betta of 80 in the first place and had omitted the base divider entirely.

Figure 8 is similar except that the lower base resistor has been replaced by

(*Continued on page 71*)

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Continued on next page

HIGH FIDELITY

has come of age...

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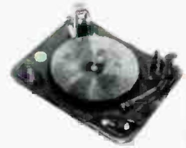

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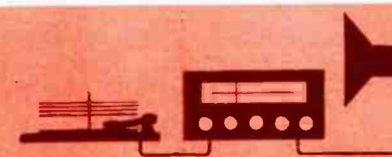
Selecting AUDIO COMPONENTS *for High Fidelity Music Systems*



A chain is no stronger than its weakest link . . . a fleet is no faster than its slowest ship . . . and a hi-fi system no more capable of perfect reproduction than its least perfect component. Any and every audio component adds *some* distortion to the signal it reproduces—the best units in just barely measurable and scarcely audible quantities, the more modest units in sufficient amounts to be audible, though still quite acceptable, to sensitive ears. A nearly distortionless component would be wasted on a system having other components that produce considerably more distortion. For example, it would make very little sense to use an amplifier costing over $300 to drive a nice little $20 eight-inch speaker. The resulting sound would be nearly indistinguishable from that of a good $60 or $75 amplifier in conjunction with the same eight-inch speaker—which can be very agreeable sound indeed.

There is very definitely a hi-fi system for every ear and budget, but it must be properly *matched*—and that's where HARVEY's audio comparator panels and audio consultants come in. It is, of course, desirable—though by no means absolutely essential—to have some idea of the process of selecting suitable audio components even before coming to HARVEY's AUDIOtorium. Hence the following brief pointers.

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For the innumerable people who insist on the convenience of an automatic record changer, there are now a number of de luxe models of very high performance. The more expensive of the new Garrard changers and the Miracord XA-100 fall into

Continued

Selecting AUDIO COMPONENTS

this category. Both of these manufacturers also make a manual record player. The final choice depends on the purchaser's type of record collection, technical demands and budget. Wow, flutter and rumble should be carefully checked for in any event—they can be quickly spotted in listening tests. Wow affects the pitch, and flutter the tone quality of reproduced music; rumble blankets the lowest notes at high volume levels. All three should be conspicuous by their absence in top-quality units.

The other all-important component to come in contact with the record is the pickup cartridge. Its function is to translate the zig-zag of the record groove into an electrical signal corresponding to the recorded sound. To do this without altering the quality and balance of the sound is one of the most difficult jobs in audio, and as a result there are greater audible differences among cartridges of different manufacturers than among all other hi-fi components, with the single exception of loudspeakers. A good high-fidelity pickup should respond with equal sensitivity to any part of the audible range of frequencies—in other words, it should have "smooth" frequency response. Its stylus should have as much side-to-side "give" (compliance) as possible, so that it can closely follow sudden sharp turns in the record groove. These characteristics show up in listening tests—smooth frequency response results in a natural overall sound quality, without exaggerated highs, lows or middles; high compliance makes for realistic reproduction of "transients," the sudden, sharp, fleeting sounds that begin a drum tap, cymbal crash or string pizzicato.

The finest pickup cartridges on the market today are with very few exceptions of the magnetic type—in each the motion of the stylus is converted by the cartridge into an electrical signal by means of a magnetic generator system. Most of the top cartridges—such as the Audax, the new Miratwin and the Pickering 'Fluxvalve'—utilize a magnetic design of the so-called variable reluctance type; a few other outstanding cartridges—such as the Electro-Sonic series—are of the moving-coil type. All of these cartridges have high compliance and function best in conjunction with a high-quality, manually operated transcription pickup arm. The Audax and the Miratwin may also be used in well-designed record changers; the Pickering 'Fluxvalve' and the Electro-Sonic 'Concert' and 'Professional' are generally used only in transcription arms—the last-named only in the special arm it is sold with. The Audax may also be had with its own special arm.

In choosing a pickup the thing to listen for is, above all, *natural* sound—the type of sound you would hear at a live concert. Your HARVEY audio

continued

consultant is in the best position to advise you as to the best pickup selection for a completely balanced system.

True high-fidelity record reproduction also depends to a significant degree on the condition of the record. The grooves must be clean and free of deformation due to wear or careless handling. Record cleaning and preserving accessories, such as those made by Walco, are therefore very useful items to have on hand.

The Radio Tuner Section

Radio broadcasts are another important source of high-fidelity listening fare. FM programs have inherently greater fidelity than AM broadcasts, in addition to freedom from "static" and other interferences characteristic of AM. In urban areas, most of the major AM stations duplicate their programs on FM, so that it is not always necessary to incorporate both AM and FM reception in hi-fi systems. Where there are no FM stations, high-fidelity AM reception can come close to FM quality if the best equipment is used.

It is the function of the high-fidelity tuner to take a radio signal out of the air and convert it to an audio signal of the same type as the output signal of pickups, which can then be fed into the next component in the "chain" that makes up the hi-fi system. The finest FM tuners have lower distortion, lower background noise content and wider audio frequency response than the more modest units, but perhaps the principal difference among FM tuners is in sensitivity, which is the ability to respond with full fidelity to weak radio signals. Those who live at a distance from FM transmitters, or else in the few weak-signal areas near transmitters, should invest in a highly sensitive FM tuner. AM tuners exhibit similar differences—the best have somewhat better frequency response, lower distortion and more sensitivity than the next-best.

For those with Rolls Royce tastes, there is an FM-only tuner which is entirely in a class by itself—the REL 'Precedent.' It is the most uncompromisingly designed, most sensitive, most distortion-free and by far the most expensive FM tuner available. In an altogether different price category but retaining many de luxe features is the new Fisher FM-40, an FM-only tuner with sufficient sensitivity and fidelity for very high-quality hi-fi systems. In still another category is the Pilot AF-860, a combined AM-FM tuner of excellent sensitivity and fidelity, which incorporates on the same chassis a very good preamplifier.

The Amplifier System

This brings us to another vital link in the high-fidelity system — the amplifier. It is the one component connected to all other components in the system. Its basic function is to

continued

Selecting AUDIO COMPONENTS

take the relatively low-level signals produced by other components like the pickup or the tuner and raise these signals to a sufficiently high power level to "drive" the loudspeaker. It must do this without distorting the signal in any way whatsoever. This is a reasonably simple and straightforward function, which can be accomplished to near-perfection by present-day electronics. Nearly all of the high-fidelity amplifiers made available within the last three years are therefore remarkably good, but there are still important differences as regards power output, flexibility and other factors.

All hi-fi amplifiers consist of two sections—the preamplifier section and the power amplifier section. These are built on two separate chassis in the more elaborate amplifiers and on the same chassis in more compact designs. The preamplifier's function is to apply certain corrections to the signal while giving it its first "boost"—the corrections being necessary not only to adjust bass and treble response to suit the listener's ears and room acoustics but also to "equalize" the "recording characteristic." The latter is an unavoidable but controlled "twist" in the bass-treble balance of recorded music, which must be "untwisted" in the playback. The degree of flexibility and versatility with which a preamplifier can apply these corrections will determine its size, complexity and price—and it is here that one of the greatest differences among amplifiers will be found. As far as the power amplifier section is concerned, its sole function is to step up the power of the signal passed on by the preamplifier. The maximum undistorted power available from today's amplifiers may be anywhere from 10 watts to 60 watts or more. The advantage of a high-powered amplifier over a low-powered one is not so much a gain in volume, which is not very great, but rather the ability to drive the bass end of any loudspeaker system to full output. Ask HARVEY's audio consultants about your own requirements. The things to listen for in evaluating amplifiers are, above all, clarity in heavy bass passages and a "sweet," unstrained quality on the high end, especially in loud string passages.

For those who want a very compact single-chassis amplifier with moderate but fully adequate power and practically every feature currently found in top designs, the Brociner 'Mark 10' is hard to beat at its low price. One step up on the price scale is the larger, more powerful but still compact Scott 99-B—a 22-watt single-chassis job with complete controls. In the no-holds-barred category are two of the world's finest power amplifiers, the 60-watt McIntosh and the 40-watt Marantz. These are for perfectionists. The latter is complemented by the 'Audio Consolette,' a particularly fine and elaborate preamplifier.

continued

HARVEY *the House of Audio*

JOHN M. CONLY writes, in *The Atlantic*:

"I could not quite get the AR woofer and the Janszen tweeter into phase and balance one with another, though there were tantalizing hints that, could I have done so, I might have had at my disposal the best loudspeaker system I had encountered."

The problem of matching the AR and Janszen speakers has now been solved through cooperative efforts of the two manufacturers. No external crossover network is needed, and grille cloths and wood finishes are the same. Suggested driving power, at least 30 watts.

AR-1W acoustic suspension woofer:

Walnut	154.00
Mahogany	145.00
Birch	145.00
Utility	132.00

(in mahogany)

JANSZEN 1-30 push-pull electrostatic tweeter:

(in birch)

Walnut	189.00
Mahogany	184.00
Birch	179.00
Utility	161.00

ACOUSTIC RESEARCH, INC. *Literature on request* JANSZEN LABORATORIES, INC.

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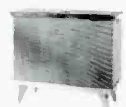

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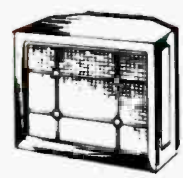

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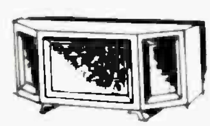

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Selecting AUDIO COMPONENTS

A noteworthy trend in hi-fi is the ultra-compact, unified system, and it is best exemplified by two unusual units—the Bogen RR-550 and the Harman-Kardon 'Festival.' Both of these incorporate a high-class AM-FM tuner, a versatile preamplifier and a large power amplifier—all on one chassis. Just hitch up a speaker and out comes the music.

The Loudspeaker System

The loudspeaker is perhaps the most important and certainly the most controversial of all the components to be selected for the hi-fi system. Being the last link in the chain—the component we actually "listen to"—it can distort a perfectly distortion-free signal fed to it by all the preceding components. Having the most complex and least well-understood function of any audio component—to convert the electrical impulses furnished by the amplifier into sound waves—the speaker can be (and is) designed in as many ways as there are designers. Choosing a loudspeaker is therefore purely a matter of listening—the speaker that sounds most like your recollection of actual, live music is the speaker for you. To be perfectly honest, though—the more expensive sound best to most people.

If you want a simple, moderately priced speaker system of very high quality, try the new Lorenz speakers. If you want to invest only a small initial amount into an excellent speaker and later expand it into a superlative system, you would do well to investigate the University line. Another justly famous line that includes all sorts of speakers from modest-but-good all the way up to price-no-object-but-sensational is Electro-Voice. Bozak also has an enviable reputation among hi-fi enthusiasts for making moderately priced speakers that sound fine as well as large systems that sound terrific. And for those willing to try something really new and different, there is the combination of the Acoustic Research low-frequency unit and the new Janszen electrostatic speaker—an extemely compact, smooth and wide-range system.

The Tape Recorder

The time has come when no hi-fi system can be considered really complete without a tape recorder. The best pre-recorded tapes often sound even better than the best records and home recording can open up entirely new areas of satisfaction to the hi-fi enthusiast. Fine music recorded off the air from live broadcasts can be built into a unique, individual tape library. The new Magnecord 'Citation' should be investigated by everyone shopping for a de luxe tape recorder—it is a unit with very high-quality features at a surprisingly reasonable price. The Bell RT-75 should satisfy the needs of all those who want a more modestly priced unit that still retains the features expected in a high-quality tape recorder.

You get more than just good components

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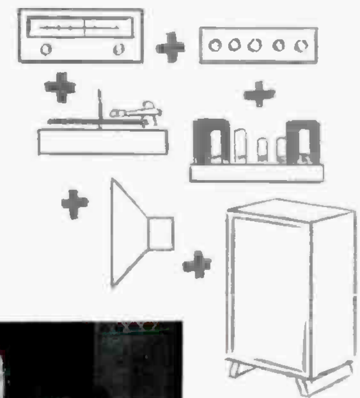

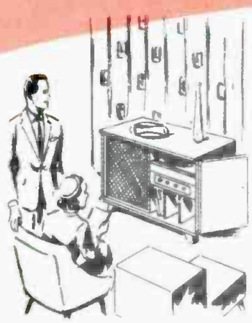

High fidelity means more than just a number of separate, high-quality audio components suitably connected. It is possible to spend many hundreds of dollars on an assortment of loudspeakers, amplifiers, pickups and other components—and end up with a system that is good for brand-name dropping but most uncomfortable to listen to. It is also possible to spend what is a reasonable sum to your purse and obtain immediate and lasting aural delight from your system. It's how, where and with whose help you select the components that makes the difference . . .

At HARVEY's new AUDIOtorium, you will be met by someone from HARVEY's unique staff of audio consultants—all of them members of the Audio Engineering Society—and briefed on the possible component choices for *your* kind of listening room, musical preferences, hearing characteristics and budget. Then you will be escorted to one of HARVEY's soundproofed, living-room sized demonstration studios and asked to listen to and compare the components under consideration. HARVEY's three huge demonstration panels—designed for instant switching from any one of many hundreds of components to any other and for hooking up many thousands of combinations—will enable you to ear-test as many complete systems, part by part or assembled, as you wish. And when you have made your choice, you will be given the opportunity to make your purchase on a time-payment plan or to trade in used components against your new equipment.

All of this in a spacious, streamlined, relaxing decor reminiscent of the top department stores and specialty shops . . . and that's not all. In your own home, your enjoyment of your new equipment will be increased by the secure knowledge that HARVEY's integrity and know-how follow every sale. Components sold at the AUDIOtorium are pre-tested by HARVEY's experts—and a leading manufacturer's reputation stands behind each. You buy the finest and most complete high-fidelity service in the world . . . when you buy hi-fi at HARVEY's new AUDIOtorium.

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Power Amplifiers

An analysis of power amplifiers—their function, important characteristics, and how they work.

SOUND—Chapter 8

EDGAR M. VILLCHUR*

NOTE: While Chap. 6 appeared in the March issue, this is actually Chap. 8 as it will appear in the book of this series to be published this coming September. Some rearrangement of chapter numbers will be made. ED.

STRICTLY SPEAKING, the term "power amplifier" refers to the output stage of an amplifier. This stage receives signals of relatively high voltage but negligible power, and releases signals of the same wave form but of sufficiently high power to drive a loudspeaker. In its less restricted meaning, however, the term is used to represent the entire group of stages (other than preamplifier and control stages) which are housed on the power-amplifier chassis. The chassis usually includes a general-purpose voltage amplifier or amplifiers, a phase splitter, and the output stage itself, plus a "power supply" for all of these stages.

A detailed description of the functioning of different audio circuits is not considered to be within the scope of this work. Rather it is intended to provide a general understanding of the function and working of the stages listed above.

Voltage Amplifiers

A typical commercial power amplifier (the term used in the free sense as described above) is designed to produce its rated power output at an input signal of one-quarter to one-half volt. But the output stage proper needs a much higher signal voltage at its grids to be driven to its rated output. Most pentodes, under their usual conditions of operation require signal voltages in the range between 15 and 25 volts for full power output, and a triode such as the 6B4 requires as much as 70 volts. The amplifier must thus provide the facility for amplifying the relatively weak input voltage, a characteristic called *voltage gain.* With an input signal of ¼ volt, and the requirement that a driving signal of 20 volts be applied to the output stage grids, a voltage gain of 80 must be available.

A limited amount of voltage gain can be secured from a step-up transformer, but it is impractical to use transformers for large amounts of voltage gain; this gain must be provided by one or more vacuum-tube stages in the amplifier. The difference between voltage and power gain should be clearly understood: the amount of voltage gain in or preceding the amplifier has no bearing on its power capabilities. Once the input signal voltage has been increased to the required amount, further voltage amplification will merely serve to overdrive the output stage into the distortion region.

A block diagram illustrating the difference between voltage and power gain appears in *Fig.* 8—1. The voltage amplifying stages provide a total voltage gain of 30, so that the input signal is increased from ½ volt to 15 volts at the output stage grids. The power at this point, however, is only of the order of a milliwatt, one-thousandth of a watt; the power gain of the first stages has been incidental.

The output stage of *Fig.* 8—1, on the other hand, supplies real power gain, and can drive the loudspeaker with 30 watts. The power gain available has thus been thirty thousand, from .001 watt to 30 watts. Any voltage gain in the output stage is incidental: if we measure the output voltage at the plates of the tubes we will find a moderate gain, while if we measure the output voltage at the speaker itself we may, depending on the impedance of the speaker, find that there has actually been a voltage loss.

Voltage amplifiers and power amplifiers differ in quantity rather than quality. Where the signal output must have high voltage but does not need appreciable power, a vacuum-tube circuit such as that illustrated in *Fig.* 8—2 is used. The input signal causes the electrical charge on the grid to vary, in step, which in turn varies the current flow through the tube and through the load resistor R_L. This variation of current through R_L necessarily creates the same pattern of variation in the voltage "drop" across the resistor. Since the greater the drop across the load resistor the smaller the voltage appearing across the total output (shown as VOLTAGE OUT), the signal output of this stage of amplification is reversed in phase, that is, instantaneous voltage peaks are reproduced as troughs, and vice versa.

Although power amplifiers do not usually have resistive loads, it would not be possible to tell, from *Fig.* 8—2, whether the circuit was that of a power amplifier or of a voltage amplifier, without knowing the tube used and the circuit component values. Tubes designed for voltage amplification have limited maximum current flow, and are used in

* *Acoustic Research, Inc., 25 Thorndike St., Cambridge 41, Mass.*

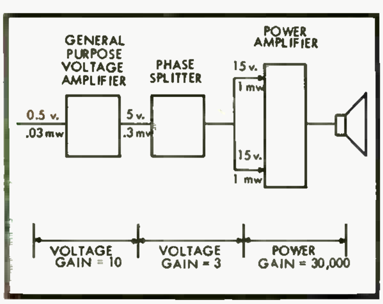


Fig. 8—1. Block diagram of voltage and power amplifiers, showing voltage and power gain.

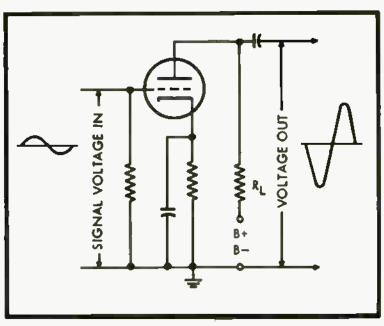


Fig. 8—2. A general purpose voltage amplifier. Varying current through the load resistor R_L creates the output signal voltage, which has been amplified and reversed in phase relative to the input signal.

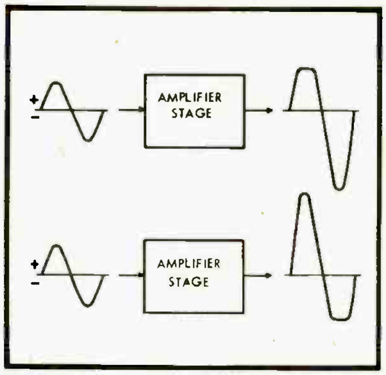


Fig. 8—3. Two types of vacuum-tube distortion. (A) Distortion due to saturation (B) Distortion due to cut-off.

conjunction with circuit values which provide the desired voltage gain, under the required conditions of bandpass (range of frequency response), distortion, and absolute values of signal voltages that must be handled.

The proper functioning of a voltage amplifying stage involves intelligent design and layout rather than expensive parts. Cheap parts may indeed interfere with optimum performance—capacitors may be leaky, resistors noisy or inaccurate in value—but the cost difference in going to high quality parts is normally measured in cents rather than dollars.

Vacuum-tube Distortion

Although vacuum-tubes do a fine job of amplifying without distortion they are not perfect, especially when high powers are involved. Let us follow a simple sine-wave signal through the vacuum-tube to see how it can be changed from the original during the process of amplification.

When the signal on the grid changes in the positive direction the current through the tube and through the associated output circuit is increased. The more positive the instantaneous value of the input signal the greater the current. Now there is obviously a limit to the amount that the current can increase. After the current has been driven to this limit (*saturation*), no further increase of positive input voltage will increase the current flow. This condition is illustrated in (A) of *Fig.* 8—3, in which the input voltage covers too great a range, in its positive peak, for the current to follow accurately. Further, the picture is not in simple black-or-white, where the tube is either saturated or not. Before complete saturation is reached the changes in current flow begin to lag the changes in voltage, so that distortion of a less graphically obvious nature is introduced.

A similar condition exists on the negative peaks of the signal. The smallest amount that the current flow can be reduced to is zero (*cut-off*), and if the input signal continues to go more negative after cut-off has been reached, the value of current flow in the tube is helpless to follow. This is illustrated in (B) of *Fig.* 8—3. Here, again, distortion of a less drastic nature begins to introduce itself before the actual cut-off point is reached.

In order to minimize the distortions described above, the *operating point* (an index of the no-signal current flowing) is chosen carefully, so that maximum current swing is allowed. The operating point is determined by the value of a fixed negative voltage applied to the grid, called the *bias* voltage. The valve of input signal is then limited to the non-distorted regions of operation.

The wave-form distortion that we have been describing can be analyzed into spurious harmonic components, at frequencies which are integral multiples of the original, and is thus called *harmonic* distortion.

Push-pull Operation

Certain elements of the distortion introduced by vacuum-tubes are reduced or eliminated by using two tubes in a circuit configuration referred to as *push-pull*.

A close analogy to push-pull operation can be constructed, using a situation in which a person is engaged in the task of sawing through a log. Let us consider his back-and-forth motion analogous to the up-and-down current changes in the vacuum-tube, and let us further consider that the condition of no distortion is represented by a back-and-forth motion in which the saw is pushed forward from its neutral position (operating point) exactly the same distance as it is pulled backward from this position.

It would be conceivable that, for one reason or another, the operator of the saw cannot push as hard as he can pull, and that while he pulls the saw back a foot the best he can do on the push, with the same maximum effort, is half a foot. We will use this condition to represent the fact that the tube current flow can follow the direction of the input voltage on the increase, but is unable to do so in the negative direction due to cut-off characteristics of the tube.

We now introduce a handle at the other end of the saw, and a second woodsman (subject to the same limitations on the force of his push relative to that of his pull), who pushes when our first operator pulls, and vice versa. What will happen? Each motion of the saw is subject to two unequal forces, a pull from one direction and a lesser push from the other, but the *sum* of these two forces will be the same for each direction of motion. The saw must then move the same distance coming and going. It is being operated in push-pull.

In the case of our tubes, the total output current during each half of the cycle is made up of two parts, one full (corresponding to maximum current flow in one tube) and one incomplete (corresponding to operation of the other tube past the cut-off region), as illustrated in *Fig.* 8—4. An analysis of the operation of a push-pull stage will show that, with perfect balance between the two halves, the part of the distortion that is eliminated is that represented by spurious *even* harmonics only. It is possible to take advantage of this fact by choosing the operating point of the tubes to produce very low harmonic distortion, at the expense of allowing higher even harmonic distortion, and then to cancel out spurious even-order harmonics by push-pull circuitry.

The force of each of our sawyers was, from the point of view of time, applied out of phase one with the other. But these forces were also applied to the saw out of phase from the point of view of direction. There were thus two phase reversals, and the forces combined to create a final power equal to the sum of the separate parts. Similarly, each of the tubes in push-pull are driven out-of-phase, and their individual outputs are out-of-phase from the point of view

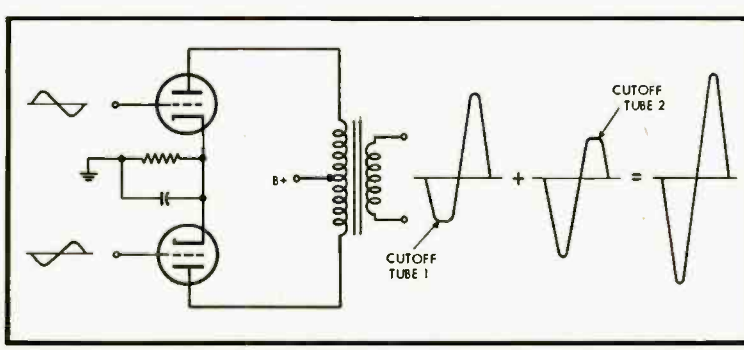
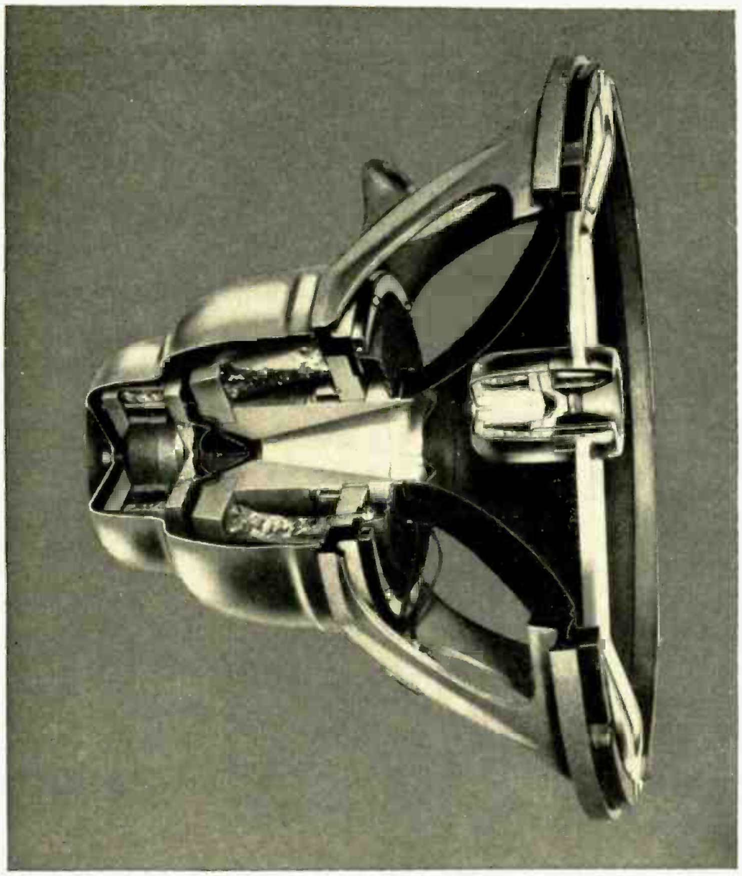


Fig. 8—4. Combination of two distorted signals in push-pull operation to create undistorted output.



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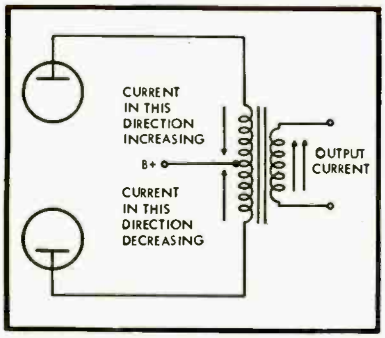

Fig. 8—5. How the out-of-phase halves of a push-pull circuit are combined in-phase.

of time. The two output currents are combined in such a way, however (as shown in *Fig.* 8—5) that the direction of flow in the output transformer constitutes a second phase reversal, and the final output power is equal to the sum of the powers available from each tube.

Push-pull circuitry is universal in modern high-fidelity audio amplifiers. It can be used for both voltage and power amplifier stages: it is common in the former and universal in the latter.

The Phase-Splitter

Push-pull stages must be driven by two signal voltages which are identical except for phase—one must be in its positive half of the cycle at the same time that the other is in its negative half. There are various ways of splitting the signal in this manner, and the stage which does the job is called the *phase-splitter*.

One type of phase-splitter, called a *split-load* stage, is illustrated in *Fig.* 8—6. It will be seen that the currents through the two load resistors are in opposite directions relative to ground. The output voltages across these resistors, taken in each case relative to ground, are thus out of phase with each other, as required.

Negative Feedback

The application of negative feedback in amplifier circuitry, as an additional method of reducing distortion, is so important that a separate chapter is devoted to the subject. (Note: this has already appeared in an article in the June, 1955 AUDIO)

Source Impedance of the Amplifier

Amplifier output terminals are labelled according to the speaker impedance to which they are to be connected: 4 ohms, 8 ohms, 16 ohms, or etc. A mis-match downwards (from an 8-ohm tap, for example, to a 4-ohm speaker) will usually not affect quality appreciably but will reduce the power capability of the amplifier—how much depends on the amplifier itself. A mismatch upwards, however, from a lower-impedance tap to a higher-impedance speaker, can usually be used with impunity. The fact is that the amplifier is "mismatched" to the speaker in an upward direction, in any case, over most of the frequency spectrum. We will see that the rated or nominal impedance of the dynamic speaker holds over only a small frequency band, usually in the 150–400 cps region, and that the actual speaker impedance increases manyfold at the frequency extremes.

The *source impedance* or *internal resistance* of the output stage (which is the source impedance of the amplifier) is an entirely different thing, although it is sometimes confused with the ratings of the output taps. The terms are synonymous, and refer to the resistance that the speaker "sees", looking back at the amplifier, rather than to the load that the amplifier is designed to see.

The source resistance is effectively in series between the amplifier and the speaker, as the internal resistance of any generator is in series between it and the load. If the value of this source resistance is high, relative to the nominal impedance of the speaker, it effectively controls the relative voltage fed to the speaker at different frequencies. When the speaker impedance is high, as at the extreme frequencies, a maximum of voltage will be fed to it. This tends to create a combination of boominess and shrillness. Such used to be the case, as a matter of fact, in the old pentode power amplifier without negative feedback, and this was the main reason for the generally acknowledged superiority of triodes in the output stage prior to the general use of feedback.

The source resistance has another significance relative to amplifier performance. If the speaker is set into vibration, especially at some low frequency near the natural resonance of its mechanical system, it will tend to continue to vibrate after the signal has stopped (an action referred to as *hangover*). Such a tendency is common to any mass-elasticity system that has received a mechanical stimulus.

The tendency to hangover in speakers is controlled by damping, of which there are three kinds; mechanical, acoustical, and magnetic or electrical. The last of these is a function of the source resistance. When the speaker voice-coil undergoes vibrations it acts as an electrical generator, and the vibrations are braked electrically by the source resistance. Electrical energy created by motion of the voice coil is dissipated in the source resistance, which the speaker generator sees as a load, and vibrations unauthorized by the signal are brought to an abrupt halt.

With speaker systems which are horn-loaded, or which are in resonant-type enclosures such as the bass-reflex, it is generally desirable to have the source resistance as low as possible (although once the source resistance is one-fourth or less of the value of the load there is not much further damping action). With speakers mounted in the wall or in totally enclosed cabinets, however, the value of optimum source resistance may be higher, in some cases as high as the impedance of the speaker. The proper value depends on the speaker used, and on where it is mounted in the room. Too low a value may attenuate the bass, but in any case a very high source resistance, corresponding to the old pentode-without-feedback, is never desirable.

The source resistance of an amplifier, relative to the speaker impedance, is also expressed as a ratio called the *damping factor*. A high damping factor represents a low relative value of source resistance: a damping factor of one represents a source resistance equal in value to the rated impedance of the speaker to which the amplifier is connected. Many modern amplifiers have variable damping factors for adjustment to different speakers and conditions, which means that their source resistances (or the effective values thereof) are variable.

The Power Supply

The amplifier requires certain operating voltages—tube filament supply (normally *a.c.*), plate and screen voltages (*d.c.*), and in some cases fixed grid voltages (*d.c.*). These are provided by the power supply, which step the power company's voltage up or down as the case may require, and rectifies and filters the input *a.c.* (converts it to a smooth *d.c.*). This power supply should be hum-free, rugged, and stable. The voltage should not change when large current demands are made by the signal, or distortion will be increased.

The requirements of a power amplifier

(*Continued on page 85*)

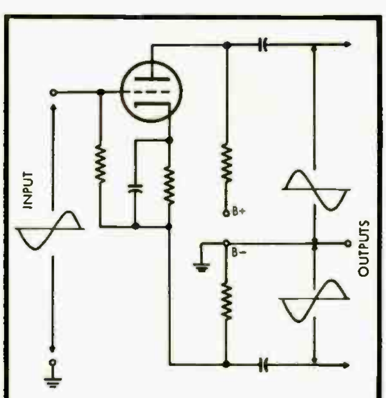

Fig. 8—6. Split-load phase-splitter stage.

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Equipment Report

The Ferrograph Tape Recorder—Rogers Developments Ltd. "Cambridge" Amplifier—Fentone B&O Velocity Microphone

ONE OF THE ULTIMATE AIMS of every audio enthusiast is to own a good tape recorder. Unfortunately, a good tape recorder is likely to cost as much as many a complete system, presuming that the individual is, perforce, budget conscious or is especially efficient in his purchasing department. The serious enthusiast is not likely to settle for the common "consumer-type" recorder that is offered at bargain prices because he is too conscious of hum, poor frequency response, flutter and/or wow, and many of the other ills that seem to be indigenous to the low-priced tape recorder. True, such machines fulfill the same need for many families that the inexpensive box camera does, but the real audio fan is in the Leica class, and demands much more from a recorder.

Fortunately there are a few tape recorders that approach the professional models in everything but price, and when one of them is introduced into a system, the user—unless he has had considerable experience with the true studio-type recorder—is more than likely to be fairly well satisfied with the performance. The Ferrograph appears to be in this class. It is not strictly in the top-bracket studio class, yet its performance is well above the average—we would call it a "semi-professional" model, which is not intended as "faint praise" at all but serves to set it apart from the box-camera class. In all departments, it performs sufficiently well to warrant giving it a place in even the best home systems.

Reference to *Fig.* 1 shows how the Ferrograph performs from the frequency-response standpoint. The upper section shows the output from an Ampex Standard Tape #5563, which most closely fits the curves employed in all recorded tapes we have observed so far. With tone controls at the maximum position—which is 10 on the dial—the output is up approximately 2 db at 50 cps and up approximately 4 db at 8000 cps, rolling off slightly at 10,000 cps. Minor adjustment of the tone controls would permit practically flat reproduction from the standard tape—and, consequently, from recorded tapes.

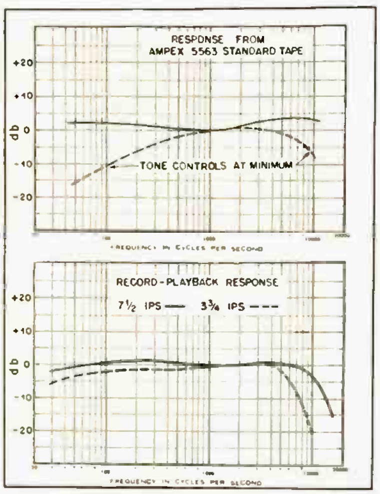
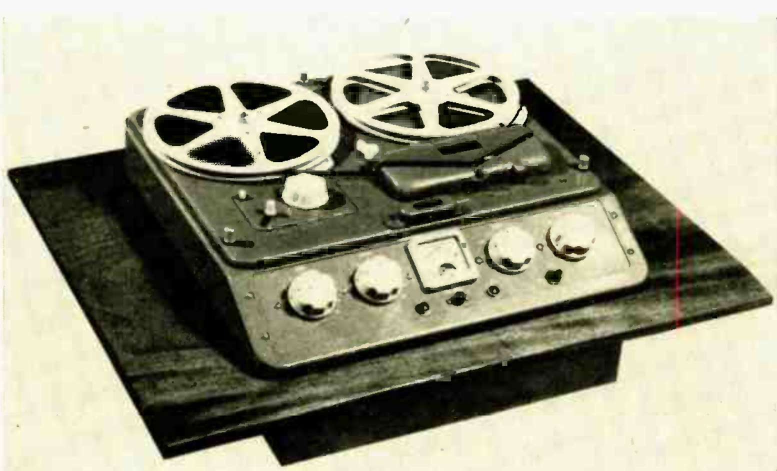


Fig. 1. Performance curves for the Ferrograph tape recorder. Tone controls were at "10" for both of the lower curves.

The lower section of *Fig.* 1 shows the response from a "flat" signal fed into the input, recorded on the tape, and then played back. For both speeds the tone controls were at the "10" position. Thus it may be seen that the output is down only 3 db at 10,000 cps at a speed of 7½ ips, and down about the same at 5500 cps at a speed of 3¾ ips. The frequency response curves are essentially the same whether measured at a high-impedance output (on the portable machine) or at the 15-ohm speaker output. There are two inputs—one intended for microphones, and requiring an input of 3.8 mv for peak recording level, and the other intended for outputs from a tuner or similar source and requiring a signal of 0.135 v. for peak level. The high-level input can also be used as an output to feed other amplifiers in a system.

The Ferrograph, being British-made, differs somewhat from conventional U. S. recorders. It is available in a portable case in which is mounted a loudspeaker, or it may be had in a form intended for installation in a home system on a permanent basis. It is also available with various speed combinations, but the one most likely to be used here has speeds of 7½ and 3¾ ips. It is equipped with three motors—two of the shaded-pole type for takeup and rewind, and a synchronous hysteresis capstan motor which provides a high degree of long-term speed stability. A speed control knob is mounted between the two reels, and a function control is just to the left of the head assembly, which is covered for protection. The machine is started by moving one knob up to a stop, where it is held by a magnet, being released by a push-button to stop, or automatically when the end of the tape passes through the head assembly. The front section of the head cover may be removed, without tools, to permit marking the tape for editing. The portable model is flexible in use, and will accommodate inputs and outputs likely to be encountered in any application. On the "permanent" model, switching is controlled by a panel-mounted switch.

Flutter, wow, and hum level are all satisfactorily low, and the performance of the Ferrograph is considered completely adequate for high-quality music system use.



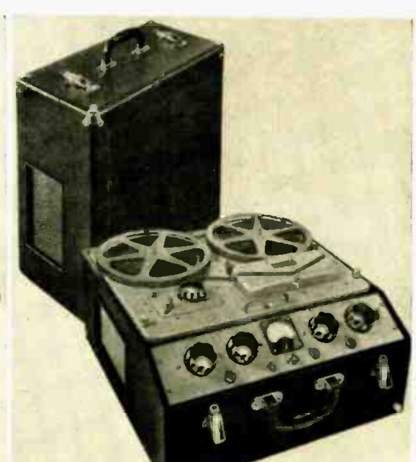


Fig. 2 (left). The "permanent" model of the Ferrograph is intended for installation in a home system, and provides all control from the panel. Fig. 3 (right). In portable form, there is greater flexibility but less ease of handling.

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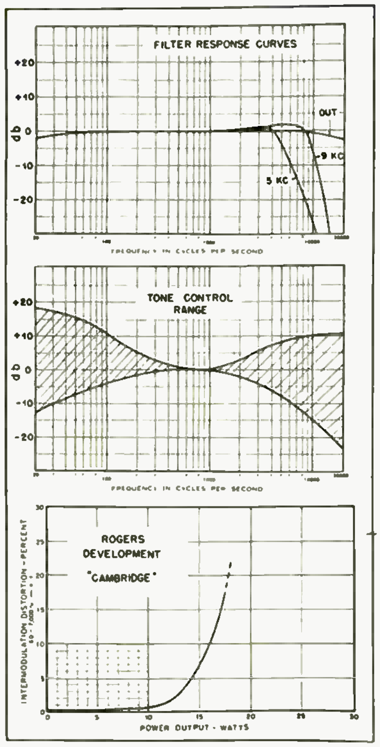

Fig. 4. Performance curves for the Cambridge amplifier.

ROGERS DEVELOPMENTS LTD. "CAMBRIDGE" AMPLIFIER

The two units comprising the "Cambridge" amplifier, a product of Rogers Developments Ltd., London, England, provide a small amplifier system suitable for most home applications where the power requirements are not so severe as to warrant an amplifier of 25, 30, or more, watts. And while it may be argued that *any* home system needs upwards of 20 watts, it must still be remembered that the greatest majority of hi-fi systems are started with 10- or 15-watt amplifiers—as the user adds more speakers or becomes more conscious of the desirability of considerably higher power, he may go to higher powers, but for the average small home, 15 watts can be considered satisfactory.

The Cambridge amplifier consists of two separate units—the control unit and the power amplifier, shown in *Figs.* 5 and 6 respectively. *Figure* 7 is the schematic of the power amplifier, while *Fig.* 4 represents the performance of the combination.

The control unit provides for three inputs—a microphone input which requires a signal of 2.8 mv for a 1-watt output, a radio input which requires a signal of approximately 32 mv for a 1-watt output, and a pickup input which requires a signal of approximately 3 mv for a 1-watt output. In addition, there are two jacks on the front panel which permit feeding a tape recorder with a signal which is not affected by the volume control, and another which will accept the output from a tape recorder (low-level, high-impedance). This makes it posible to use the Cambridge with a portable tape recorder with a minimum of connection difficulty.

Four phonograph positions are provided—with conventional curves being offered. All fall within ± 2 db of those specified by the manufacturers, and are for HMV LP, Decca LP, Ortho (RIAA), and 78. The input selector switch also selects the phono curve. The equalization is obtained by feedback around the first section of the dual triode, with a "flat" feedback being applied for the radio and microphone positions. Plugging a tape recorder into the TAPE REPLAY jack eliminates the first stage.

The tone controls are associated with the second stage—the bass control being a six-position switch while the treble control is a potentiometer. In addition, there is a filter control which is continuously variable from a cutoff at 9000 cps down to a cutoff at 5000 cps. A switch on the counterclockwise end of the control's rotation cuts out the filter altogether, leaving the response essentially flat up to 20,000 cps. The effect of the filter is shown in the upper section of *Fig.* 4, while the range of the tone controls is shown in the center section. The control unit employs only one tube—an ECC-83, which is a high-mu twin triode. The volume control follows the filter and tone-control network, and the TAPE RECORD jack is connected at the high side of the volume control. The control unit is connected to the power amplifier by a single cable which includes the a.c. pair leading to the power switch which is integral with the volume control.

The control unit is quite small, being only 1⅞ in. deep behind the panel, which is 8½ × 5¼ in. A feature unique to this amplifier is its availability in four panel colors—red, ivory, black, or bronze—and with pointer knobs in red, ivory, black, or gray or with round fluted knobs (as shown in *Fig.* 5) in ivory, black, or brown. This permits the user to select the colors most suitable for use with his particular decor and cabinet style.

In case the control unit were to be used with any power amplifier other than the 10-watt unit in the Cambridge combination, the connection could be made through a single octal socket mounted on the power amplifier chassis, and a plate supply of 8 ma at 270 volts is required. The heater drain is 0.4 a. at 6.3 v.

The Power Amplifier

The 15-watt main amplifier of the Cambridge employs an ECC-83 as the voltage amplifier and phase splitter, a pair of EL-84's in the push-pull output stage, and an EZ-81 rectifier. It is a relatively small unit, yet sufficiently large to permit neat and careful workmanship and to accommodate an improved C-core Partridge output transformer. A semi-fixed presence control (the 220-ohm resistor and the 0.5-µf capacitor shown below the rectifier tube on

Fig. 5. The Cambridge control unit, which is compact enough for even the smallest installation.

Fig. 6. The power amplifier of the Cambridge combination.

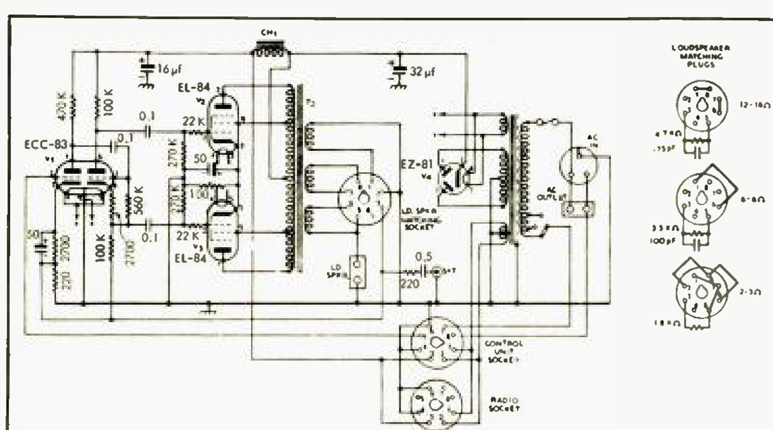

Fig. 7. Schematic of the power amplifier.

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the schematic, *Fig.* 7), provides a boost of approximately 5 db maximum, commencing at around 500 cps, for the frequency range above 1000 cps. This improves intelligibility with certain types of speaker systems, and "brightens" up the response with practically any speaker. The output stage is of the Ultra-Linear type and employs a transformer designed to a 25-watt rating. It has a response of ±1 db from 20 to 50,000 cps, and the leakage inductance is said to be extremely low, thus permitting the application of a relatively high amount of feedback.

The amplifier is mounted on a 6×11 in. chassis, and is 5¼ in. high. The presence network is introduced into the circuit by inserting a shorting plug into a tip jack on the top of the chassis, thus indicating that it is to be set up on a semi-permanent basis, since it is not a panel control.

The output circuit is arranged so as to accommodate three ranges of loudspeaker impedance—from 12 to 16 ohms, from 6 to 8 ohms, and from 2 to 3 ohms. The method of changing impedances permits the optimum use of the interleaved secondary of the output transformer, and at the same time changes the feedback resistor and phase-correcting shunt capacitor. This impedance selection is accomplished by the use of loudspeaker matching plugs, as shown on the schematic.

Study of the circuit will show that it is fairly conventional in some respects, although the characteristics of the output transformer are not apparent from the schematic. However, with the increasing use of the EL-84, even in U. S.-built equipment, the values employed may be of some interest to the serious experimenter. The signal input to the power amplifier for an output of 1 watt is approximately 0.19 volts, which indicates the sensitivity of the circuit used. Large coupling capacitors and adequate bypassing of input and power stage cathodes result in an exceptionally stable amplifier.

It will be noted that the power amplifier provides for plugging in a tuner or other device which can draw as much as 40 ma at 270 volts and 2 a. at 6.3 volts. This is hardly sufficient filament current for an FM tuner, for example, but would be sufficient for an average AM tuner. Most U. S. tuners provide their own power supply, however, although in England it is common to obtain the power for the tuner from the amplifier. Since the plate supply is adequate, it would suffice to place a filament transformer on the tuner chassis if more than 2 a. were to be drawn by the tuner circuit.

On subjective listening tests, the Cambridge gave a good account of itself. Its controls give a satisfactory degree of range for both bass and treble, and the availability of a filter is a desirable feature, although perhaps less necessary with LP records than it was with shellac 78's. We believe that if the Cambridge is to be a regular item on the U. S. market it should be equipped with standard U. S. pin jacks for the inputs so as to be readily interchangeable with other U. S. equipment. On the whole, it is a well built amplifier and performs most satisfactorily.

Fig. 8. The Fentone B&O-50 studio-type velocity microphone.

FENTONE B&O STUDIO-TYPE VELOCITY MICROPHONE

It is difficult to evaluate a microphone without entering into the realm of subjective judgement, yet after all this is the crucial test of any equipment that is to be used for reproduction of sound rather than for making measurements. Velocity microphones have certain advantages that are not duplicated by any other type, although the unidirectional models can approach the velocity in many applications and in some situations they may be even more effective. For interview purposes, for example, the velocity microphone is desirable because it offers maximum sensitivity on two opposite sides, with relative freedom from interfering sounds coming at right angles.

The B&O-50 follows the modern trend for small mircrophones, being only 1 3/16 in. in diameter and 7¾ in. long. The external projections on the chrome case indicate the directivity of the microphone, and the ribbon itself is screened by two layers of nylon screening, suitably separated for maximum protection. When mounted on a stand, the microphone can be tilted by means of a ball swivel.

An integral transformer provides an output impedance of 50 ohms, and a built-in switch permits adjustment of response so as to allow the use of the microphone in a close-talking position—the response being 18 db down at 50 cps. In the normal position—indicated by an M on the switch (T indicates close talking and there is also an off position)—the response is within ±2.5 db over the range from 30 to 15,000 cps. The polar pattern indicates that response at 1000 cps is down 10 db at an angle of approximately 50 degrees either side of the front or back faces. Sensitivity is rated at 55 db below 1 volt per microbar, which means that normal speech would give an output of the vicinity 2 mv at a distance of 24 inches.

The microphone is extremely attractively in appearance, is small enough to be useful in a TV studio for audience participation, for example, and is particularly convenient for person to person interviews. Because of the close-talking provision, the B&O-50 does not have the boominess that is associated with certain types of velocity microphones, but produces crisp, clear speech. It would appear that this is a suitable microphone for the tape recording enthusiast, for instance, when he wants something better than the usual inexpensive model furnished with the average recorder. The low impedance would necessitate an input transformer, however, but even this might be well worth while because of the improvement in quality.

The Fenton Company has recently announced an acoustic separator for B&O microphones which permits using two of them for stereophonic recording. This separator consists of a rectangular sheet of damping material about 8×12 inches in size and about 1 inch thick. It is mounted in metal channels with one end about one and a half inches forward of the axis of the two microphones and extends between them and back for some distance. The microphones are mounted on a bracket with their two faces turned outward some 30 to 40 deg. from the plane of the separator. Thus the back portion of the figure-eight sensitivity pattern is effectively blocked by the separator, and the whole device serves, approximately, as the equivalent of a listener's head. The microphones are about 8½ inches apart.

While there are two schools of thought as to the placement of microphones so as to make realistic recordings, it must be admitted that the placement for binaural recording—that intended for listening by two headphones, one on each channel—practically demands that the microphones be located in positions relative to the two ears of the normal human listener. It is possible that suitable quality and the proper effect can be obtained for *stereophonic* recording—that intended for listening by means of two loudspeakers, both of which are heard by both ears of the listener—but that is likely to depend on the acoustics of the studio as well as on many other conditions.

In any case, for those who are interested in making experimental recordings on a two-channel basis—whether binaural or stereophonic—the availability of the acoustic separator and the ease and convenience with which it may be used with the B&O microphones may come as a possible solution of the placement problem.

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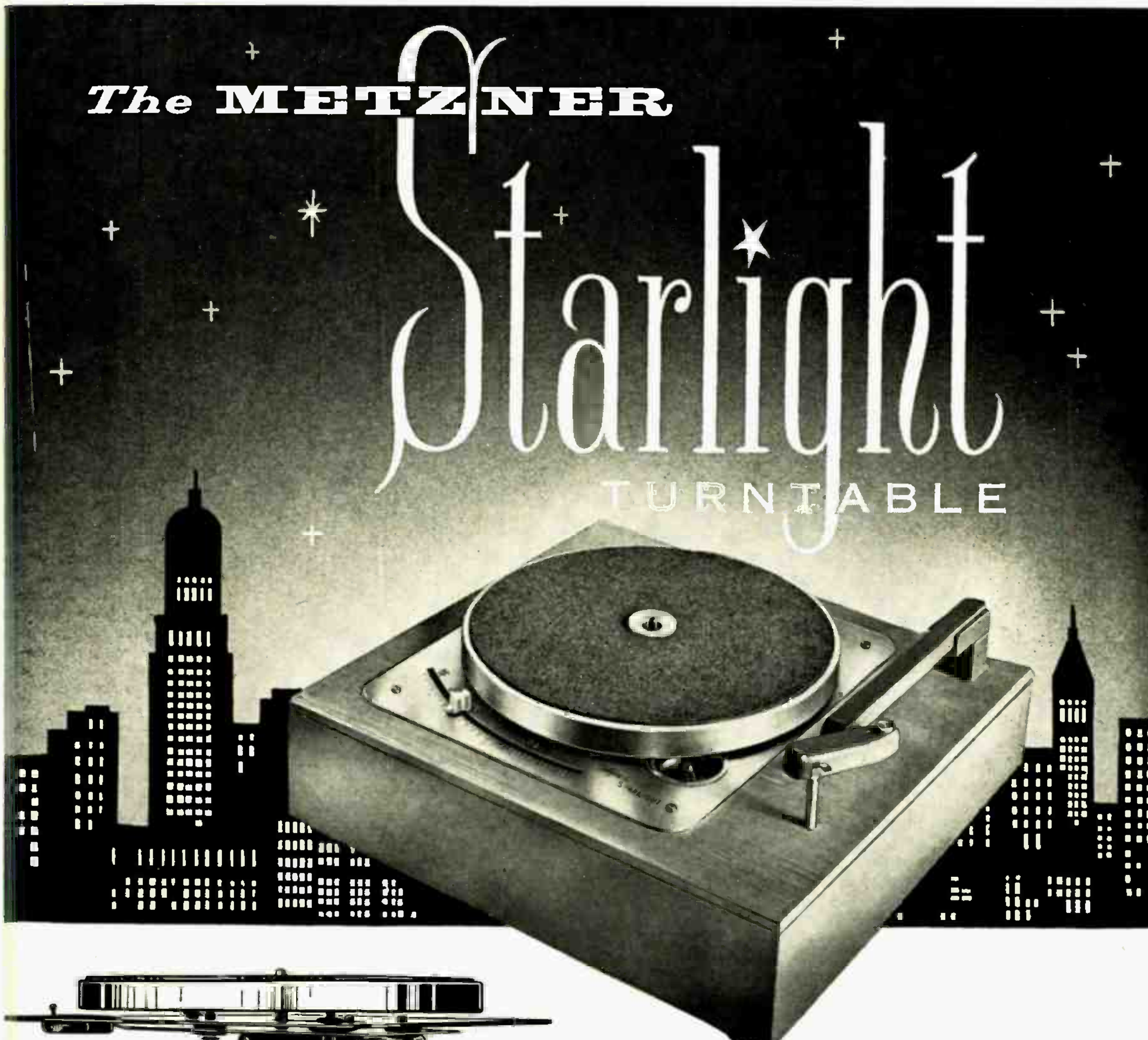

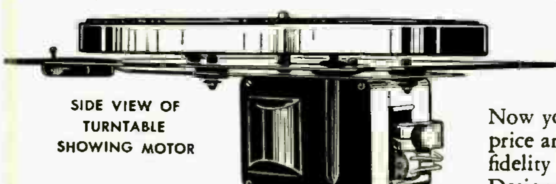

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The Home-Grown Tape Program

Editing for the Home Experimenter I

PRECEDING INSTALLMENTS of this series, which you will find in the September 1955, January 1956 issues of AUDIO, have traced the informal history of my informal radio program produced more or less regularly on tape right in my home. In January I got as far as describing some of the psychological aspects of tape editing in such a program, some of the tricks that can be used both for good effect and to minimize the inevitable disadvantages of home-style recording. This month I'm steering away from my own show, as an aside, to bring you some accumulated observations on how anybody can best go about the job of tape editing in the home.

By anybody, I mean anybody, amateur or professional, who is gadget-minded, or artistic-minded enough to want not only to produce tapes of his own but to fix them up, afterwards, for optimum effect. My thesis is that You Too can be a Tape Editor, right in your living room. In other words, I'm suggesting that there are many things that can be done on a less-than-professional basis which can well rival the sort of expert fixing-up that is produced by the high-powered editing of the professionals—probably a lot more can be done than you have any idea. And your basic equipment, aside from tape and tape recorder, need be no more than the simplest splicer and a roll of white editing tape.

Professionals who read this please be tolerant—it's old stuff to you. Amateurs, or professionals in audio who are technically amateurs in this particular area, be encouraged, and if I seem to say the obvious, just remember that for some other reader it ain't obvious at all. Depends on how far you've got in your own experimenting.

Scissors—Ugh

In this installment I'll confine myself mainly to non-audible aspects of home tape editing, and I don't intend to be comprehensive and super-organized about it, either. This isn't an instruction manual—yet. Let's begin with a picture, that familiar drawing found on innumerable boxes of home tape which shows a large pair of sissors slicing diagonally through two very loose ends of tape that have obviously been unwound from their respective reels. This picture never fails to give me the plain willies.

Sure, you can "edit" tape that way, if you have to. Just dismantle the entire machine, remove both reels, unwind the tape, put the whole business in the middle of a large table, get out your scissors, superimpose a foot or two of the free ends—make it two feet—and slice neatly decisively across. Then take your roll of patching tape in hand, strip off six or seven inches of the white stuff; take the two tape ends and lay them down on the table next to a full-size yard-stick, to be certain that your forthcoming joint will be straight. In fact, you'd better get out a batch of paper weights or maybe a dozen empty milkbottles, to hold the tape down flat and taut in a straight line. When all is rigidly under control, the tape straight along the yardstick, the two butt-ends nicely lined up next to each other (this should take you a good half hour to accomplish), take your piece of patching tape in hand, take a deep breath, hold it for five seconds, then *lunge* towards the splicing-point, hitting both tapes simultaneously and in a perfectly flat plane.

If your aim is right, you'll now have a straight joint that doesn't overlap, nor is it separated by a "crack" between the tapes, and you may in due course of time proceed to the final step. But the chances are that your lunge missed fire, or the tape slipped or curled up. If your new joint turns a corner or has a crease down the middle—throw the whole thing out, cut off a foot of tape from each end and start all over again. (Be sure there's enough tape on each reel for four or five tries of this sort.)

When you get your splicing tape on, pick up the new joint in one hand, tape and all, and hold before a 500-watt lamp for proper illumination; trim carefully and slowly along each edge of the tape, leaving no white margin of patching tape but, on the other hand, avoiding any cuts into the tape itself. This requires a steady nerve and a practiced scissor-technique and you'll probably spoil your splice, in which case start all over again. . . .

* * * *

In other words, go out and buy a tape splicer! It's just silly to edit tape without the aid of one of these gadgets. You'll seldom get a good splice without one, and you'll save vast quantities of time with even the simplest splicer as compared with the deadly scissors technique.

My own preference, along with most professional editors, is for the simple splicing block, on which you can align the two tape-ends, cut your diagonal and even splice the splicing tape to fit. But there are many fancier gadgets if you feel like trying them. I'll stick with the EdiTall, a plain block with groove into which the tape fits without clamps thanks to a curved bottom and shaped edges. You push it in, snap it out. The less expensive blocks with clamps to hold the tape down are slightly clumsier to use but reasonably effective.

The first principle of tape editing, as I see it, is to avoid dismantling your entire set-up for each splice, as with OPERATION SCISSORS, just described. That is, don't take any more tape off the machine than you can possibly manage. Leave the reels in place. Do the work right on the machine. It's surprising how seldom this occurs to those who do only occasional tape patching.

I've watched many a professional operator unroll tape from reels removed from the tape machine, risking all sorts of dreadful accidents, preventing any sort of audible checking and, worst of all, losing time courting confusion. We once lost a couple of feet of tape, in this fashion, that put a professional recording back a couple of years—it was a performance-made tape and we had no satisfactory replacement on hand for that second or so of missing music.

The procedure for non-dismantle tape editing, right on the machine, varies from machine to machine but the principle is the same in all cases. You pull out a loop of tape, after you have marked the spots where it is to be cut and excision made. The tape splicer is mounted, or simply placed, on any convenient flat part of the recorder and you pull your loop out just enough to reach to it—without removing reels. On the big professional Ampex your loop is simple enough; just lift the tape out of the channel that goes past the recording and playback heads. So, too, with other recorders where this is easily accomplished, and that includes many newer home-type tape recorders. You can place your splicer directly above the tape slot, for easy access.

But a useful trick, which I learned with my Magnecorder, is to pick up the tape, not at the heads but off to the left, between the supply reel of tape and the first roller, leaving the section directly over the heads untouched. This is particularly useful in the case of those Magnecorders which have the "lid" type of shielding over the head, which must be lifted up on its little hinge before tape can be removed. But it undoubtedly will work well with other recorders. Why to the left? Because if you make your splice to the left of the playing head, it will be in position to play directly, without rewinding, when you reel it back. Saves a tiny fraction of a second on each splice. Always do the reeling up of the loop with the *left* reel, the supply reel, after finishing your splice. That puts your patch in position for listening—and of course you should listen to every splice you make before going on to another, no matter how good you think you are.

You'll find that with experiment and practice this non-dismantle system for splicing can become very efficient on just about any recorder, from the cheapest home model on up. The thing to do is to study your motions, find out how to reel off just as little tape as you possibly can when you lift it out to put on the splicing block. You'll get so that not more than a few inches are involved. Then things move fast.

Marking the spot on your tape is a major problem, because the only proper way is to do it directly at the playing head, with a soft china-marking pencil. (Yellow is a professional favorite; I find that jet black shows up even better in most lights.) Unfortunately, it is not always possible to get at the playing heads with your pencil, especially in those recorders that have a slot into which the tape is dropped. The difficulty is present in all price ranges;

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MEMBER INSTITUTE OF HIGH FIDELITY MANUFACTURERS INC witness the Ampex 600, where in order to mark tape at the playing head itself you must (and can) remove the outer and inner metal shields that cover the three heads. One way to get around this problem, though it will likely reduce your accuracy somewhat, is to mark the position of the playing head's center on the outside cover or shield. Once you have determined this, you can audibly spot the place where a splice is to be made by moving the tape back and forth, then lift it straight up and out of the slot and cut it at the point where the playing head should be. But as I say, this is likely to be inaccurate if you're not careful—and be *very* sure you've marked the playing head and not one of the others (record or erase, on a three head machine; just erase on two-head models) which are some distance away.

Whatever marking system you find is best for you, stick strictly to the non-dismantle technique. Don't take the reels off the machine for splicing. Don't unreel great lengths of tape. Keep the splicer block as close to the actual playing heads as you can manage.

Perhaps I should point out, for those who are likely to make the biggest boner of all in tape editing, that one does *not* edit dual-track tape! You can, of course, edit tape on a dual-track machine provided you use only one of the two tracks in your recording. And (while I'm at it), a dual-track recorder will play a single-track professional tape fairly well, though, since the head is running along the edge of the centrally-placed single track, there may be some uneven fading or change of quality. Usually not bad. But a single-track machine plays a (single) recording made on a dual-track machine perfectly, since the single-track head works all the way across the tape and will pick up anything on it, wherever it is recorded.

Note also that a few recorders are dual-track reversible, that is, the tape motion is reversed when the second track is recorded and the reels need not be interchanged. In my remarks, above, simply delete the word "left" and do your editing on the supply reel side, whichever direction that happens to be. DeJur, Webcor, and Twin-Trax (ACA) recorders operate in this way, among others. Note further that there are two recording heads in these models and you must be sure you're working at the right one when it comes to marking your tape for splicing.

The Tape You Remove . . .

So much for the preliminary mechanics of editing in the home, applying to any recorder from the cheapest to the fanciest professional model. Before I get to the actual sound, let me consider more of the mechanical aspect—for this is a vital part of the whole operation. Without the proper mechanics your ear will not help you a bit.

I suppose you may lump numerous kinds of splicing together in this mechanical sense under the general title of editing. Repairing accidental breakage, joining odd pieces of tape purely mechanically, these things are not really editing in the higher sense, since sound isn't important. Much more interesting is true editing, whereby you splice not so much tape as sound itself, whereby you remove sounds, add sounds, play tricks with sounds, all via the purely mechanical operation known as tape splicing.

The odd thing is—and this strikes me every time I do it—that the entire subtle art of tape editing, which can involve some marvelously ingenious tricks with music and with speech, which covers an enormously wide range of intellectual activity, from, shall I say, Bach to Boogie, soap opera to Shakespeare, boils down physically to one, single, mechanical operation. Mark, cut and splice, mark, cut and splice, go through exactly the same motions again and again, and the entire vast range of artistic and intellectual interest, from one splice to the next and the next, is in the vastly different audible problems being solved in the splicing. Mechanically it's the same, routine finger process, and not a very exciting one at that. Without sound, splicing is no more than a minor menial task, dull and repetitive. But the ideas, the intellectual qualities of the operation, fascinating and endlessly varied, are in the ear and the mind, and there's no limit to their interest, professionally or in the home.

How do you make a splice? There are always two points at issue—that is, places on the tape upon which you'll operate. You make two marks, you slice the tape first at one (with the loop technique as of above) and then the other, preferably cutting the "earliest" first, then running the tape through the player in the normal direction (either by power at playing speed or by hand until you reach the second mark, which you then cut, too. Whereupon you bring the severed ends together, *lay the excerpted piece aside carefully*—never junk it until the work is done on the splice—and apply your patching tape to finish the job. (More of this in a moment.)

If you slice the "early" mark first, the spot which comes first in the playing of the tape, you can often allow the following tape, (to be excised) simply to play freely, right out of the machine and into your lap or on the floor, until you get to the second mark. (But don't step on it.) You must, of course, hold onto the take-up reel during this operation so it won't spin forward wildly. A good idea; for you can in this way actually hear the tape which you are going to remove and so be doubly sure that you are doing what you want to do. This playing-onto-the-floor is more or less standard procedure professionally when long pieces of tape are to be removed.

If your splice isn't right, you can re-insert the removed tape as needed, and begin over again without prejudice, as the legal phrase goes. You won't begin to throw away the removed tape immediately until you are a *very* old hand and extremely sure of perfect results every time; anybody with any sense always puts aside the removed section until the all-clear is sounded, the patch is played and it is OK.

And remember that all tape looks alike. If you once lose a fragment among other similar scraps, you're not likely to find it again—and if you do, you'll probably patch it in upsidedown and backwards. It looks just the same that way, but it sounds funny.

When you begin fancy tape juggling and find yourself with three or four pieces of tape from various rolls, waiting to be used or tried out, it's a very good idea to attach labels to them. Have a roll of sticky cloth tape handy, tear off a piece, write on it, and attach to the end of the tape—the beginning end. (Or if the other end, be sure you are clear as to which end is which, or you'll have your sound patched in backwards before you know it.)

It is often a good idea, in such situations, to stick the tape fragments onto a nearby wall so they dangle down like clothes on a clothesline. Then you can pick off the one you want at your convenience. *Don't* rely on memory as to which slice of tape is which, unless you are extremely sure. And look out for stray breezes. The breeze caused by your own arm moving about may easily blow two or three precious bits of tape up in the air, on the floor, or upsidedown, reducing your delicate operation to chaos in an instant. You can't *play* a tape fragment without splicing it onto the longer tape on the supply roll, unless it is long enough to pull over the heads. And even then, it may merely produce unrecognizeable grunts and squeaks, unless you can manage to get it to run through the capstan drive for long enough to recognize the contents. But avoid this sort of trouble by keeping track of your fragments, even if it is a nuisance. Do all your audible work before you slice, if you possibly can.

By the time you've done quite a bit of splicing your work-space will begin to look really professional—i.e. the floor, table, waste basket, window sills and every other open spot will be covered with snippings and tangles and whorls and slivers of red tape, a terrible mess and only a vacuum cleaner will pick up the little pieces, though it will choke itself on the long ones which, moreover, have an annoying way of wrapping themselves around and in and out of telephone wires, power cords, and the like. The more you yank, the more hopeless the snarl.

I suppose something of the sort is inevitable, and I watched a cleaning lady at Columbia Records, with amusement, doing a quickie brush-off of the editing room last week in the time-honored way; she didn't brush the tape bits under the rug—there wasn't any rug. But she deftly swished it all behind several amplifier racks, where not even a vacuum cleaner could get at it, and her dustpan had only a token handful in it, just for the record, so to speak.

In another ten years Columbia will be knee-deep in the stuff, if I know anything, and so will you. Wives beware.

Which leads me to a final thought on tape fragments: don't try to save them, and so economize on tape costs.

Economizing

Yes, tape costs money, even with price reductions. When I started out, I saved all the pieces I could, and spent much time patching them together for re-use. But then I discovered that a good proportion of tape splices cause a noticeable thump or flutter when a new recording is made over them. Not all, and the effect varies according to the machine, but you may count on an annoying or even a disastrous bad spot every so often even with the best professional machines. So—don't record over splices, except for experiment or in work where perfection is unimportant.

My first glimpse at a professional tape recording session had me horrified at the enormous quanitites of tape that are "wasted". The big machines, running at 15 inches (or even 30), roll on and on and are seldom reeled back; mistakes, aimless conversations, long interludes, all go merrily onto the tape and are eventually thrown out, by the mile, into the waste basket. But on reflection I realize, and you will too, that in such operations on a commercial scale tape is decidedly expendable. Better a mile of lost tape than a few inches of lost music or speech, paid for at fabulous overhead expense.

The record and radio people know that their best policy is to take down everything, useable and unuseable, during every recording, and they are very willing to waste tape in vast quantities, if the tape that is left after editing is what they want. And, remember, bulk for professionals is

(*Continued on page 68*)

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1. WESTMINSTER: CORELLI TO CLEMENTI.

Organ Works of Bach, Vol. 1: Orgelbuchlein (Little Organ Book). Carl Weinrich, organ of the Varfrukyraka, at Skanninge, Sweden.
Westminster WN 2203 (2)

Here's the start of a new complete series, the entire organ works of Bach, which will complement the similar series released by Decca from Deutsche Grammophon with the German organist Helmut Wachla. (Comment in later issues.)

Weinrich is a first rate authority, his playing brilliant, brightly registered, modern, a bit on the cool side with strict and fairly rapid tempi. He represents very well the continuing reaction against the old heavyweight and soulful kind of Bach playing. The many short chorale settings are here played in a businesslike but colorful way, setting forth their inner elaborations with clarity.

In the sumptuous accompanying booklet Westminster describes impressively the difficulties of "hi-fi" recording of the many soundsources spread out in such an organ as this across the width of a church. In fact, the company hung dozens of mikes, in order to find a combination for each of the hundreds of works, as registered on various sets of pipes by Mr. Weinrich. (Not all mikes were used at once!) The result is a hi-fi sound remarkably consistent with that in other recent Westminster recordings, clear, brilliant, closeup, the inner details standing out startlingly like the white trees and clouds in an infrared photograph. My own preference would be for a simpler and more distant miking, if perhaps more blurred, but this type surely affords interesting inside views of the music and a fine hi-fi effect via the phonograph.

The organ has a fine sound and splendid variety and seems to have been an excellent choice for the forthcoming series.

Scarlatti: Sonatas for Harpsichord, vols. 11, 12. Fernando Valenti.
Westminister WN 18094,18192

It's an accomplishment to have carried this series on so lustily into its twelfth volume, with more announced. At a dozen or so short sonatas per disc, the net so far must be about 144 out of a projected grand total of something like 500. Many a project of this sort has foundered before it was on its feet.

I tried Vol. 6, for comparison, and found no great tonal difference, though the new ones seem a trifle heavier in the bass, perhaps due to an intervening change of recording curve, to the present RIAA for which I did not change compensation. Valenti continues the polished, fluent performer, a bit more easygoing and relaxed now than in the earlier discs. He is not a profound interpreter, not as serious and as probing as Kirkpatrick nor as electrically dramatic as Landowska, but this is small criticism, in view of the urbane inclusiveness of the Valenti performance—the longer he plays, the more charming he sounds, and these are getting better and better.

* * * * *

The Valenti records should be treated as Absolute recordings. I mean simply that in them there is virtually no recorded room sound, no reverberation; the mike is close and you hear virtually "pure" harpsichord, without echo. Thus you listen to the instrument without being conscious, as in other recordings, of the space in which the recording was made. That means that, as you play the record, it takes on the sound of *your* space. In effect, the instrument is playing inside your listening room.

In all such Absolute recordings (and there are a good many on the market) realism is impossible unless you set the volume *at the absolute volume of the original sound.* No more, no less. That sound is often less loud than you tend to play your records. At any louder volume the absolute recording is ugly and mechanical, distorting the music and the instrument. Hence some criticisms of this type of miking.

But if you will turn Mr. Valenti down *very* soft, you will hear him as he actually plays, with unexampled fidelity, right in your room. Remember, the harpsichord has a *very* small literal sound, a tiny fraction of the piano's volume, though its musical effect, oddly, can be very massive, as we all know.

Clementi: Sonatas for Piano (with "Didone Abbandonata"). Vera Franceschi
Westminster WN 18091

Here are more Clementi sonatas, supplementing those recently issued by Horowitz on RCA Victor (*see* AUDIO, Feb.)—he is the great pianist and composer of the turn of the last century whose bigger works are now being rediscovered. "Didone" (Dido Abandoned) is his last sonata, composed in the full early Romantic period and a touching attempt of an essentially classic master to write in the new idiom; the expression is Romantic enough, but the harmonic language isn't ripe enough. The earlier works, pioneer piano sonatas closer to Haydn than to Mozart and remarkably foreshadowing Beethoven, are the best.

And the three earlier works here are more congenial for Franceschi, who plays them in a crisply expressive way, lacking only a certain larger sense of line and phrasing that keeps her performance out of the "extraordinary" category. She is a sweet, sincere, and understanding player and does the piano literature a good turn here—setting an example for other pianists. Big, handsome piano sound.

Corelli: 12 Concerti Grossi, Opus 6. English Baroque Orch., Quadri.
Westminster WN 3301(3)

This album continues the documentation of the solid core of Italian 18th century music with another dozen concerti of the sort that in pre-LP days were often praised but seldom heard. (The Corelli "Christmas Concerto" was the standard example, out of many.) See also similar collections of Vivaldi, Torelli, Albinoni, etc. on various labels.

Nobody expects you to play these a dozen at a time but since for convenience they were published in dozen lots, they are now so recorded. Take your time and you'll enjoy them for many a month to come. Corelli was the "father" of this now-familiar style, a somewhat earlier composer than others who write similar music—Vivaldi, Bach, Handel *et al.* He has not Vivaldi's dramatic flair nor his sometimes strange harmonies, but his music is immensely solid, brilliant, strong rhythmed, and makes fine fiddling.

The Italian conductor Quadri makes these English players hop a bit more energetically than, I suspect, they might do on their own; the music is intensely vigorous, somewhat choppy in the fast movements and not too well phrased (a very un-British fault), but even so it makes a rather pleasant contrast to the ultra-serious German playing of similar music in other recent recordings. Most listeners will like this, and the fi is hi.

Mozart: Early Quartets, K. 155, 156, 157, 158. New Music Quartet.
Columbia ML 5003

Mozart: Early Quartets, K. 159, 160, 168, 169. Barylli Quartet.
Westminster WN 18092

An interesting collaboration—Columbia's and Westminster's releases, as you can see, supplement each other nicely. These make a fascinating dynamic study of the young composer learning his trade—at astronomical speed. The quartets K. 155–160 were composed during his trip to Milan, age 16, and are the first in which he began truly to sense the possibilities of four strings. The first two or three are already finished and competent, but not too interesting; the interest rapidly deepens as we move from quartet to quartet. The last two, K. 168 and 169, are from a year later when Mozart visited Vienna.

Both quartets play exquisitely, the New Music in a more classic way with physically a smoother, less highly colored tone, the Barylli quartet almost passionately, with a good deal of vibrato and a real Viennese earnestness.

In the recording Westminster wins honors with a brilliant, stringy close-up sound, bringing out the individual instrumental colors most effectively in a good liveness. The Columbia

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See page 77

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

recording is at a greater distance, the sound a bit wooden and the sense of presence less convincing. Not musically at all serious, this difference.

Mozart: The Last Quartets, K. 499, 575, 589, 590. Budapest Quartet.
Columbia SL 228 (2)

Well, while we're at it . . . here's the other end of the line, some twenty-odd quartets and a dozen-plus years later. At first hearing you won't notice much outward difference in style—still the same lyric, intimate transparent Mozart. But, of course, there are vast differences when the quartets make their mark on your memory. Outward lightheartedness, as we now realize, often covered the most profound and intense expression on Mozart's part. Takes awhile to feel it, but when you do . . .

This is not a good album. First, the Budapest, still at the top, are beginning to lose their marvellous electric vigor now, after a couple of million performances and a quarter century or so of constant work. There are superb things here, as always, spots where no other quartet can match this group in perfection of ensemble and phrasing and in the understanding of the musical implications. But then, granted this ultra-high standard, there is a slight but creeping sense of tiredness that is just barely—yet persistently—noticeable. In a word, this is getting to be an old quartet, which is no reflection on it whatsoever. We all get old. Yet it begins to show in the sound.

Secondly, Columbia has done poorly by the Budapest. The sound is good, sharper than that of the New Music Quartet, above, and more live, but it is occasionally strident and blurred in the reproduction, with pre-echo even in softer spots. (Columbia's pre-echo has been bad, lately.)

Worse are technical faults of pitch that are hardly to be excused. Not only an off-center waver, in one of my discs, but in the last movement of the B Flat Quartet K. 589 the music begins, incredibly, almost a half step flat and so continues to the end. The pitch seems to sag a bit even earlier, towards the end of the Minuet movement preceding. I haven't heard a *faux pas* like this since the early days of LP and I'm amazed that, somehow, Columbia allowed it to get out at all, even if (perhaps) it was corrected in later production than mine.

2. THE 18TH CENTURY WITH L'OISEAU-LYRE ET AL.

Mozart: Litaniae Lauretanae, K. 195. Jennifer Vyvyan, Nancy Evans, W. Herbert, George James; St. Anthony Singers, Boyd Neel Orch., Lewis.
L'Oiseau-Lyre OL 50085

This French record company, recording often in England and sponsored in the U.S. by London, has an extraordinarily enterprising group here, which has been turning out unusual items faster than I can keep up with them—ranging from Monteverdi to Purcell and Mozart.

The Mozart Litany is one of those astonishing works that most of us (musicians) had not the faintest idea existed—yet here it is, one of the loveliest, freshest, warmest, most expressive works of its kind in all the Mozart literature, and the performance is absolutely lovely, no less.

Five movements, a medium-sized work, plenty big enough to "rate" with the Masses, The Requiem, but on a less formal basis. Several lovely soprano arias, a generous mixture of solo quartet and chorus, with some solo work for the tenor as well, a great deal of wonderfully joyous expressiveness and a few unearthly touches of more seriously expressive genius. What a piece! Double-A-Plus, for all Mozart collectors and even higher for lovers of classic choral works. Superbly recorded with a beautiful balance.

And when you've absorbed this, there's another waiting, the Litaniae de Venerabili Altaris Sacramento, K. 243, in album OL 50086. No review yet because I haven't played it yet. One at a time, and I haven't got over my excitement about the above work.

Handel: Sosarme (complete opera). Alfred Deller, countertenor, Wm. Herbert, Nancy Evans, Margaret Ritchie, et al., St. Anthony Singers, St. Ceceilia Orch., Lewis.
L'Oiseau-Lyre OL 50091/2/3 (3)

Here we go again! For a good part of my life I've been waiting, just *waiting*, for a chance to hear one of the dozens of Handel operas, never staged and, so far, never recorded either, though numerous arias from them are known to every singer.

And so—here are three whole discs of the finest solo Handel you've ever heard, an opera complete, beautifully performed and styled. The entire work is a series of recitatives, carrying on the drama, followed by big solo arias and an occasional duet, plus a short chorus or two. The format is rigid, but the music is all plasticity. What the old man could do! Every aria is a gem, and there are dozens. Wonderful tunes, in the broad Handelian manner, memorable obligato accompaniments, like a broader and more gracious Bach, and not one will fail to stick in your memory after a few playings. Priceless material.

Even the plot, highly classic, turns out to be quite interesting, though you'll have to follow the Itailan-English parallel columns closely to untangle it. No synopsis provided. Battle between King-father and Prince-son, abetted by wicked villain.

And when you finish all this—a good, long evening's worth for a single playing—there's another waiting: the complete work "Semele," three more LP's, done in English by the same group! Haven't played it yet, either. (It's OL 50098/99/100.)

Rameau: Hippolyte et Aricie (1733). Claudine Verneuil, Geneviève Moizan, Raymond Amade, Flora Wend, Cho., Orch. Désormières.
L'Oiseau-Lyre OL 50034

Another "first," a famous French opera that also has seldom been heard, and done here with all-French personnel. But these are merely excerpts though the cover doesn't say so, and the performance is less well shaped than the English ones and, granted a tough musical proposition here, a bit hurried in many spots. The recording, too, is OK but a bit on the dull-sounding side.

"Hippolyte," Rameau's first opera, was one of those revolutionary works that threw the French into a tizzy of critical warfare, for and against—the Ramists and the Lullists (for the older master, whose monopoly of influence Rameau broke).

There is much colorful and boisterous popular-style music here, sailors' dances, mob choruses, etc., and the choral background of commentary is lovely. The solos are typically French, with thin, bright, wiry voices, ultra-accurate, and there is lots of accompanied recitative, a much freer dramatic style than in Handel's music of the same time. Marvellous orchestral accompanying music, also numerous suites of instrumental ballet music. A record to get to know, but at the beginning its style won't be easy and familiar as that of the Handel operas.

Couperin: Messe Solennelle (for organ). Gaston Litaize, organ of Saint-Merri.
London-Ducretet-Thomson DTL 93039

This is a gentle and most memorable organ recording, mild and not impressive at first but building up extraordinarily well as you play it again. It is a whole Mass, for organ only, numerous Gregorian chants set with florid counterpoint forming the great pillars of the work, interspersed with wonderfully ornamented quiet sections for the more colorful registrations on the organ, full of the highly expressive elaborate ornamentation of Couperin's time.

This is an interesting piece, since Couperin has been known mainly for his harpsichord music. If you have heard one of the several recordinsg of his "Leçons de Tenèbres," the Tenebrae, or Lamentations of Jeremiah, you'll jump to try this music, with its similarly lovely dignity, a bit stiff and starched but the more expressive for it. Fine organ recording and the French organ makes an interesting comparison with the numerous early German, Danish, Swedish organs we now hear on records.

Masters of Early English Keyboard Music. (Four centuries of music for Organ, Harps., Clavichord). Thurston Dart.
L'Oiseau-Lyre OL 50075/6 (2)

A two-record, one-man survey on three instruments, beginning with some raw and wild Mediaeval tidbits on the organ that will make you sit up. The organ, a 1760 "bureau" model of the English type, without pedals, is unusually colorful and alive.

The harpsichord is less interesting. Coming right after the organ, it is too loud and so rather unpleasantly heavy in tone. Mainly an engineering problem, since though the organ should by rights be louder, both are necessarily cut at the same standard level on the disc. The clavichord on the second side of the first disc is, again, at the same loudness as the harpsichord on the same side, whereas it should be much less loud.

Knowing this, you can treat the record as three Absolute recordings (see Scarlatti, above), setting each at a different and appropriate volume level for your own playback.

The organ music, all too brief, is the most appealing part for general listening. The harpsichord items, heavy in sound, center on side 1 around the Elizabethan period, with Byrd, Gibbons, Farnaby; the music on side 2, of the English "Bach-Handel" (18th c.) time, is aurally more endearing, especially the lively, Scarlatti-like Thomas Arne sonata. The clavichord music (again, too loud) is quite interesting—it comes over better than the harpsichord.

The second record (not mentioned on the album cover, by a printing mistake) covers but two composers and major ones, Byrd and Tomkins, the latter well known for his madrigals. This disc, being more consistent and less diffuse, makes for more purposeful listening. Byrd is all harpsichord, Tomkins has two organ pieces along with the harpsichord.

Johann Christian Bach: Three Quintets and Two Sonatas. Collegium Pro Arte.
L'Oiseau-Lyre OL 50046

The youngest Bach son, he of the Mozart-like style, is given an excellent work-out and survey in this German performance. The interesting items are the quintets with flute and oboe, highly colorful and airy works with plenty of life, if lacking in inner harmonic tension. The sonatas are for flute and harpsichord. This is a revealing display of the sort of music that led from "old" Bach and Handel on to Haydn, Mozart and Beethoven.

Four Concertos of the Neapolitan School (Paisiello, Durante, Auletta, Mancini). Ruggiero Gerlin, hps., Ens. Orch. de L'Oiseau-Lyre, Froment.
L'Oiseau-Lyre OL 5009

From the same in-between period, these lively works also illustrate the dynamic changes of style that led from the Bach-Handel-Vivaldi concerto grosso to the light and airy style of early Mozart and Haydn. These range from the Handelian music of Auletta (you'd swear it was Handel), to the Bach-like Mancini, the lighter style of Durante and the "Mannheim" fritters and furbelows of Paisiello. A very nice study in style.

Haydn: Three Trios, Piano, Flute and Cello. R. Veyron-Lacroix, pf., Jean-Pierre Rampal, fl., J. Huchot, cello.
L'Oiseau-Lyre OL 50036

Here's another nice item from the same period—these (early) Haydns are actually no more than keyboard sonatas, with extra baggage. The flute is virtually optional (as is the violin in the slightly later early violin sonatas of Mozart); its part is doubled in the piano and can be omitted entirely. The cello merely plays along to reinforce the bottom, in the old figured-bass style of Bach's time. It is

(Continued on page 78)

AUDIO ETC

(*from page 62*)

far cheaper than tape for amateurs can ever be.

What is a sensible home policy for tape and tape editing in this respect?

For all recording that is important to you, use either (a) fresh tape or (b) old tape in good condition that is not full of splices—preferably without any splices. One splice in a whole roll may ruin a crucial bit of your recording.

Don't save little bits. For that matter, don't save long pieces, even up to 25 or 30 feet, unless you want to go to the trouble of splicing a number of such pieces together for an extra experimenting reel, not to be used for permanent work. (But it takes a lot of tape fragments to make up even a short reel of this reclaimed scrap, at 1200 feet on a 7-inch reel.) It just isn't worth it, even for the most penny-pinching, poverty-stricken beginner.

Buy tape in larger lots, a dozen rolls if you can, and so get a discount that will make up for all the salvaged bits you can splice together in a dozen years.

There is only one exception to this healthy but difficult admonition, that you throw out all your tape fragments, even the long ones. The exception covers two possible uses for odd pieces of tape that belong in a forthcoming installment, but should be mentioned here. First, you will need short lengths of extra tape to splice into the middle of a reel on some occasions when you plan to re-record a section of material and are afraid that you may run on accidentally into the following part and so erase vital material that you can't afford to lose. If you will splice in a few feet of loose tape at the point where you plan to *end* your re-recording job, then in case you run over the original distance a bit you'll have that much emergency leeway waiting for you.

You run the risk of a "thump" across the splice, but better that risk than an accidental erasing of valuable material. I use this method again and again in my radio program when I am touching up work that isn't entirely satisfactory.

The second use for extra tape bits is as what I call background tape. Tape on which the background sound of your recording is heard, but without recorded content. You can always find bits of this in and around your recorded material and it's wise deliberately to record some of it at every recording session. Just let the machine run freely for a couple of moments at a point where no "program" material is happening—just silence, or rather, background noise.

If you will keep a dozen or so feet of this background-noise tape handy, you can insert very useful pauses and breaks into your recording in a completely natural and undetectible way, during the editing. Not only are breaks between musical numbers and the like possible, as short or as long as you may feel desirable, but you may even re-phrase your speech recording to a remarkable extent. Perhaps I should say re-pace; for you can add pauses for dramatic emphasis, for audible "punctuation" (to give the effect of a paragraph or a change of subject), or to slow down a delivery that sounds too hurried and breathless. You can improve a speech recording surprisingly in this fashion if you work at it.

Note that your background-noise tape should best be made at the same recording session as the material-proper, since different sessions, different occasions, produce varying types and degrees of background which won't mix. You can convert a liability—audience sound, coughs, autos, etc.—into an advantage by using it in your editing for a really "on-the-spot" realism.

Note finally that you cannot patch blank tape into your show for these purposes. The sudden "dead" sound is instantly noticeable, as is the equally sudden return of the otherwise unnoticed background-feeling. (See the discussion of this in the January installment). Professional editing makes far too much use of blank tape and even in the most professionally "dead" studio recordings it shows up for the ear as that effect of soundless "ionosphere" that I spoke of; it isn't any better because you happen to hear it (between LP bands, for example) on a highly professional commercial hi-fi recording, than it is in your own home-grown production.

* * * *

So far so good—and I haven't come any nearer to actual recorded sound than the faint hiss and rustle of background noise. This account is, more or less deliberately, hindside foremost, beginning with the purely mechanical aspects of home-grown tape operations. True, the very first thing you do in tape editing is to listen—but as far as technique is concerned, that comes last. You must get the mechanical aspects under control before your listening will do you any good.

Next installment will take up the listening aspects of home editing.

LONDON LETTER

(from page 16)

which lifts up discloses transcription turntable and pickup.

Finished in bird's-eye maple and walnut, three drawers are provided for storing 40 tapes each whilst other cupboards provide accommodation for about 100 records and a further 25 tapes. This equipment is connected to one pair of a four-pair circuit which runs around the house, out into the garden, garage, etc. The other three pairs are used for a main relay system somewhat similar to those provided in hotels. Three FM tuners, operating through 10-watt amplifiers, are kept permanently tuned to the three B.B.C. programmes. These tuners and amplifiers are controlled by a time switch so that they are switched on automatically in the morning and off in the evening. In each room there is either a built-in loudspeaker or a separate one each fitted with a 4-way station selector switch and a volume control. No other radio sets are used in the house.

AUDIO PATENTS

(from page 2)

The inventor gives a sample arrangement consisting of an amplifier rated at 10 watts output using a pair of 6V6's connected in class AB_1 with a plate-to-plate load of 10,000 ohms and a transformer ratio of 26 to 1. The loop to which the secondary is connected has an impedance of 15 ohms and uses a single wire composed of three strands each .029 inch in diameter. This arrangement covers an area of 1,000 square feet. He points out, by the way, that the amplifier should have plenty of negative feedback to minimize the effect of the inductive impedance of the loop on frequency response, and should be accurately matched to the loop, a series resistor being inserted if necessary.

Anti-Feedback System

One of the latest approaches to the cure of acoustical feedback in public-address systems is contributed to by John D. Goodell, a name not unknown in the audio industry, and Tenny Lode, and assigned to The Minnesota Electronics Corp. One of the methods disclosed is simple enough in principle not to require a drawing. The patent number is 2,723,316.

Sound from the input of the system—which is probably a microphone and preamplifier of some kind—is fed into a tape-recording head. This, plus a playback head and an erase head, is operated with a continuous loop of tape. The recorded sound is picked up by the playback head and sent to the rest of the system and the speaker, the speed of the tape and relative positions of the heads being such that the delay in time is negligible.

The gimmick is that the tape-loop speed is not kept constant. Instead it is constantly varied—whether in a random or periodic manner probably doesn't matter—so that what is picked up by the playback head is not at the same frequency as what goes into the microphone. And since feedback requires a continuous loop for a given signal, this breaks the loop at a point between the two heads. The limits and amplitude of the frequency change are not specified and I suppose if John Goodell says it's practical, it is. But I can just imagine the thing used in Madison Square Garden, adding additional mechanical vibrato to the already throbbing tones of some politico. The idea reminds me a little of the phase-shift vibrato system used in the Schober Electronic Organ kits. Not only does it make the music sound nice, but if you put your finger on a preamplifier grid it puts a lovely vibrato on the resulting hum!

The Goodell-Lode patent, by the way, also contains some details of another method, this one changing the frequency of all signals by a fixed number of cycles. It is all-electronic and rather interesting, but the explanation is a little more involved than we have space for.

AUDIO CLINIC

(from page 30)

rest, the mollecular motion within the crystal causes some current drift or flow. The crystal, having a high resistance, will therefore have a voltage developed across it although there is no external stress applied. When such a crystal is stressed, its resistance or impedance is changed, causing a change in the current. This causes a change in the output voltage. This stress, or bending motion, also produces great acceleration of the mollecular motion, causing even larger voltages to be generated which, again, vary because of the constantly changing resistance of the crystal under stress. In some commercially available phonograph pickups using this principle, voltages as high as three or more volts can be obtained at their output terminals.

Cabinet Finish

Q. I've heard that the finish used on the sound box of a violin has some effect on the sound of the instrument. Does this same situation exist in relation to speaker cabinets? Olive Torpe, Utica, N. Y.

A. The wood of which both the backs and bellies of violins are constructed is made very thin, since it is intended to vibrate in accordance with the motion of the strings. The finish on the instrument must, obviously, be one that will not diminish the ability of the wood to vibrate. Bridges and posts are used to convey as much energy as possible from the strings to the backs and bellies. Holes in the bellies allow the energy of the vibrating air columns inside the instruments to be transmitted into the surrounding atmosphere. The output from the strings, without this added reinforcement, could scarcely be heard. Even with all these precautions, the tone of a violin is fragile and easily masked; a string section of perhaps forty violins can easily be matched in acoustical power by the output from two oboes.

Speaker cabinets, on the other hand, are constructed of heavy wood—the heavier the better. Sand, or even concrete, is often used in an effort to minimize cabinet vibration; in some types of enclosure, sound-absorbing material is placed inside the cabinet to absorb the backwaves. Thus it is apparent that the type of finish used will not affect the performance of the speaker cabinet, for the cabinet should not be permitted to vibrate anyway.

TRANSISTOR PREAMPS

(*from page 40*)

a diode. If this diode has an impedance of the order of 12 megohms and a back current, at approximately 22 volts, equal (or nearly so) to the cutoff current of the transistor the circuit will be temperature compensated—provided also that the temperature coefficients of the two currents are similar. The collector diode of another transistor would appear to be the only device capable of meeting these requirements and while the purist is likely to be disdainful of the notion of using a transistor for such a simple function —with an unused electrode at that—it nevertheless remains a possible solution to the general problem. The matching of cutoff currents would certainly be tiresome and vexatious—virtually impossible to the experimenter with a limited number of units at his disposal although, at the equipment design level, it is not improbable that the stage could be designed to an acceptable tolerance on input impedance *vs.* temperature without resorting to an excessively large number of current brackets.

Figure 9 is a two stage amplifier with a power gain of 49 db from a 500-ohm source to a 5600-ohm load and a frequency response flat within 0.5 db from 20 to 20,000 cps. Although constructed with a 5-volt supply (four mercury cells) at approximately 800 µa, a similar design operating with one or two cells at somewhat lower gain is not particularly difficult. As in the case of the phono preamp the large emitter bypasses may be eliminated by changing to the type of regulation in which the base divider feeds from the collector at some sacrifice in stability and gain.

Compensation Methods

The network for high-frequency cor-

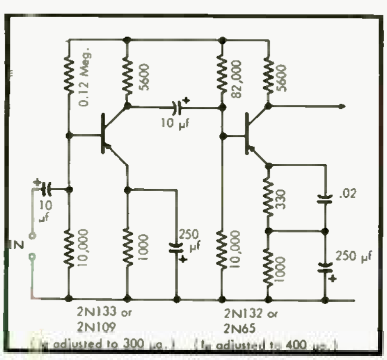


Fig. 9. Two-stage microphone amplifier with a power gain of 49 db between a 500-ohm source and a 5600-ohm load.

rection (to compensate for alpha cutoff in both stages) is in the second stage emitter in the form of an extra emitter resistor with a small bypass capacitor. Although there are severe practical limitations to this type of network as far as frequency range is concerned, it is quite adequate to the present purpose of providing flat response to 20,000 cps. The actual values will, of course, vary according to highest frequency of interest, transistor and circuit parameters, alpha cutoff, and so on, and are consequently more difficult to compute than to deduce experimentally. At the risk of appearing obvious, we may outline the following routine:

(1) Run a response curve of the uncorrected amplifier out to 1.25 or 1.5 f_H (f_H is the high end of the desired band).

(2) Insert an emitter resistor (without bypass) of such a value that the 1000-cps gain of the amplifier is now less by an amount 2 to 3 db greater than the loss at 1.25 f_H in the uncorrected curve.

(3) Add the bypass, computed to have the same impedance at 1.25 f_H as the resistor.

In the final curve, slight second-order curvatures will be discernible with magnitude depending upon the required bandwidth and the alpha cutoff of the particular transistors used. This is associated with the usage limitation mentioned previously and is due to the fact that, while alpha cutoff has essentially the same characteristic as an *RC* network, merging rapidly into a 20 db/decade slope, the frequency characteristic of a stage using a selective emitter network is a sigmoid with asymptotic limits at both ends. *Figure* 10 is a plot of stage gain as a function of external emitter resistance for a stage of reasonably average characteristics and loading. In *Fig.* 11, the corresponding attenuation from maximum gain has been plotted against frequency for a network having a crossover point of 25,000 cps. Since the maximum slope at any part of this curve is only 8 db per decade, a casual inspection might lead one to suppose that the device is not particularly suitable but (1) more slope may be obtained by increasing the value of the emitter resistor and (2) the actual corner of the alpha/frequency characteristic is somewhat more rounded than its *RC* analogy because of dispersion of charge carrier transit time, non-planar geometry, and so on. This effect mitigates the severity of the original problem of correcting the response to 20,000 cps although, for a band appreciably wider than this, it would be preferable to use r.f. transistor types.

For considerable amounts of treble boost, it may be more practicable to use an emitter network in more than one stage in order to avoid attenuating more than 15 db in any single stage. For the completely transistorized tape recorder amplifier in which both bass boost and treble boost may be required, a considerable excess of mid-frequency gain will be necessary and, if the over-all gain must be fairly high, a promising stage line-up would be:

1st stage: Wide open to secure good noise factor and controlled input impedance.

2nd stage: Collector to base network for low-frequency boost.

3rd and 4th stages: Emitter networks for treble boost.

In the event that the low-level stages must be restricted to three, it may be feasible to incorporate the treble boosting into the first and third stages—leaving the second free to handle the full swing of the low boost. The deciding factors are the relative amounts of mid-

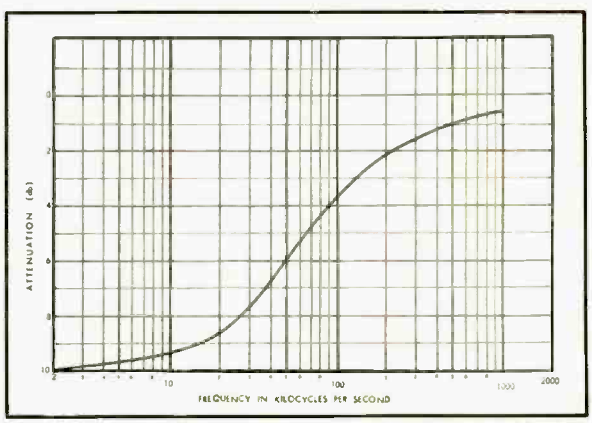


Fig. 11. Response of corrective emitter network to compensate for normal high-frequency droop of transistor.

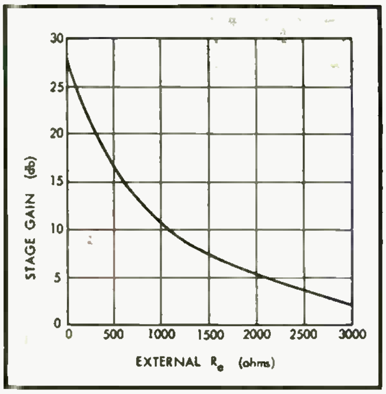


Fig. 10. Plot of stage gain vs. external R_e for a typical RC-coupled stage.

frequency gain and end-frequency boosting required.

Conclusion

By way of conclusion, we may be permitted to make some general remarks—particularly with respect to the noise factor.

The hallmark of a good transistor is its ability to withstand moderate increases of collector voltage and/or temperature without showing a substantial increase in the noise factor. These are also the units having:

(1) 1000-cps noise factor below 10 db.

(2) A noise power spectrum better than that of the average vacuum tube having an oxide coated filament or cathode.

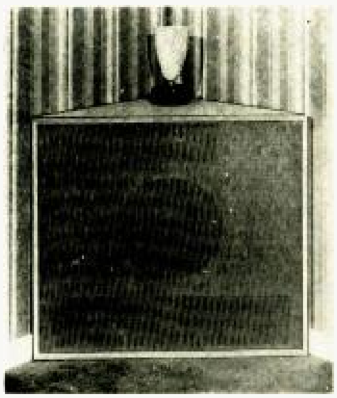
(3) The same (or slightly better) integrated noise factor over a band of 16 to 20,000 cps as the spot noise factor at 1000 cps.

(4) Wider tolerance to input mismatching without a significant increase in the noise factor.

However, for the purposes described in this account, the potential transistor user should not place an abnormal emphasis upon the desirability of securing units having factors of 4 or 5 db as against those having factors of 7 or 8 db. It is a demonstrable fact that a subjective listening test conducted to provide a direct comparison between systems differing in noise factor by as much as 3 db must be set up with virtually no time lag between the two—as by direct switching—in order to hear the difference and if the lag is as great as one-half minute, it is extremely difficult, if not impossible, to distinguish between them.

NEW PRODUCTS

• River Edge Corner Enclosure Kit. The new Kit No. 900, recently announced by River Edge Sales Corporation, 80 Shore Road, Port Washington, N. Y., is a deluxe do-it-yourself version of the popular corner speaker enclosure. Designed according to sound acoustic principles, the No. 900 kit is a true horn-loaded enclosure dimensioned for optimum reproduction. It will handle all standard speakers, including tweeters of any size and shape. It is a completely self-contained cabinet making use of a front, top, and two sides. Deluxe

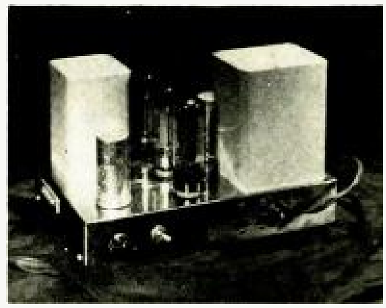


furniture features include a decorative grill cloth covering the entire front. Full description and illustrated literature will be mailed on request to Dept. V-A1 at the address shown above. **A-9**

• TruLine Reproducer Arm. Elimination of tracking error through linear travel of the pickup carriage is accomplished in the TruLine reproducer arm. It is engineered in such a manner that the reproducing stylus travels the exact path established by the recording stylus at the time the record was made. The TruLine arm is available in both binaural and monaural models, differing only in the fact that the former is equipped with two pickup carriages. Since both carriages function independently, the binaural model may be used for standard records when desired. Each carriage is provided with a simple adjustment to balance the weight of the cartridge to meet the manufacturer's recommended tracking force. Both models are designed for automatic indexing. Rotating the index knob to the desired record

size, then raising and lowering the arm, automatically positions the stylus in the run-in groove. Both arms are equipped with precision jewelled bearings. All parts are machined. Audio Specialties Company, 13167 Steel Ave., Detroit 27, Mich. **A-10**

• Fifty-Watt Ultra-Linear Amplifier. Intended for professionals and for high-fidelity enthusiasts who are particularly demanding, the Gott Model G-50-D studio amplifier meets the highest standards of audio development. A 50-watt basic amplifier, it is stated to have a frequency response of 5 cps to 200 kc, distortion 0.1 per cent at 35 watts, and noise level down 99.7 db below maximum output. The circuit employs 22 db of negative feedback. Features include ultra-linear output stage, variable damping control, and variable a.c.



dynamic balance. Recovery to overload is instantaneous and transient stability is claimed to approach perfection. Manufactured by Bigg of California, 2506 W. Washington Blvd., Los Angeles 18, Calif. **A-11**

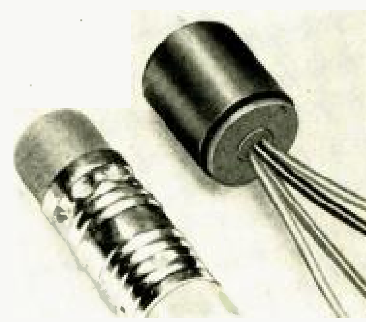
• Knight Music Distribution System. Featuring a Knight 24-watt high-fidelity amplifier and supplied complete with microphone, record changer and two 12-in. speakers, this new system is ideal for making voice announcements and for

affording background music in restaurants, lounges, factories, offices, waiting rooms, etc. The amplifier is equipped with separate tone controls for bass and treble, and contains a loudness control which assures full-range sound even at very low volumes, an important feature when the system is used for low-level background music. Amplifier frequency response is 20 to 40,000 cps at full output. The changer is equipped with a G. E. magnetic cartridge. The microphone is a Shure reluctance-type Model 520-SL. Speakers are G. E. Type S-1201-A mounted in Argos bass-reflex corner enclosures. Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. **A-12**

• Starlight Hi-Fi Turntable. Dubbed the "Starlight" as a token of its quiet and dependable performance, this new turntable is of the center-drive type and operates at four speeds, including 16 2/3 rpm, all of which may be adjusted to perfect pitch by means of a variable-speed

drive and a built-in illuminated stroboscope. The motor is of the conventional 4-pole type and is fully shielded to assure minimum hum when magnetic cartridges are used. Adding to the silence of the Starlight's operation is the manner in which the drive motor is fully encased and cast in lead to eliminate vibration. Wow and flutter are less than 0.2 per cent rms. The turntable is machined of aged aluminum to close tolerances for excellent balance. The entire unit is mounted on heavy-gauge aluminum plate with the vernier-type speed control conveniently located and clearly marked. For complete information write to Dept. D, Metzner Engineering Corporation, 1041 N. Sycamore St., Hollywood 38, Calif. **A-13**

• Transistor Transformers. Deci-Ouncer transformers, recently introduced by United Transformer Company, 150 Varick St., New York 13, N. Y., advance the concept of such units for use in transistor applications. Remarkably small in size

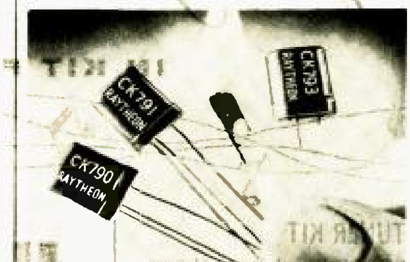


(only 0.03 cu. in. volume), Deci-Ouncers operate at very high efficiency. They permit excellent frequency response considering their small size, being down only 1 db at 200 cps at 100 mw. Fully cased. They are hermetically sealed for long life. Eight standard models cover most transistor requirements. Literature is available on request from UTC. **A-14**

• Altec Lansing Speaker. The new Model 401A is an 8-in. full-range industrial speaker designed particularly to meet the requirements of public-address installations and various types of commercial sound systems. The unit has a power ca-

pacity of 14 watts. Impedance is 8 ohms and cone resonance is 75 cps. Voice coil diameter is one inch. Installation of the 401A is facilitated by the fact that the entire assembly is only 3⅝ in. deep. Altec Lansing Corporation. **A-15**

• Raytheon High-Temperature Transistors. Design engineers will find welcome interest in the new Raytheon PNP silicon transistors for high-temperature applications. Intended primarily for audio and low r.f. equipment, Types CK790 and CK791 have power gains in a typical audio amplifier of 32 and 34 db, respectively.



Current gains are 14 and 24 times. The CK793 is a low-noise transistor for low-level audio preamp circuits, typical units having a noise factor from below 10 db to a maximum of 15 db. Collector dissipation at 135° C. is 50 mw. Complete data is available from Technical Information Service, Raytheon Manufacturing Company, 55 Chapel St., Newton 58, Mass. **A-16**

• Fairchild Turntable. Operation which is exceptionally free of vibration, and rumble content lower than that of most records, are inherent in the new Fairchild Turromatic "400" home turntable. Typical measurements of flutter and wow show less than 0.07 per cent rms at 78 rpm and

less than 0.1 per cent at 33 1/3 rpm. An automatic pressure release prevents flats from developing on the idler, as pressure is applied only when the motor current is on. Additional details can be obtained from Fairchild Recording Equipment Company, Whitestone 57, N. Y. **A-17**

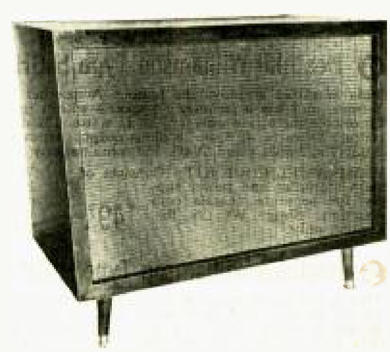
• Fisher FM Tuner. Superb performance, engineering excellence and moderate cost are combined in the new Fisher Model FM-40 tuner. Among its specifications are many features normally found only in tuners designed for professional use. Sensitivity is 3 microvolts for 20 db quieting. Frequency response is within ±1 db from 20 to 20,000 cps. Circuitry in-

cludes a three-gang variable capacitor, three i.f. stages, and a cascode r.f. stage. The chassis is completely shielded and shock-mounted. Tuning accuracy is assured by a panel-mounted meter which indicates center-of-channel reception. The FM-40 is self-powered and may be used with any high-quality audio amplifier. Fisher Radio Corporation, 21-21 44th Drive, Long Island City 1, N. Y. **A-18**

• Rek-O-Kut Turntable Arm. Although meeting professional standards in every respect, the new Rek-O-Kut pickup arm is a modestly priced unit intended primarily for home music systems. The arm proper is of tubular construction. The cartridge shell, made of die-cast aluminum is attached to the arm by means of a bayonet-lock arrangement which permits instant cartridge interchangeability. Silver plating and spring loading assure positive contact. Arm resonance is considerably below the usable audio band. The base is an aluminum die-casting with provision for raising and lowering the arm to coincide with the height of the turntable. Dual ball-bearing races are employed for movement in the horizontal plane and vertical compliance is achieved by the use of special 1-mm-diameter chrome-steel balls in a

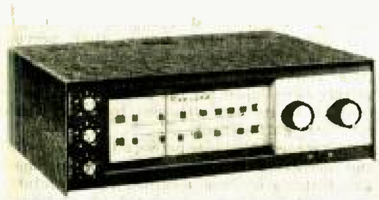
bearing which is virtually friction-free. Precise stylus pressure adjustment is obtained by means of a counterweight which is threaded to the rear end of the arm. For further information, write to Rek-O-Kut Company, 38-01 Queens Blvd., Long Island City 1, N. Y. **A-19**

• Stephens Low-Boy Enclosure. Known as the "Catalina," this handsome new speaker enclosure features a fully-expanding rear-horn-loaded acoustic chamber with all front radiation. It is capable of handling virtually any type of speaker system in which the basic unit is a 15-in. driver. When used with a high-quality two-way system, such as the Stephens Model 801 with 800-cps crossover, the Catalina provides ample room for the addition of the Model 214 super tweeter and its associated 5000-cps network, thus making a complete three-way system available in a moder-



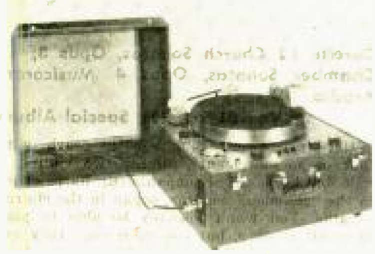
ately small enclosure. Dimensions are 36"w x 30"h x 20"d. Finishes are blonde, walnut, mahogany, with grill cloth in beige, bronze, or random gold. Stephens Manufacturing Corporation, 8538 Warner Drive, Culver City, Calif. **A-20**

• Rauland "Golden Ensemble" Hi-Fi System. Combining three units in a single compact cabinet, the new Rauland Model HF335 "Golden Ensemble" consists of an AM-FM tuner, a preamplifier-control, and a 12-watt amplifier. Addition of a speaker and a record player is all that is required to complete a high-quality home music system. The tuner has separate front ends for AM and FM. The FM section has a tuned r-f stage, discriminator with dual limiters, AFC with defeat on function switch, and incorporates drift-compensated circuitry throughout. FM sensitivity is 3 microvolts for 20 db quieting. Amplifier frequency response is 20 to 20,000 cps within ±0.5 db. Separate tone controls afford both boost and cut of 16 db at 40 and 10,000 cps. A panel-mounted toggle switch permits a choice of regular volume control or loudness control. An exclusive feature is a special TV control position intended for use with the Rauland TV55 television sound tuner which permits hi-fi reproduction of TV sound over the home music system. The HF355 measures only



5¾"h x 15¾"w x 11½"d. It is housed in a charcoal black cabinet with marbleized gold finish. Complete details covering both the HF355 "Golden Ensemble" and the TV55 television sound tuner are available from the Rauland-Borg Corporation, 3515 W. Addison St., Chicago 18, Ill. **A-21**

• **Presto Disc Recorder.** Compactly built and housed in a portable carrying case, the new Presto Model K-11 is a disc recorder intended primarily for home and semi-professional use. It affords three-speed recording and playback without any adapters, cuts both standard and microgroove records, incorporates two separate speakers—tweeter and woofer—in the carrying case lid, and is furnished complete with a quality crystal microphone. Both record-



ing and playback amplifiers are self-contained. An advance ball is furnished for microgroove recordings. The control panel includes a VU meter, level controls, a high-frequency equalizer, and a tone control. Choice of recording, playback, and public-address operation is made by means of push-button selectors. The K-11 will cut any disc up to 13-¼ in. diameter. High fidelity enthusiasts who have their own amplifying systems may purchase the K-11 without amplifiers. Presto Recording Corporation, Paramus, N. J. **A-22**

• **Hi-Fi Microphone.** Of special interest to hi-fi enthusiasts and semi-professional recordists, the new American D-300 Series dynamic microphone is built to meet broadcast standards for quality, yet is

equipped with a built-in transformer to meet the high-impedance input requirements of modern high-fidelity amplifiers and tape recorders. Frequency response is 40 to 15,000 cps. The microphone is equipped with the new Cannon Type XLR "quiet" connector, which eliminates annoying clicks and crackles when the unit is carried. Weight of the D-300 is only six ounces and length is 4⅜ ins. A miniature desk stand is available as an accessory. American Microphone Company, Pasadena, Calif. **A-23**

BE YOUR OWN RECORD CRITIC

Choice of LP records for three best reviews sent in each month.

Simple as that! Just write your own review on the record selected by Mr. Canby for the "Problem of the Month," send it in, and perhaps yours will be one of the fortunate three chosen by the judges. If your review is first, you may select any three records reviewed in this issue; if yours is second, you may select two; the third choice may select any one record. Your selections will be shipped to you postpaid at no cost to you.

Each month, Mr. Canby will name one record as the "Problem of the Month." Listen to it, study it both as to music and as to recording quality. Then write a brief review on a postcard—no other entries will be considered—and send it to AUDIO, Dept. RR, P. O. Box 629, Mineola, N. Y. so that it arrives on or before May 4, 1956. Winners will be announced in the June issue, and the review chosen as first will be published, along with Mr. Canby's own review, in the same issue.

For this month's problem, Mr. Canby has selected:

Kid Ory's Creole Jazz Band
Good Time Jazz 1-12008

Buy it, borrow it, or just listen to it somewhere—then tell us what you think about it.

RULES

1. Decisions of the judges are final and no correspondence will be entered into regarding entries or choices of the judges.
2. Reviews of the selected record must be submitted on a government postcard. No others will be considered.
3. Only one entry will be considered from each contestant.
4. All entries are to become the property of Radio Magazines, Inc., and the one chosen as first will be published.
5. From the list of records reviewed by Mr. Canby in the issue in which the "problem record" is announced, the writer of the review chosen as first will be given three records of his choice; the writer of the review chosen as second will be given two records of his choice; the writer of the review chosen as third will be given one record of his choice.
6. Entries will be judged on the basis of both musical and technical accuracy. Neatness and form will not count, but the reviews must, in the opinion of the judges, be sufficiently legible to be read easily.

RECORDS

(*from page 67*)

wholly unnecessary here, though it would add bulk if a harpsichord were being used instead of a piano, as originally envisioned by Haydn. No solo cello work at all.

But the music is lovely of its sort. Those who know the Haydn piano sonatas will find these works very much like them, on a slightly larger scale. Rather dull recording, evidently L'Oiseau-Lyre's own home-grown product—see the Rameau opera above.

3. THE VOICE OF VOX

Sweelinck: Harpsichord Music (Fantasias and Toccatas; Vars. on Secular Tunes and Dances). Helma Elsner.

Vox PL 9270

Well, maybe you've never heard of old Sweelinck. If not—then get introduced, even if solely via his harpsichord music, to the jolliest, most solid old Dutchman you'll ever run into, musically speaking. He was truly a first rate master and a showman too, as well as an expert in all the tricks of counterpoint and structure. He had a masterful sense for the apt tune and the danceable rhythm. All this, of course, back in the late 16th and early 17th centuries—a bit before our official Century for this article, but let that pass. This man was a musical Peter Breughel.

This record makes an interesting contrast to Thurston Dart's of Byrd and Tomkins, from England of the same time (see above). This one is immeasurably easier in the listening. Part of it is in the more dramatic playing of Elsner. Part, too, is in the modern sweep of expression that showman Sweelinck commanded. Byrd, in England, was a great composer but no showman and no extrovert. His keyboard music has that peculiarly British antique quality that persisted—beautifully—until the time of Handel a century later. Britain was an isolated island, remember.

One side of this record goes to the brilliant and complex Toccatas and Fantasias for keyboard, full of chromatics, echo effects, high harpsichord coloration. The other is given over to some of the astonishingly bright variations on popular tunes in the Sweelinck repertory. It is interesting that these memorable old tunes were also used for keyboard variations in England—Sweelinck's "Fortuna werd ich getrieben" is in England "Fortune, My Foe" and well known, the sturdy tune "Est-ce Mars" also appears in British music, as does, if I remember, the wonderful melody "Mein Junges Leben," "My Young Life is at an End." Highly catchy tunes, and brilliant keyboard variations upon them, and Helma Elsner does a most intelligent and alive job in the playing. A fine harpsichord disc.

Bach: Harpsichord Concertos in D Minor, E Major. Helma Elsner; Pro Musica Orch., Stuttgart, Reinhardt

Vox PL 9510

Bach: Concerto for Two Harpsichords in C Minor; Concerto for Oboe and Violin in D Minor, Concerto for Two Harpsichords in C Major. Helma Elsner, Rolf Reinhardt, harps., Will Beh, vl., F. Milde, oboe, Pro Musica Orch., Stuttgart, Reinhardt.

Vox PL 9580

Two excellent concerto recordings, featuring the same vigorous lady harpsichordist as above (aided by the conductor in the concertos for two instruments). This is fine Bach playing, smoothly phrased and without bouncing and jouncing, happily minus that nervous tautness which so often spoils "big-name" Bach recordings. The orchestra is positively velvety here—good for the music, which comes through in its own vigorous terms if played thus straightforwardly.

The recorded balance between harpsichord(s) and orchestra is remarkably well managed. The instruments are recorded rather faintly, at a distance and surrounded by orchestral sound, which is precisely right for the music. Too many recordings blow up the harpsichord into a grossly ugly musical bull-in-a-china-shop. Yet, faint as they are, not a note from these harpsichords is inaudible, and the slow movements with their solo harpsichord melodies are particularly lovely.

You'll enjoy the concerto for oboe and violin too, with an oboist whose vibrato is almost human, like a singing voice. And after a playing or two you'll discover, perhaps to your amazement, that this concerto is the same music as the preceding concerto for two harpsichords. It is, in truth, a reconstruction of a lost hypothetical original, that from which the two-keyboard work had been arranged, by Bach.

Corelli: 12 Church Sonatas, Opus 3; 12 Chamber Sonatas, Opus 4. Musicoram Aradia.

Vox DL 163 (3); Special Album

Here are twenty-four sonatas, each with four or so movements, all for two violins, a cello and keyboard accompaniment, harpsichord in the "chamber" sonatas, organ in the church sonatas. You won't possibly be able to play them all at once, but you need not; they are all sweetly melodic, making for easy, melodious listening, the two violins floating in a silvery duet above the accompanying music. Recording of both sets is big and live, sounding larger-than-life, almost orchestral. Playing is excellent. An enormous and profusely decorated booklet gives a long and interesting history of Corelli's life, plus detailed study of every work, and a plethora of comparative charts and the like, the latter of so-so interest to non-musicologists. (Cf. The Westminster Corelli album, reviewed earlier in this column.)

Note that in these two Corelli albums alone there is recorded one half of that master's entire published life output. The LP revolution!

Lalande: De Profundis. Soloists, Chorus of Radio Stuttgart, Pro Musica Orch., Couraud.

Vox PL 9040

On LP the men of the past in music emerge again from the mists of time—as who would have thought possible. Rameau, Couperin, in France, then the once-famous Marc-Antoine Charpentier, now restored, and on this record another once-famous composer of Louis XIV, Lalande. Make no mistake, these were big men in their time, profound musical thinkers, enormously respected composers of the highest rank. But we are so steeped in the German and Italian music of the time that the French is still a rather unfamiliar variant of the basic style for our ears—and to the ears of the French, too, who did not worship their musical ancestors as heartily as did the Teutonic countries.

This is a big piece with all the trimmings, but in a clearly "pre-Bach" style as of the late 17th century. Most notably, it is cast in fragmentary form, many short and dramatic sections and few formal "pieces" uninterrupted by dramatic changes. That was the method of earlier composers of the time—Monteverdi, Schütz, Purcell. But the harmonies are full 18th century "Bach-style," though there is the characteristic French ornamentation.

The German performance (under an imported conductor) leaves a mixed impression. Rather too grandiose and over-Romantic, I'd say, with a consequent loss of rhythmic security and shape, in favor of much fervor. The sound is immense; the solos, Germanic rather than French, are good.

But I'd like to hear an all-French try at this music, to get, so to speak, a triangulation "fix" on it. It's a kind of music that has an increasing attraction for us today.

4. ANGEL, VANGUARD, PERIOD

Pergolesi: La Serva Padrona. Rosanna Carteri, Nicola Rossi-Lemeni; La Scala Orch., Guilini.

Angel 35279/L (1)

Here is the famous short comic opera, with its two characters, in a rousing and effective performance. Both singers are excellent, the bass a hearty Don Giovanni type, wonderfully masculine (and eternally frustrated—until the end), the soprano exactly the right blend of coquettish fury and feminine appeal! Gorgeous Italian enunciation. Big, solid string accompaniment—too big, but very nice in the sound. Note that this opera, too, sent the French in Paris into a tizzy of critical warfare, French *vs.* Italian. As we know, the French are always going into tizzies.)

Pergolesi: String Concertinos #1 to #6; Sonata in stile di concerto; Sinfonia per violoncello. I Musici.

Angel 3538B (2)

The famed I Musici present some stylish problems in their playing which can make for interesting listening. Only eleven players, they perform much concerto-like material in what is perilously close to a modern "chamber" style, with an intimacy and lightness that suggests, perhaps, the Mendelssohn Octet—true chamber music, wholly non-orchestral. This is in contrast to the familiar tendency to build up small-scale concerto music of this period into orchestral impressiveness, as in so many performances of Bach, Handel, and Vivaldi. In I Musici's playing the contrast between solos and "tutti"—orchestra—tends to be blurred, and the continuo for harpsichord, invariably present in German and English performances (and indicated, too), is mostly absent or inaudible.

But Pergolesi's music itself titillates tantalizingly on the border between "chamber" and "orchestral" and so I Musici's viewpoint here is more than usually valid. The playing is dramatic, light and transparent without a trace of orchestral ponderousness—which some will miss, rightly or wrongly. Who knows?

You'll find the same little string concertos on Westminster, for an interesting comparison, as played by a Swiss orchestra in the more usual non-chamber style.

Pergolesi: Stabat Mater. Stich-Randall, Hoengen; Vienna Akademie Kammerchor, Vienna State Opera Orch., Rossi.

Vanguard (Bach Guild) BG 549

The famous work for treble voices—soprano and alto solos, plus an occasional chorus—is here given the full Viennese treatment, with the titular majesty of the Vienna State Opera Orchestra, i.e. the Vienna Philharmonic, added to the prestige of soloists Stich-Randall and Hoengen. A gorgeous sound throughout and a very moving performance.

My only reservation, mainly intellectual, is the "I Musici" argument (above): should this music sound as big and "orchestral" as this? I honestly doubt it, though the presence of a choral fugue more or less indicates a certain bigness of concept.

Most of the music is as thinly and sparingly written as the "Serva Padrona"—it could be played with a handful of fiddles and a keyboard plus supporting bass. Borderline music, again, and as such quite fascinating.

Vivaldi: Concertos for Two Trumpets in C, E Flat; Concertos for Oboe in D Minor, F. Solos; Concert Hall Symphony, Ackermann; Winterthur Symphony, Dahinden.
Concert Hall CHS 1242

What a master of sheer monumental brilliance was old Vivaldi! Given two valveless trumpets, that could play the notes of the overtone series only—what could be done? Listen and you will hear. Both trumpet concerti are extraordinarily rich and ornamental works, outblasting our feeble radio "entrance music" fanfares 100 to 1 with ease. Relatively immoveable music, static, but realizing the full majesty of the mighty brass sound. In those days of horse and man power, minus machines, what a gorgeous effect of strength this sort of music must have made!

The oboe concerti are, relatively, more routine, that being the only word when one considers the hundreds of Vivaldi works now reappearing for our enlightenment. The first of the two is the more striking, with an unusually forceful last-movement idea, many times repeated. Big, live, clean recording, fully "hi-fi" though—wonderful—the jacket doesn't even mention that word.

(Note that Concert Hall is still very much worth watching, though the company's bloated offspring, Musical Masterpiece Society, not to mention its Jazz and Opera relatives, has distracted most of its attention and Concert Hall records are now rather haphazardly distributed. Hard to get, but worth it.)

Bach: Works for the Lute. (Suite #1 in E Minor, #3 in G Minor; Prelude and Fugue in E Flat). Michel Podolski.
Period SPL 724

Bach for the Lute? Yes, and Period has obligingly reproduced on the cover a manuscript in Bach's own hand, headed in his handwriting, "SUITE POUR LA LUTH, PAR J. S. BACH."

The lute was antiquated and on the way out, but as we well know, Bach had an extraordinary sense of instrumental color and a curiosity as to the possible uses he could make of many exotic instruments; he used the viola d'amore, the gamba, the oboe d'amore, the recorder—and the lute, even in his largest works, such as the St. Matthew Passion, and always with a special and wonderful effect in mind. It is an increasing pleasure for us to discover his prowess, as we restore these color-instruments to his music in they way he intended.

Note that the big lute, related to the present guitar, has a wider tonal range with bass notes far below those possible on the guitar. Its tone is flutier and less juicy, but it gets over its complex effects, one-handed, more adroitly than the guitar.

This disc, then, is highly recommended to all guitarists who have a yen for "classical" stuff on their instruments. It'll make you feel much more important when you play Bach yourself, à la Segovia.

Renaissance and Baroque Music for Lute and Guitar. Karl Scheit, guitar.
Vanguard (Bach Guild) BG 548.

Here's the classical guitar, for a good contrast to the lute, above. The record covers a pile of music, ranging from the 16th century through the 18th, the composers largely unfamiliar; most of it was written originally for the lute and so is of course appropriate for the guitar—if you aren't a lutenist.

Mr. Scheit's playing is technically proficient and nicely colored, but after awhile it seems to plod. Musically he is sincere, earnest, concientious, hard-working. I suspect that many an amateur guitarist will not only thank him for the wide display of interesting repertory here, but also for the chance to play the same music with more life and verve.

ORGAN REPRODUCTION

(from page 28)

monaural, or stereophonic sound.

Four brief selections were chosen to illustrate various properties of the organ, including its mellowness on soft passages, its full dynamic range, the purity of its upper registers, and the directional effects made possible by the locations of its two groups of pipes. These were recorded an hour before the performance.

Changeover from recorded to live sound was done by visual signals between the organist and the operators. Although the organist was not wearing earphones and was unable to monitor the outputs of the recorders, his tempo was so accurate that he was rarely more than a fraction of a note away from the recorded music when a switchover was made.

The Result

At most locations in the rear half of the church, it was nearly impossible to detect the switching from live to recorded sound. Even monaural playback sounded enough like the organ to confuse many listeners. During the final selection, the signal lights were switched off, and the transition from live to monaural and stereophonic playback, followed by several alternate periods of each method of playback, was made without being detected by most members of the audience.

At certain places in the church, particularly near the front, some tape hiss and hum were audible at times. This usually was the only indication that a recording was being played. Even where differences were detectable at changeover, it was usually not possible to determine which sound was live and which was recorded, without assistance from the signal lights.

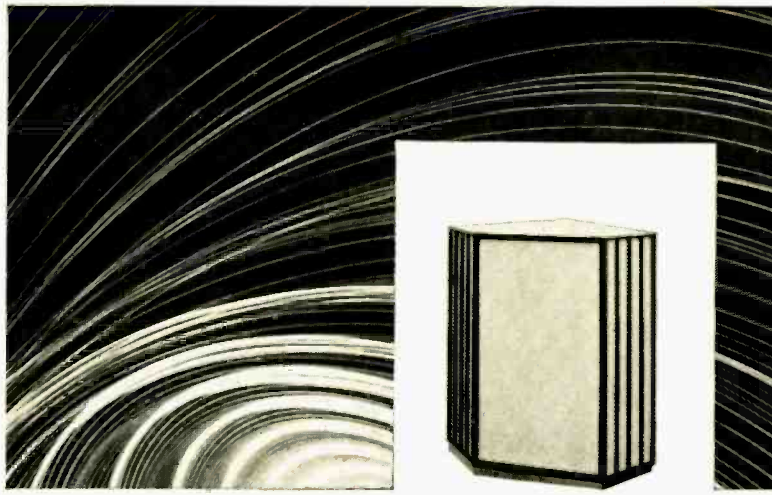
Our conclusions, as a result of these experiments, concurred with by virtually all who heard them, are:

(1) True-fidelity or facsimile recording and reproduction of the pipe organ in its original environment has been accomplished.

(2) The audio art has progressed to the point where high quality amplifiers and loudspeakers, designed for home use, are capable of virtually undistorted, true-fidelity performance, when supplied with input signals of comparable quality.

Acknowledgments

In addition to the individuals and companies named earlier, this experiment was made possible through the wholehearted cooperation of St. Mark's Episcopal Church, Mount Kisco, N. Y. Valuable assistance was also rendered by the members of the Harmonic Hill Radio League, James Wallace and Gladden B. Houck, Jr. Photographs by Ed. Dombert.



SIMPLITRONICS

(from page 29)

the mathematical feedback equation and at the same time clarify the symbols of this formula. This equation is written

$$Gain = \frac{A}{1 - \beta A}$$

where $Gain$ = voltage gain of the circuit under consideration with feedback,
A = amplification without feedback
β = feedback factor.

β is the Greek letter beta, and is the symbol used to designate the feedback factor—the fraction of the output voltage fed back. This value may also be expressed as a percentage. Let us now insert the foregoing data in the feedback equation.

A equals the gain without feedback, which is 39. β equals the fraction or percentage of the output voltage fed back, which is 1.17 divided by 9, or 0.13. Therefore, the gain with feedback is equal to,

$$\frac{A}{1 - \beta A}, \text{ or } \frac{39}{1 - (-0.13 \times 39)}, \text{ which is } \frac{39}{6.07}, \text{ or } 6.43.$$

To express the feedback voltage as a percentage we multiply β by 100, or 0.13×100 equals 13 per cent. It can also be given in decibels and the reader familiar with logarithm tables will have no difficulty with the expression, $db = 20 \log E_2/E_1$. Here we ascertain the ratio of the voltage gains, find the logarithm of this ratio from a log table, and multiply the log of the ratio by 20. It is worked out as follows,

$$db = 20 \log \frac{39 \text{ (v.g. without feedback)}}{6.43 \text{ (v.g. with feedback)}}$$

and this ratio equals 6.07. The logarithm of 6.07 is 0.7832, and 20×0.7832 equals 15.7 db. Thus it can be stated that we have introduced 15.7 db of negative feedback. The feedback in decibels may also be found by employing the ratio of the voltages of the input signal from the audio oscillator with and without feedback in the same manner. The above figures are accurate for all practical applications; the answers were found on a slide rule and the results rounded off for simplification.

The foregoing study of feedback voltage has been made with resistance only in the feedback circuit which permits feedback voltage to be of about the same magnitude throughout the audio-frequency band. Frequency-selective circuits may be used which will result in variation in the amplitude of the feedback voltage with frequency. It is beyond the scope of this present article to analyze these circuits. The *Radiotron Designer's Handbook*[2] is an excellent reference for further study of feedback voltage.

[2] Tube Department, RCA, Harrison, N. J.

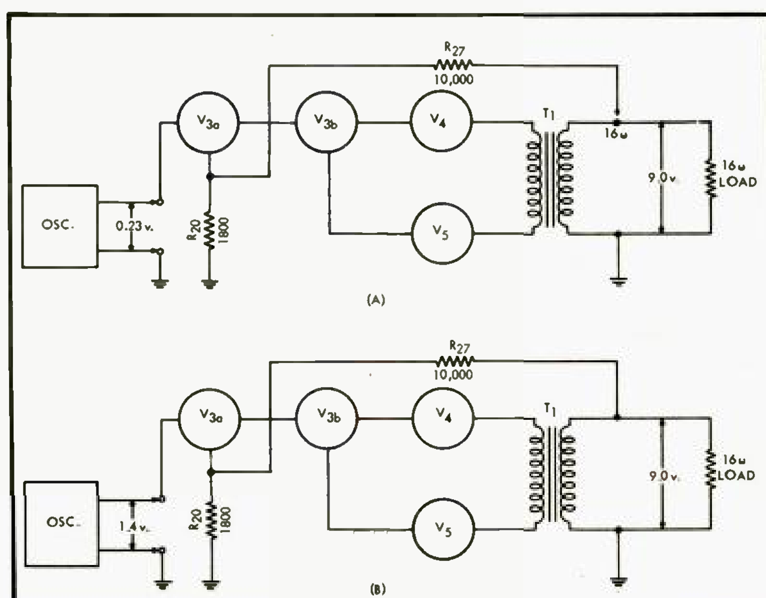


Fig. 3 (A) Circuit arrangement for measurement of amplification without feedback. (B) Same circuit with feedback loop connected for measurement of gain with feedback.

NEW LITERATURE

• **Electro-Voice, Inc.,** Buchanan, Mich., has just issued Bulletin 222, a comprehensive, colorful brochure on E-V Circlotron high-fidelity power amplifiers, amplifiers with controls, and music control centers with preamplifiers. The publication gives complete technical data, specifications, and prices on 15-, 20-, 30- and 50-watt power amplifiers, 15- and 20-watt enclosed lowboy amplifiers with external controls, and enclosed modular music control centers for use with E-V power amplifiers and AM-FM tuners. The bulletin also includes information on the new E-V 100-watt high-fidelity amplifier for multispeaker installations and professional applications. Your copy will be mailed free on request. **A-1**

• **University Loudspeakers, Inc.,** 80 S. Kensico Ave., White Plains, N. Y. announces the availability of a new guide to Progressive Speaker Expansion. Known as the PSE guide, it is complete in every detail. It contains detailed information for expansion of speaker systems to their full potential, illustrating step-by-step expansion with simple color-coded charts. Included in the guide are data on the use of adjustable networks, dual-impedance woofers, adjustable-response woofers, midrange speakers, and tweeters of various types. In addition, the complete line of University speakers and network components is illustrated with all important specifications. Your copy may be obtained without charge by writing to the attention of Desk LA32 at the address shown above. **A-2**

• **International Resistance Company,** 401 N. Broad St., Philadelphia 8, Penn., offers Bulletin A-3 describing the new IRC Type 2W variable wire-wound control, which is ideally suited for many electronic applications such as outdoor-movie speaker control, and control for test and measuring instruments. The cover of the unit is so styled that, for all practical purposes, it may be considered dust-proof. Bulletin A-3 will be mailed on request. **A-3**

• **Fine Hardwoods Association,** 666 Lake Shore Drive, Chicago 11, Ill., offers a wealth of information to anyone who specifies, buys, or sells hardwoods in the "Fine Hardwoods Selectorama," a handy reference guide which has just been published. More than 400 commercially available species of hardwoods are described, giving geographical sources, color, pattern, common uses, availability, and general price range. In addition, 146 of the most popular hardwood figure and species types are handsomely illustrated, 38 in full color, as an aid in specifying or identifying woods. An especially valuable feature of this 60-page reference book is a chart of the comparative physical properties of 65 of the most widely-used hardwood species. Each wood's ratings are given for specific gravity, weight, strength, stiffness, hardness, shock-resisting ability, bending strength, and shrinkage. This book will be of great value to anyone engaged in the design and construction of equipment and speaker enclosures. Copies of the "Fine Hardwoods Selectorama" can be obtained directly from the Association at $1.50 per copy. **A-4**

COMING EVENTS

(from page 10)

May 1–3—Joint Electronic Components Conference, I.R.E., National Bureau of Standards, Washington, D. C.

May 21–24—Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago, Ill.

June 17–23—Second International Congress on Acoustics. Registration at Mass. Inst. of Technology, Cambridge, Mass.

Aug. 21–24—WESCON, I.R.E. Convention and West Coast Electronic Manufacturers Association show, Pan Pacific Auditorium, Los Angeles, Calif.

September 27–30—New York High Fidelity Show, New York Trade Show Building, New York. Sponsored by Institute of High Fidelity Manufacturers, Inc. and the Audio Engineering Society.

October 4–7—New York Audio Fair, Hotel New Yorker, New York City.

PROFESSIONAL HOME MUSIC SYSTEM

(from page 25)

TV/FM tuner. When not in use, the front panel of the drawer is flush with the rest of the rack, which makes for a neat appearance. Both the changer and the transcription arm use plug-in cartridges, so that only one stylus need be replaced at a time, instead of having to replace two when only one is worn out. Diamond styli are used throughout; which not only gives less record wear, but provides a needle which actually costs less in the long run than any other type.

Both the tape recorder and transcription turntables are powered by hysteresis-synchronous drive motors. There has always been a great misunderstanding about this type of motor in that the user feels that it is included to reduce or eliminate flutter or "wow." Actually, exactly the reverse is true, for a synchronous motor creates flutter. The very principle upon which it is built requires that the motor make instantaneous speed changes. This motor locks itself to the a.c. power-line *frequency* rather than to the voltage. Then, if the frequency changes, the motor will speed up or slow down. This continual "hunting" for the proper speed shows up as flutter.

The great advantage of this type of motor is that over a period of time it will average its rated rpm. This results in superb timing in tape and disc recorders and players, sometimes as little as one second timing error in 30 minutes. The inherent flutter due to hunting is minimized in tape equipment by a carefully designed flywheel, and in disc equipment by the turntable itself.

At the top of the rack panel area, just above the tape recorder, is the master power panel. This contains a fuse, an a.c. convenience outlet, the master power switch which controls all the equipment in the rack as well as power to the turntable and cueing amplifier, a tally light, and an electric clock accurate within one-half second. It the master fuse should blow, the tally light will glow, the clock will stop at the time of failure, and

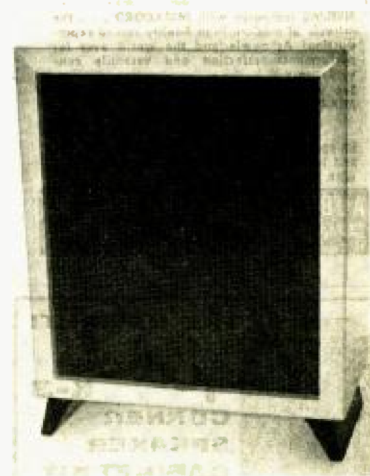


Fig. 5. Bass-reflex two-way speaker system incorporating 10-inch accordion-cone woofer and a high-frequency horn.

Fig. 6. Program line mixer-amplifier to drive tape recorder at proper level and impedance. Volume metering is also provided in addition to three microphone inputs.

power to the above named equipment will be cut off. The bulb—a 117-volt neon lamp across the fuse—continues to glow until the fuse is replaced. Since the small toggle switch cannot handle all of the 117-volt 60-cps current drawn by the rack and its associated equipment, the power is actually controlled by a relay located behind the panel, and operated by the master switch.

The system described above was designed essentially for home use. However, since it incorporates professional equipment—besides being extremely versatile—it may find many commercial applications, depending upon the user's requirements. This set-up has been in use for a number of months, and no design faults have shown up; so it can be assumed to be virtually foolproof. In addition, although no preliminary hook-ups of the equipment were made prior to the actual installation, no hum, distortion, or switching difficulties were encountered. Doubtless, the reader will find variations of the design that he will wish to incorporate into his advanced sound system.

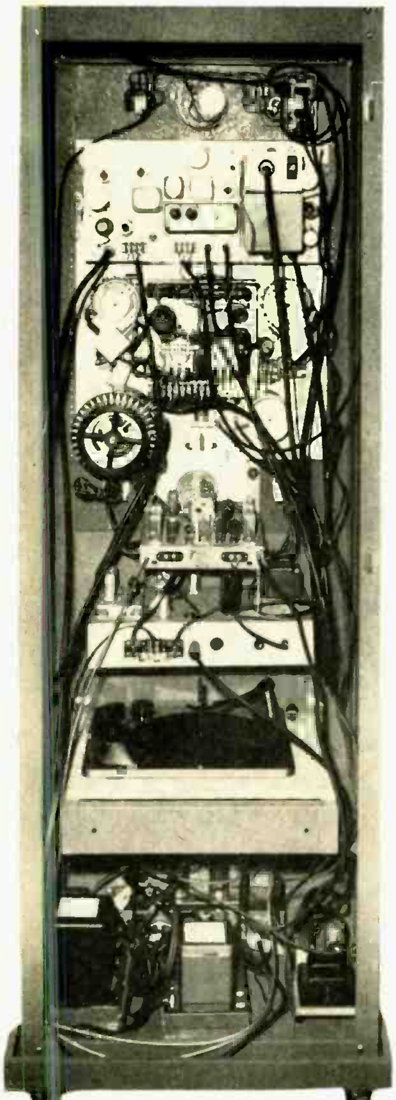


Fig. 7. Rear view of the equipment rack.

POWER AMPLIFIERS

(from page 52)

may be listed as follows:

1. Adequate power capability for the task at hand. For common home installations this may be anywhere from 5 to 50 watts, depending on the electroacoustic *efficiency* of the loudspeaker system (the percentage of amplifier electrical energy converted into sound), the size and furnishings of the room, and the sound levels that are desired.
2. Low harmonic (and intermodulation) distortion—preferably below 0.5 per cent harmonic at rated power.
3. Uniform frequency response, within ±1 db, from 20—20,000 cps at rated power. Almost any amplifier will show a wonderful frequency response curve at very low power.
4. Low hum and noise—at least 60 db below the rated power.
5. Stability—absence of "ringing" or tendency to self oscillation.
6. Proper damping factor for the application, or a variable damping factor.

FORTHCOMING BOOKS

This series on "SOUND" by E. M. Villchur will be published in book form, with the probable publication date around October 1, 1956. His earlier series, Handbook of Sound Reproduction, which appeared serially in the magazine, will be published approximately May 1, 1956. Further announcements of the publication date and price will be made in the May issue.

IF YOU ARE MOVING

Please notify our Circulation Department at least 5 weeks in advance. The Post Office does not forward magazines sent to wrong destinations unless you pay additional postage, and we can NOT duplicate copies sent to you once. To save yourself, us, and the Post Office a headache, won't you please cooperate? When notifying us, please give your old address and your new address.

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Industry People...

I.R.E. CONVENTION SCUTTLEBUTT: Harold Renne, one of the country's best liked and most competent editors in the field of electronics, receiving congratulations on his new position with Bell Telephone Laboratories, Inc. . . . **John M. Lowery,** who designed and developed the remarkable new RCA tube tester which was one of the hits of the I. R. E. exhibition, has promised to write an early article for AUDIO on his "perfect" home music system. Really an audio man's audio man. . . . **Harold D. Weiler** handling hundreds of queries with the same answer, "April 1." That was the scheduled publication date of his new book, "Tape Recorders and Tape Recordings." . . .

Saul White of Racon Electric Company, Inc., elated over the interest shown in the new Racon "pneumatic-damped" hi-fi speaker. A two-cycle tone was used to display the speaker's exceptionally long cone travel. . . . **E. J. (Manny) Marcus** and **Howard Weinberger** of Tetrad, Inc., world's largest manufacturer of diamond styli, spent endless hours in the Tetrad display proving to visiting engineers the economy of diamond over sapphire, not to mention the former's superior performance.

Sandy Cahn formally announced as Executive Secretary of the Institute of High Fidelity Manufacturers and will direct the New York High Fidelity Show to be conducted this Fall. . . . **Elwood King (Woody) Gannett** doing his usual first-rate job of hosting the visiting press, at the same time proving, contrary to common opinion, that it is thoroughly possible for a top-drawer engineer to be equally talented in the contrasting field of public relations. . . . Observation: **Whitney Baston** of NBC and **Will Copp** of I. R. E. look so much alike that, on at least one occasion, **Whitney** was introduced to an old friend as **"Mr. Copp."** . . . **Jim Ford,** advertising manager of Ampex Corporation, dividing his attention between I.R.E. activities and the impending arrival of a new "Henry" or "Lizzie" in the Ford household sometime around April 13. . . .

NEWS BITS FROM HERE AND THERE. The hi-fi picture in New York has been brightened beyond measure by the presence of Mrs. Harvey E. Sampson behind a counter in the new "Auditorium" of Harvey Radio Company, Inc. Pressed into service because of increased business in the new sound room, Mrs. Sampson, whose husband, Harvey, is the company's president, is adding a note of grace and charm to an industry whose esthetic nature makes such qualities a virtual necessity. (Unpaid Adv.)

Jim Pickett, well-known New York factory representative, back on the job after a fall which caused a serious arm injury. . . . **M. Roberts Rogers,** president of Washington's Good Music Station WGMS, has

CLASSIFIED

Rates: 10¢ per word per insertion for noncommercial advertisements; 25¢ per word for commercial advertisements. Rates are net, and no discounts will be allowed. Copy must be accompanied by remittance in full, and must reach the New York office by the first of the month preceding the date of issue.

THE AUDIO EXCHANGE has the largest selection of new and fully guaranteed used equipment. Catalog of used equipment on request. Audio Exchange, Dept. AE, 159-19 Hillside Ave., Jamaica 32, N. Y. OL 8-0445 and 367 Mamaroneck Ave., White Plains, N. Y. WH 8-3380.
AUDIO EXCHANGE EXCHANGES AUDIO

25-50% DISCOUNT. Factory-fresh guaranteed LP records, 69¢ and up; send 20¢ for catalogue. SOUTHWEST RECORD SALES, Dept. A, 1108 Winbern, Houston, Texas.

HIGH FIDELITY SPEAKERS REPAIRED
Amprite Speaker Service,
70 Vesey St., New York 7, N. Y. BA 7-2580

6-ELEMENT BROAD-BAND ANTENNAS
All seamless aluminum, $10.95 ppd.
Wholesale Supply Co., Lunenburg 10, Mass.

SELL: Webcor Model 210 tape recorder; good mechanical and electrical condition, factory maintenance, $80. AMPRO Model 756 Hi-Fi, like new, $100. Sell either one. Ray Knochel, Lincoln, Illinois.

TRADE: Pickering D-240 cartridge, used 5 hours, excellent, for an Audax Hi-Q7. Charles Leigh, 162 Passoic St., Trenton 8, N. J.

HELP WANTED
EXECUTIVE TO HANDLE CONSUMER TECHNICAL CORRESPONDENCE AND ASSIST IN GENERAL SALES. MANUFACTURER, NEW YORK SALES AREA. TECHNICAL BACKGROUND AND EXPERIENCE IN HI-FI AND PUBLIC ADDRESS COMPONENTS AND INSTALLATIONS ESSENTIAL. SEND RESUME. STATE SALARY REQUIRED. BOX CA-1, AUDIO.

"SOUND RECORDING & REPRODUCTION" The BBC's Training Manual for its own Engineering Staff. 272 pages, 176 illustrations covering every phase of recording and playback: disc, tape, film, wire, pressings, etc. Every point concisely explained; illustrated with examples of American and European equipment; technical level definitely not above the ambitious layman. Send check or money order for $6.25 to: Gotham, 2 West 46th St., New York 36, N. Y. We pay postage in U.S.A.

WANTED: EXPERIENCED ELECTRONICS RECORDING TECHNICIAN —LOS ANGELES LOCATION. REPLY BOX CA-2, AUDIO.

FM ANTENNAE
FM BROADBAND YAGI for fringe and long distance reception, high-gain design for maximum sensitivity to 72 or 300 ohm tuner input. Apparatus Development Co., Inc., Wethersfield, Conn.

Fisher 70RT tuner, $125; Fisher 50C Audio Control with cabinet, $60; Pickering 190B arm, $20; Hartley 215 speaker, $40. All like new. Norman Tetenman, 2350 East 27th St., Brooklyn 29, N. Y.

Custom-made, 22 cu.ft. infinite baffle, sand-filled front panel, 1 3/16" plywood, fully lined, braced, cut for 15-in. speaker. Unfinished. Sacrifice $65. J. Albert, 135-33 230th St., New York, N. Y.

FAIRCHILD #541 cutterhead, perfect, asking $110. ST 4-0426. New York City.

ALTEC 601A speaker, used, but like-new condition, $65 f.o.b. N. Y. Box CA-3, AUDIO.

BACK ISSUES OF AUDIO, 1947 through 1955, $5.00 per year. W. Connor, 5304 N. Mason St., Chicago 30, Ill.

AM and FM tuner repairs and realignment. Write for further information. 12 years experience. AUDIO CUSTOM CRAFTERS, 19 Pine St., Woburn, Mass.

WANTED: Vertical transcriptions; also address of Chicago party regarding same. James Orlando, Dickerson Run, Penna.

been designated a life member of the Philadelphia Orchestra Pension Foundation. The honor was accorded in recognition of the special "high-fidelity" concert he produced for the Foundation on February 13. . . . **Lawrence (Larry) LeKashman**, vice-president in charge of sales for Electro-Voice, Inc., Buchanan, Mich., announces recent expansion of the E-V sales division. Appointments include **Jay Carver** who will handle wood product sales, **Frank Stroempl** who has been named assistant manager of the distributor sales division, and **Jim Johnson** as assistant manager of the manufacturers' sales division. . . . Having completed a tour of duty as first lieutenant with the Army, **Arthur Z. Adelman** has re-joined his father's business firm, the Leon L. Adelman Company, manufacturers' representatives in the metropolitan New York area. . . . **Bruce Payne, William R. Swett**, and **Damon Van Utt** have been elected to the board of directors of Magnecord, Inc. **Mr. Payne**, who was chosen chairman of the Magnecord board, is also president of Bruce Payne & Associates, management consultants of Westport, Conn. Both **Mr. Swett** and **Mr. Van Utt** are vice-presidents of the Payne organization. . . . **Bob Karet** and **John Margolin** have organized the rep. firm of Karet-Margolin, Inc., with offices and warehouse at 13 W. Hubbard St., Chicago 10, Ill. The company is opening shop with many high-fidelity equipment accounts. . . . **Fred Gluck**, formerly chief engineer of Fada Radio and Electric Company, has been appointed chief engineer of The Astatic Corporation of Conneaut, Ohio. . . . **George J. Parker**, formerly president of the Daystrom Instrument Division at Archbald, Pa., has been named vice-president of Daystrom, Inc., in charge of the corporation's Washington office. . . . the East's newest high-fidelity haven is Audio Enterprises, Inc., in Hackensack, N. J., operated by **Robert G. Zurheide**.

H. C. (Bill) Hornickle, who developed the "Schickelgruber" noise cancelling microphone during World War II, was named as general manager of the Pacific Division of United Transformer Company, and will head a sales staff which will be located at C. R. Strassner Company, in Los Angeles. . . . **R. E. Carlson**, formerly manager of the High Fidelity Division of Fairchild Recording Equipment Company, Whitestone, L. I., recently appointed vice-president and general manager of the company; **Ray F. Crews** resigned as executive vice-president effective March 31st, according to an announcement by **Sherman M. Fairchild**, company president.

William Herrman, well-known in New York audio circles from his coverage of the field for Retailing Daily, has been advanced to the position of news bureau manager for Hoffman Electronics, Los Angeles firm which Bill joined after moving to sunnier climes. . . . **Burton Browne**, Gaslight Club president and head of Chicago ad agency bearing his name, named by mayor to special All-Chicago Citizen's committee which aims to promote Chicago as an industrial, commercial, cultural, and recreational center.

ADVERTISING INDEX

INSTALLATION SIMPLIFIED

that's the story behind the 2 new series of the ...

Collaro

RC-54

Automatic Intermix
RECORD CHANGER

Three Speeds: 33⅓, 45 and 78 rpm

More people can now enjoy the reliable quality and performance of the Collaro RC-54 – because something has been done about the installation problem.

The two new RC-54 series have power and sound leads wired and soldered in position.

Both are supplied with Automatic 45 rpm Spindle Adapters and both offer a choice of pickup cartridges: either the G.E. dual-sapphire magnetic or Collaro Studio O dual-sapphire crystal.

The 'C' Series are supplied with *pre-cut, unfinished mounting boards,* suitable for easy installation into record cabinets and consoles – without the need for intricate carpentry.

The 'M' and 'B' Series are supplied with *hardwood bases* instead of mounting boards – 'M' for mahogany and 'B' for blond. These require no carpentry whatever. They can be fitted into most cabinets, or placed on open shelves, tables or any other convenient surface.

With woodworking, wiring and soldering eliminated – it takes no time at all to install an RC-54. And of this you can be sure . . . there is no finer record changer than Collaro.

Priced from **$56.00**

Sold by Leading Sound Dealers

Write for complete specifications to Dept. CD-1

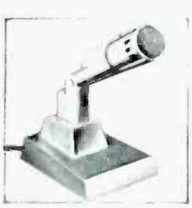
ROCKBAR CORPORATION • *215 East 37th Street, New York 16, N. Y.* *Made in England*

...STOP UNWANTED SOUNDS

Now...Broadcast Performance Designed for Public Address

COMPLETELY NEW ALL-PURPOSE CARDIOID DYNAMIC MICROPHONE BRINGS NEW EFFICIENCY OVER WIDE FREQUENCY RANGE

All the advantages of the E-V Variable D* are now available in the new high-fidelity "664"...for public address, recording, communications and similar applications. Uniform cardioid polar pattern provides high front-to-back discrimination against unwanted sounds, without close-talking boominess. Easily solves sound pick-up and reproduction problems under a great variety of conditions. Gives distinct, natural reproduction of voice and music. Increases working distance from microphone. Gives greater protection against feedback. Especially useful where ambient noise and severe reverberation exist. Pop-proof filter minimizes wind and breath blasts. E-V Acoustalloy diaphragm guarantees smooth wide-range reproduction. Can be used on a floor or desk stand or carried in the hand. No finer microphone for performance and value! *Write for Technical Specification Sheet A64.*



*EV Pat. Pend.

Model 664. Variable D* Super-Cardioid Dynamic Microphone. Uniform response at all frequencies from 60 to 13,000 cps. Output level —55 db. 150 ohm and high impedance. Impedance changed by moving one connection in connector. Line balanced to ground and phased. Acoustalloy diaphragm, shielded from dust and magnetic particles. Alnico V and Armco magnetic iron in non-welded circuit. Swivel permits aiming directly at sound source for most effective pick-up. Pressure cast case. 5/8"—27 thread. Satin chrome finish. 18 ft. cable with MC4M connector. On-Off switch. Size: 1 1/4 in. diam. 7 3/16 in. long not including stud. Net wt.: 1 lb. 10 oz. List Price **$79.50**

Model 419 Desk Stand available for use with the "664" (extra).

Electro-Voice®

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HIGH-FIDELITY MICROPHONES • SPEAKER SYSTEMS • PHONO-CARTRIDGES • AND OTHER ELECTRO-ACOUSTIC PRODUCTS