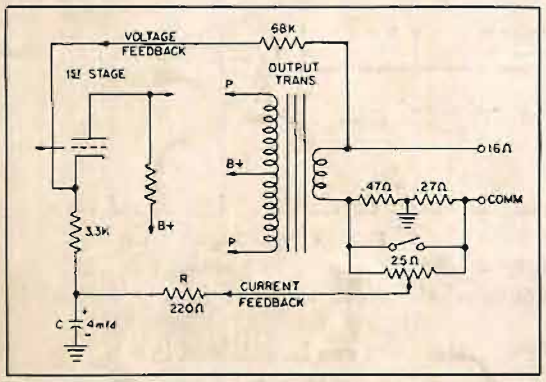
AUDIO

SEPTEMBER, 1954

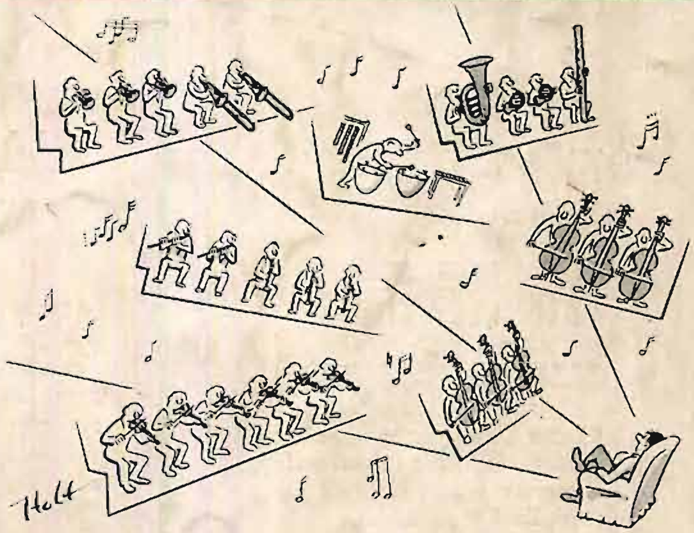
50c

200 Watt Mc Intosh

ENGINEERING MUSIC SOUND REPRODUCTION



Only recently have the advantages of an adjustable damping factor been explored. A simple and practical circuit provides complete control. See page 31.



Long familiar to audio engineers, the principle of maintaining the level of reproduced sound equivalent to the original is clarified amusingly. See From High Fidelity to Music, *page 28.*

VERSATILE CONTROL UNIT FOR THE WILLIAMSON
IMPROVING LOUDSPEAKER PERFORMANCE
FROM HIGH FIDELITY TO MUSIC
A TRANSISTOR REMOTE AMPLIFIER

audiotape

TRADE MARK

on Mylar‡ or plastic base

... and for magnetic DATA RECORDING it pays to specify

Type EP* audiotape

***Extra Precision** magnetic recording tape for telemetering, electronic computers and other specialized applications.

• Specially produced from the most carefully selected materials and ingredients, to meet the most exacting requirements for uniformity and freedom from microscopic voids or imperfections. Available in any desired width, on standard plastic base and on 1, 1½ and 2 mil "Mylar". Ask for Bulletin No. 207.

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‡DuPont trade mark for their polyester film

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SEPTEMBER, 1954 Vol. 38, No. 9
Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

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CONTENTS

AUDIO (title registered U. S. Pat. Off.) is published monthly by Radio Magazines, Inc., Henry A. Schober, President; C. G. McProud, Secretary, Executive and Editorial Offices, 204 Front St., Mineola, N. Y. Subscription rates—U. S., Possessions, Canada and Mexico, $4.00 for one year, $7.00 for two years, all other countries, $5.00 per year. Single copies 50c. Printed in U. S. A. at Business Press, Inc., 10 McGovern Ave., Lancaster, Pa. All rights reserved. Entire contents copyright 1954 by Radio Magazines, Inc. Entered as Second Class Matter February 9, 1950 at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.

RADIO MAGAZINES, INC., P. O. Box 629, MINEOLA, N. Y.

AUDIO PATENTS

RICHARD H. DORF*

THE FILES OF THE PATENT OFFICE are chock full of tone-control circuits, since it seems that any of the large companies whose engineers design a new tone control immediately have the patent department put the circuit into an application just as a matter of course. Most of them are of some use outside the particular equipment they were designed for, but few have any very special aspects to recommend themselves to those who appreciate and can use something with a little original thought behind it.

For certain applications, a new tone control invented by Harry J. Reed, Jr., of Pleasantville, N. J., has two rather interesting merits. First, it is very simple. Second—and more important, it has only half the attenuation (insertion loss) in db of the usual bass-treble control system. The patent is numbered 2,680,231, and it is assigned to General Precision Laboratory, Inc.

It is routine to design dual tone controls in such a manner that each control introduces an insertion loss equal or more than equal to the maximum emphasis to be afforded. If, for example, a maximum bass boost of 6 db is wanted, the bass circuit causes an initial loss of 6 db or more at all frequencies, then allows the operator to reduce that attenuation at the bass frequencies. A treble control operates similarly. When both bass and treble controls are desired, the net insertion loss (which is permanent for the midband) is at least somewhat greater than the sum in decibels of the maximum boosts required for both ends of the spectrum. A bass-treble control capable of 6 db of boost at each end has a midband loss of 12 db, etc.

With Mr. Reed's circuit, the midband attenuation amounts only to a little more than the boost required of either bass or treble—not the sum of the two. *Figure* 1 shows his circuit, with typical values set up for maximum emphasis of about 5½ db in both bass and treble; yet the midband attenuation is only 8½ db instead of the perhaps 15 or more required for conventional approaches. *Figure* 2 shows the maximum results for both boost and attenuation obtainable at both ends of the range, with the midsetting (flat response) on the solid line. Bass and treble controls are separate and independent.

Circuit Requirements

The input tube V_1 is a medium-mu triode whose output is little affected by its load; V_2 is a tube of any sort, present merely to offer a nonloading grid impedance to the tone control output. The tone control consists of R_1 through R_4 and C_1 through C_3.

Consider first that the attenuation at midband must not vary appreciably with the setting of either control. Disregarding the bass network (R_1-R_2-R_3) for a moment, this will be true if the treble control R_4 is much smaller than the reactance of either C_2 or C_3 at the midband frequency, which in this example is 800 cps. That follows, because the midband attenuation depends on the action of C_2 and C_3 as the series and shunt legs respectively of a voltage divider. The values for C_2 and C_3 shown in parentheses are their approximate reactances at 800 cps. Comparing these relatively large reactances with the resistance of R_4, it is apparent that at 800 cps the setting of the slider will not make much difference in the voltage applied to the grid. As frequency decreases, the capacitive reactances become larger still, with the obvious total result that from midband down to lowest bass frequency the setting of R_4 will not affect output.

At frequencies above the midband, however, the C_2 and C_3 reactances become smaller and R_4 becomes more and more of a major factor in the voltage-divider action controlling output. Thus, at higher frequencies raising the slider of R_4 away from ground increases output, while moving it toward ground reduces output. This effect becomes more and more pronounced as frequency rises, so that the extreme settings of R_4 give the treble emphasis and attenuation shown by the two dashed curves at the right in *Fig.* 2.

The bass network is simply resistive, C_1 being merely a d.c. blocking capacitor of any value which will allow bass current to flow through R_1-R_2-R_3 without appre-

(*Continued on page 6*)

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

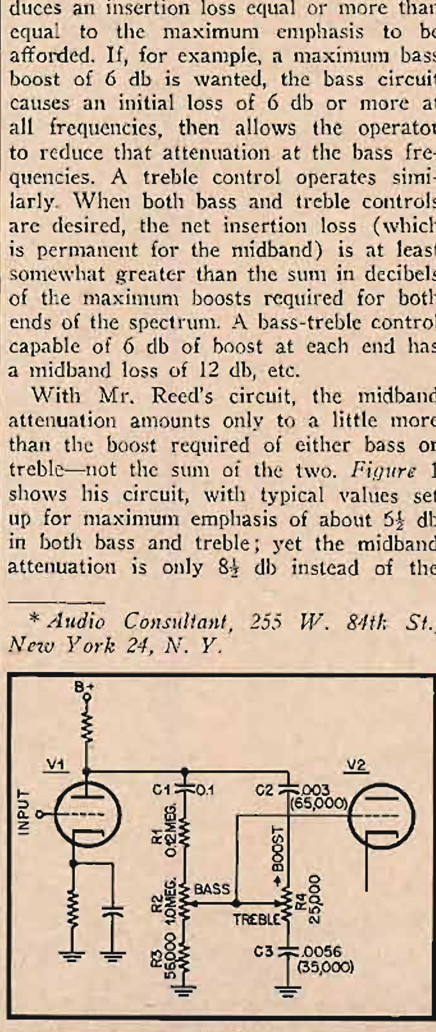

Fig. 1

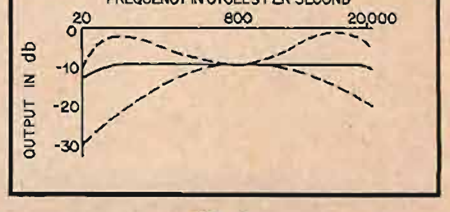

Fig. 2

Ampex magnetic tape recorders

...lasting quality for every professional use

Ampex machines are built with sustained quality and durability – the prime requirements of the major broadcast networks and recording studios. These perfectionists have chosen Ampex, some as long as six years ago, and their machines are still in use today. For example, one Ampex, after 18,000 hours of heavy duty still maintains performance equal to published specifications for new machines! This is the kind of lasting value that is the Ampex standard of excellence in sound recording.

- *Frequency Response – 40 to 15,000 cps.*
- *Tape Speed – 7½ in/sec.*
- *Signal-to-Noise – over 55 db.*
- *Flutter and Wow – under 0.25%.*

MODEL 600 • *THE NEWEST AMPEX*

The Ampex 600 is a portable model that weighs less than 28 pounds. It is an Ampex in design and performance and gives the same class of fidelity, accuracy of timing and reliability as other Ampex recorders. It is the ideal instrument for radio stations, music conservatories, educators, high fidelity enthusiasts and other professional and semi-professional users.

SERIES 300 • *THE FINEST AMPEX*

The 300 Series comprises the most perfect sound recording machines yet offered by any manufacturer. They are unexcelled for performances deserving the finest recording and reproduction it is possible to make. Superb design and flawless mechanical stability achieve the utmost in program fidelity, operating reliability and timing accuracy.

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- *Tape Speed – 7½ and 15 in/sec.*
- *Signal-to-Noise – over 60 db.*
- *Flutter and Wow – under 0.1%.*

SERIES 350 • *THE MOST VERSATILE AMPEX*

The 350 Series is universally preferred for original and delayed broadcasts, exchanging taped programs, music and drama rehearsals and other performances requiring extensive cueing and editing. Tape editing is remarkably fast with "feather touch" controls mounted within easy reach on a 30°-slanted top-plate. The 350 Series is unusually accessible for installation and servicing, and is available in a variety of tape speeds and mounting styles.

- *Frequency Response – 30 to 15,000 cps.*
- *Tape Speeds – 7½ and 15 ips, or 3¾ and 7½ ips.*
- *Signal-to-Noise – over 60 db.*
- *Flutter and Wow – under 0.2%.*

MODEL 450 • *FOR BACKGROUND MUSIC*

The Model 450 is a reproducer which provides sustained high fidelity background music anywhere. It is ideal for the finer hotels, restaurants, department stores, funeral parlors, factories and other users of pre-recorded programs. It plays continuously for 8 hours. Starting, stopping, reversing and repeating can be controlled automatically.

- *Frequency Response – 50 to 7,500 cps.*
- *Tape Speed – 3¾ in/sec.*
- *Signal-to-Noise – over 50 db.*
- *Flutter and Wow – under 0.4%.*

SERIES S-3200 • *FOR TAPE DUPLICATION*

This Series of machines achieves true mass duplication of previously recorded tapes while preserving the superb fidelity of the master recording. Up to 10 exact replicas can be made simultaneously, and up to 2500 hours of program material can be produced in an 8-hour day (or one hour in 10 seconds!). The S-3200 Series duplicates both single and double track masters and 2 track stereophonic tapes, of any standard speed, in one pass either "forward" or "backward."

- *Frequency Response – 30 to 15,000 cps.*
- *Tape Speed – 30 and 60 in/sec.*
- *Signal-to-Noise – over 45 db.*
- *Flutter and Wow – under 0.2%.*

WRITE FOR FURTHER INFORMATION AND COMPLETE SPECIFICATIONS TO DEPT. B-1723.

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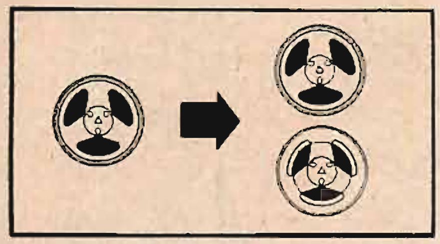
Canadian General Electric Company in Canada


EXTRA-THIN CONSTRUCTION
STRENGTH TO SPARE
INCREASED FREQUENCY RANGE
SCOTCH BRAND Magnetic Tape
190 Extra Play
Made in U.S.A. by MINNESOTA MINING AND MANUFACTURING COMPANY, Saint Paul 6, Minnesota
No. 190 A SCOTCH Magnetic Tape Extra Play

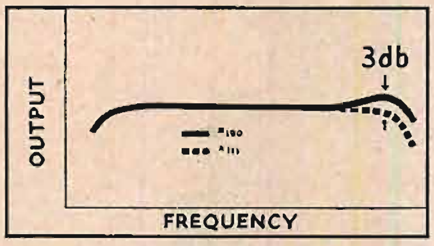
New *Extra Play* tape gives 50% more recording time!

A revolutionary development for radio stations, recording studios—in fact all users of magnetic tape! New "Scotch" Brand Extra-play Magnetic Tape 190A makes it possible to record entire symphonies, lengthy news and sports events without stopping for reel change. With 50% more tape on each reel, new Extra-play tape offers the same recording time found on 1½ reels of standard tape.

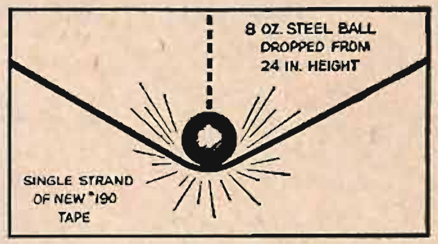
Exclusive feature of new "Scotch" Brand 190A tape is a thinner magnetic coating. Made of high-potency oxide, the new coating has been reduced from standard 0.6 mils to 0.3 mils and the high frequency range extended appreciably. A 30% thinner tape backing offers more uniform hi fi response with crisper, cleaner tones, yet maintains "Scotch" Brand's reputation for sturdy, long-life tape construction.



EXTRA THIN TAPE—50% thinner, more potent oxide coating, 30% thinner backing permit more 190A tape to be wound on standard-size reel. Result: one roll of new tape does job of 1½ reels of standard tape.



INCREASED FREQUENCY range of new Extra-play tape enables tape machines to produce recordings with greater hi fi response than formerly possible with most conventional magnetic tapes.



STRENGTH TO SPARE—New 190A tape stands up under even grueling steel ball drop test. Naturally it's tough enough to withstand severe stresses of sudden machine stops, starts and reverses.

NEW!

REG. U. S. PAT. OFF.

SCOTCH BRAND *Extra Play* **Magnetic Tape 190A**

The term "SCOTCH" and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul 6, Minn. General Export: 122 E. 42nd St., New York 17, N. Y. In Canada: London, Ontario, Canada.

PATENTS

(from page 2)

ciable attenuation. This means that if the grid of V_2 were connected only to the bass control and not to the treble control, R_2 would simply act as a volume control without frequency discrimination.

As it is, however, the grid is connected to both. At midband the bass control has little effect on the output voltage because its impedances from any slider setting on R_2 both to ground and to the V_1 plate are large relative to those of the treble network —which itself, as we have shown earlier, allows little change in midband level.

At high frequencies a portion of R_4 and the low reactance of C_3 are shunted between the slider of R_2 and ground, making a very low impedance for the shunt leg of a voltage divider. The portion of R_2 above the slider, if any, and the resistance of R_1 are the high-impedance series leg of the divider. As a total result, the bass network cannot appreciably affect output at and above the midband frequencies.

At lower frequencies, however, the reactance of C_3 becomes rapidly larger, quickly exceeding the resistance between the slider of R_2 and ground. This raises the impedance of the shunt leg of the bass voltage divider. Since R_2 is very large with respect to R_1 and R_3, the setting of R_2 has the major effect on output of the bass voltage divider, so that it gives the maximum and minimum relative bass shown by the dashed lines at left in *Fig.* 2.

The only midband attenuation is necessitated by the treble circuit and is due to the ratio between C_2 and C_3. The bass control is added like a kind of tail on the dog, as added signal for boost and as an effective shorting of C_3 for attenuation, so it does not cause an insertion loss as ordinary circuits do.

The values shown in *Fig.* 1 are only a sample for one particular kind of use. To aid anyone who may wish to do something different, the following design data is summarized.

Midband attenuation is approximately

$$\frac{E_{out}}{E_{in}} = \frac{C_2}{C_2 C_3}.$$

For this to be true

$$Z_B \gg Z_T,$$

where Z_B is the sum of R_1, R_2 and R_3 and Z_T is the sum of the midband reactances of C_2 and C_3 and the resistance of R_4 (actually the complex impedance). To render midband output independent of the setting of R_4,

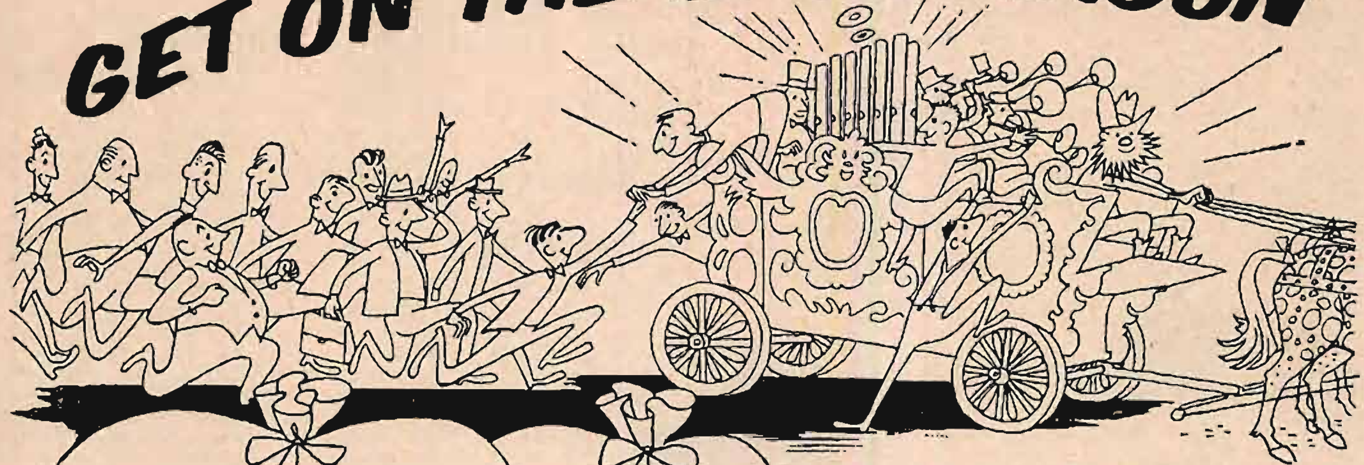
$$R_4 \ll X_{C2} + X_{C3}.$$

To keep midband output from being affected by settings of R_2, values of R_1 and R_3 should be small relative to R_2, and R_2 should be large with respect to the midband reactances of C_2 and C_3. This is approximated when

$$\frac{R_1}{R_4} \cong 2 \text{ to } 5, \text{ and } \frac{R_3}{R_4} \cong 2 \text{ to } 5.$$

You may obtain a copy of this or any other U. S. patent for 25¢ from The Commissioner of Patents, Washington 25, D. C.

GET ON THE BANDWAGON



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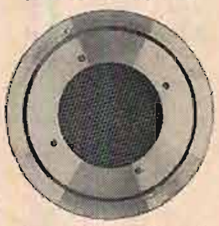

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LETTERS

GE Pickup Response

SIR:

We were pleased to notice that the June issue of AUDIO contained an article on the subject of the effect of lead capacitance on the frequency response of the General Electric variable-reluctance cartridges. The effect of excesive capacitance across an unloaded cartridge is not well understood and can be important under specialized circumstances. You will probably be interested in the following comments on the technical information in the article.

The authors substituted a 540-ohm fixed resistor for the internal resistance of the cartridge. Under conditions of d.c. and low-frequency a.c. measurement this substitution is valid, but the cartridge coils have been constructed in such a manner that the a.c. resistance rises to high values even at moderate audio frequencies. For this reason the cartridge inherently damps the resonances to which the authors refer and the values of peaking are much lower than those shown in *Fig. 2*.

For example, you will notice that whereas *Fig. 2* in the article shows a rise of 15 db at 16 kc with 140 μμf shunt capacitance, the actual value using a cartridge is only about 2 db. Furthermore, the peak is very broad, extending from +1 db at 8000 cps to +2 db across the range of 9000 to 14,000 cps, dropping to the zero axis at 15 kc. This amount and type of peaking is inaudible and is actually beneficial when playing vinyl recordings due to the inherent elasticity of the vinyl material and the tendency of the elasticity to cause a drop in high-frequency response. The curves from which these data are taken were run using a standard shellac frequency record used in laboratory and factory control.

For smooth, wide-range reproduction we recommend not exceeding a value of lead capacitance of about 250 μμf, a requirement which can be met with easily available cable (25 μμf per foot) even with lengths up to 10 feet. Advantage can be taken of the action of large values of shunt capacitance to provide very effective and inexpensive high-frequency cutoffs for noisy or distorted records, as shown in the following:

.0015 μf shunted by 22 000 ohms: 7000-cps cutoff.
.004 μf shunted by 13 000 ohms: 4000-cps cutoff.

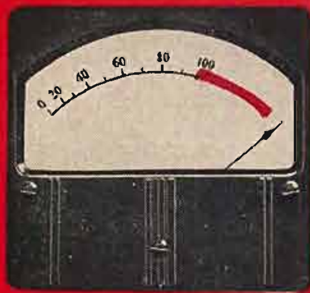
No other load resistor is used with these networks.

The condition under which the cartridge will operate without any load resistance will be very rare since it is recommended that equalization of the record high-frequency characteristic be accomplished by applying load resistance to the cartridge, common values being 3900 through 15,000 ohms. As indicated in your article, such low values of load resistor remove the effect of resonance due to reasonable values of shunt capacitance, and when the recording pre-emphasis is added to the resultant output curve it will be found that the response is flat for all practical purposes.

The addition of a cathode follower between the cartridge and preamplifier will decrease the signal-to-noise ratio, and only a cathode follower having very excellent characteristics would match the high signal-to-noise ratio obtainable from a properly designed preamplifier. Hum and noise from the preamplifier stage will add to that from the cathode follower. It is always desirable to amplify the cartridge output as much

(*Continued on page 73*)

DO YOU GET THIS AUDIO READING...



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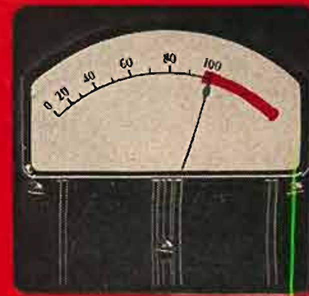

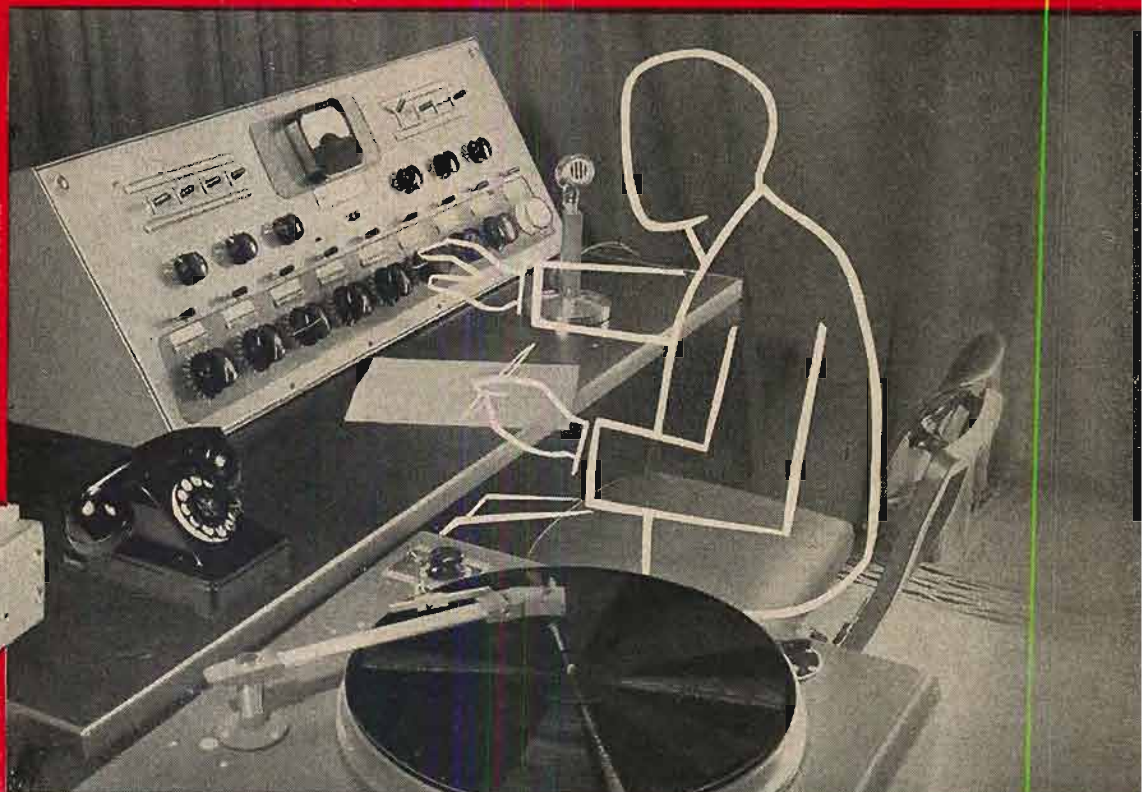

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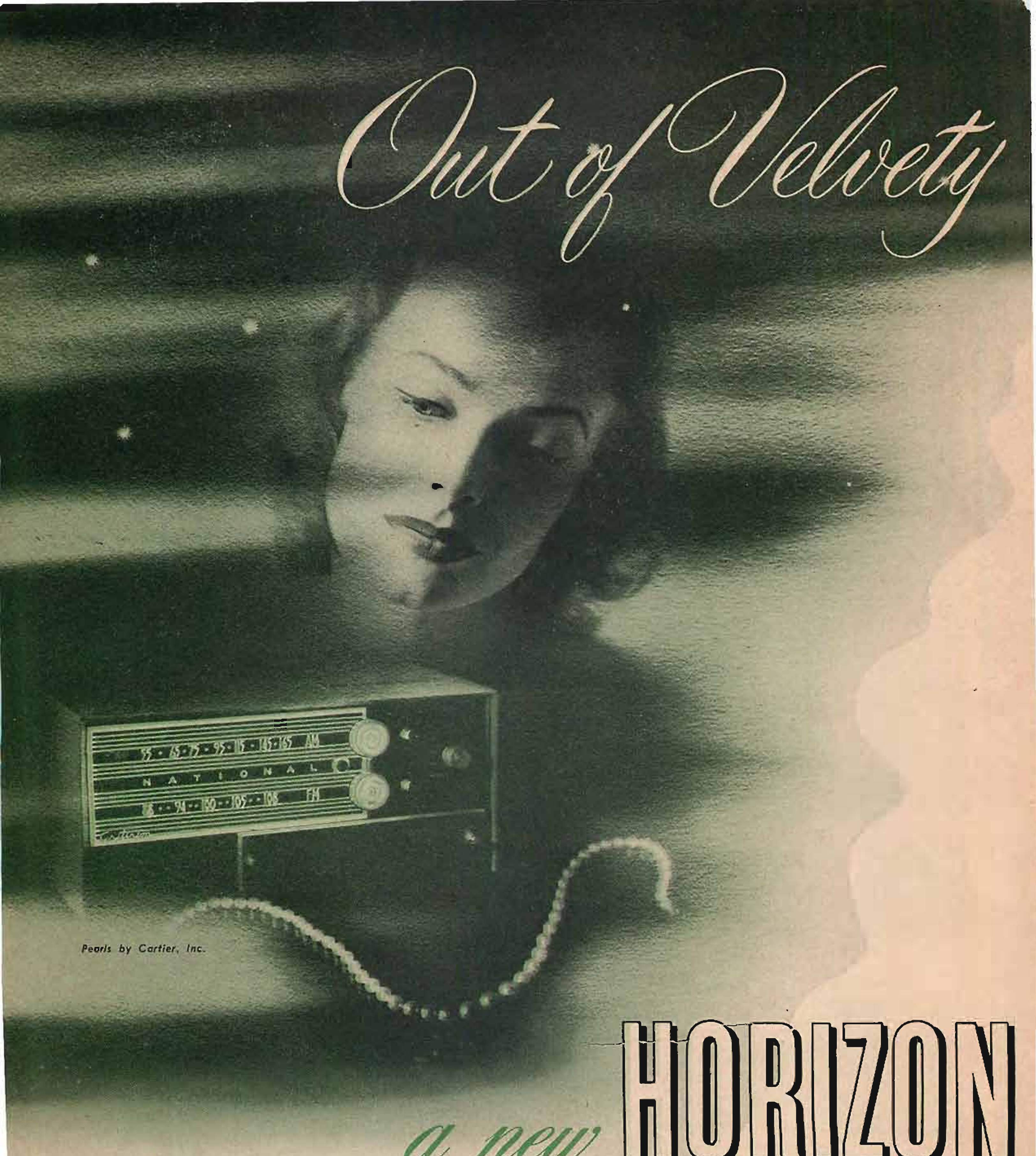

The magic mood of music is easily shattered by the slightest noise, hiss or hum. Your mood is safe when the music is played through National's magnificent new audio achievement — the new HORIZON series of intermatched tuner and amplifiers. Even hiss and noise between FM stations have been conquered by National's exclusive MUTAMATIC tuning. Stations leap in out of velvety silence — stay locked in. All tube noise, hum and distortion in tuner and amplifier have been reduced to an inaudible minimum. It's more than high-fidelity . . . It's a wholly new listening experience!

tuned to tomorrow **National**

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Silence

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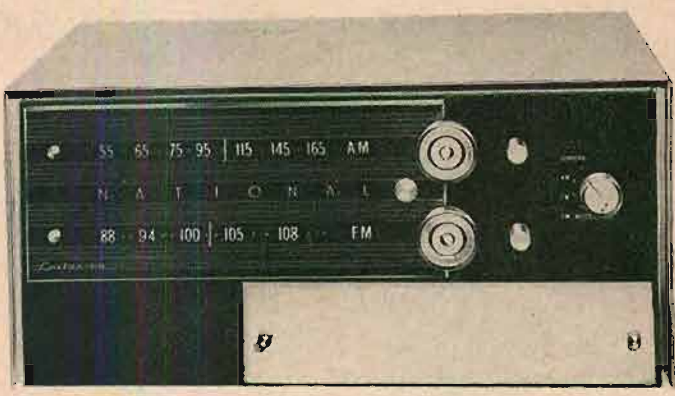

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To surpass the present high level of amplifier design, National proudly introduces new power amplifiers with a revolutionary new output circuit employing unity coupling.
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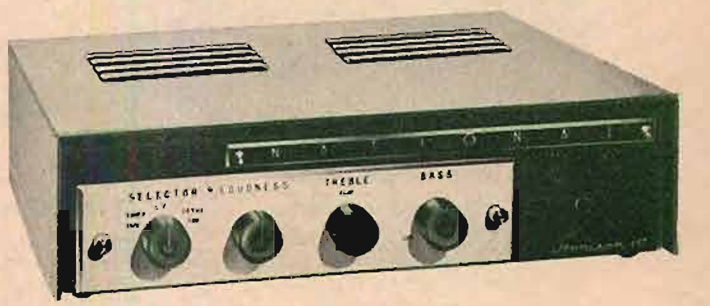
Harmonic distortion is less than .5%; intermodulation distortion, less than 2% at rated output. Frequency response is ± 1 db, 20 cps to 20 kcs; power response, ± 2 db, 20 cps to 20 kcs. Hum and noise are better than 70 db below rated output on high-level input, better than 50 db on low level input.



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The HORIZON 5 achieves a new high in frequency response (± 1 db, 20 cps to 100 kcs) and voltage output (up to 10 volts) — a new low in distortion (less than .2% harmonic, .3% intermodulation)!
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PREAMPLIFIER-CONTROL UNIT **$49.95** (SIZE: 2½" x 10½")

NATIONAL CO., INC., 61 SHERMAN ST., MALDEN 48, MASS.

NEW LITERATURE

• **Newcomb Audio Products Company, Inc.,** 6824 Lexington Ave., Hollywood 38, Calif., has performed an industry service with the publication of a new institutional booklet titled "Hi-Fi is for Everybody." A simple, easy-to-read book, it convinces its readers that high fidelity is neither difficult nor expensive. For the beginner, this handsomely-produced 32-page book is exceptionally worthwhile reading. Requests for copy must be accompanied by twenty-five cents to cover costs of handling and mailing.

• **David Bogen Company, Inc.,** 29 Ninth Ave., New York 14, N. Y., tells just about all there is to know about public-address amplifiers, sound systems, and appropriate accessories in newly released Catalog PA554. Of particular value to novice buyers is a section titled "Hints for Selecting the Proper Sound System," which discusses the more important factors involved in determining which equipment to use for various types and sizes of installations. In addition to individual items, the catalog lists complete Bogen-engineered sound systems for permanent installations, both indoors and outdoors, as well as portable systems. The catalog is available from Bogen distributors or by writing the company direct.

• **Electro-Voice, Inc.,** Buchanan, Mich., gives basic facts about the company's many products for the audio and video fields in a new condensed catalog designated No. 119. Illustrated and described are microphones for TV, broadcasting, public address, recording, and communications. Other listings include high-fidelity speakers, enclosures, phono cartridges, CDP public address speaker systems, FM and TV boosters, and various other miscellaneous accessories. Copy may be obtained free from any E-V distributor or direct from the company.

• **Jensen Manufacturing Company,** 6601 S. Laramie Ave., Chicago 38, Ill., is issuing a new catalog, No. 1040, and two new data sheets, Nos. 164 and 165. Catalog 1040 covers the Jensen line of general purpose and commercial sound speakers, as well as accessory cabinets, volume controls and transformers. Data sheet 164 introduces the Weather Master drive-in theater speaker line and No. 165 lists the latest Jensen high-fidelity equipment. Copies may be obtained from Jensen distributors or direct from the company.

• **Kester Solder Company,** 4201 Wrightwood Ave., Chicago 39, Ill., has made a greatly-needed contribution to technical literature in an authoritative 80-page treatise on the subject of Solder. Titled "SOLDER . . . its fundamentals and usage," the book required more than three years to compile and was written by Clifford L. Barber, Kester research director. Purpose of the book, according to Dr. Barber, is to rectify basic literature inadequacies on solder and to provide the solder user with a thoroughly scientific study. The book is being offered without charge to interested manufacturers, laboratories, universities, vocational institutions, and qualified individuals. Requests for copy should be addressed to Dept. TP.

• **Minnesota Mining and Manufacturing Co.,** 900 Fauquier St., St. Paul 6, Minn., in "Sound Talk" Bulletin No. 28, features a paper titled "Recent Progress in the Production of Error-Free Magnetic Computer Tape." The four-page illustrated bulletin discusses the physical causes of signal dropouts in modern digital computers designed to use magnetic tape as a long-period storage medium. In addition, it covers the reasons why errors arise from such defects, steps taken to eliminate errors, and a summary of progress made during 1953. Available upon written request.

(Continued on page 61)

After more than five years of study and development, we present our most prized accomplishment, the RONDINE. We are satisfied that it is the finest 12-inch turntable unit we have ever built . . . and that its performance is years ahead of high fidelity standards as we know them today.

The Rondine achieves almost complete acoustical isolation between motor and turntable. Rumble has been reduced to a minimum. Wow and flutter are virtually non-existent.

Features include: • Single selector-knob for setting speed: 33⅓, 45 or 78 rpm • Three-speed strobe disc, permanently affixed, for instantaneous speed-checking • Built-in retractable hub for 45 rpm records — no adapter required • Special cork-neoprene mat material to eliminate record slippage • Neon pilot light • Rectangular chassis fits most changer boards—pre-drilled and tapped for standard pickup arms.

The Rondine embodies other well known, time-tested, Rek-O-Kut features: The turntable is cast aluminum, and exerts no 'pull' on magnetic cartridges. An extra heavy rim is precisely lathe-turned and is dynamically balanced for smooth flywheel action. Internally rim-driven with a neoprene-compound idler, perfect drive traction is assured. All inter-moving parts are case-hardened, and ground to a microfinish.

The Rondine is available in 2 models:

RONDINE, Model B-12—with specially designed 4-pole induction motor — noise level better than 40db below average recording level. $69.95

RONDINE *Deluxe*, Model B-12H—with new type custom-built hysteresis synchronous, self-lubricating motor — noise level better than 50db below average recording level. $119.95

See the Rondine at the
HIGH FIDELITY SHOW
September 30th through October 2nd
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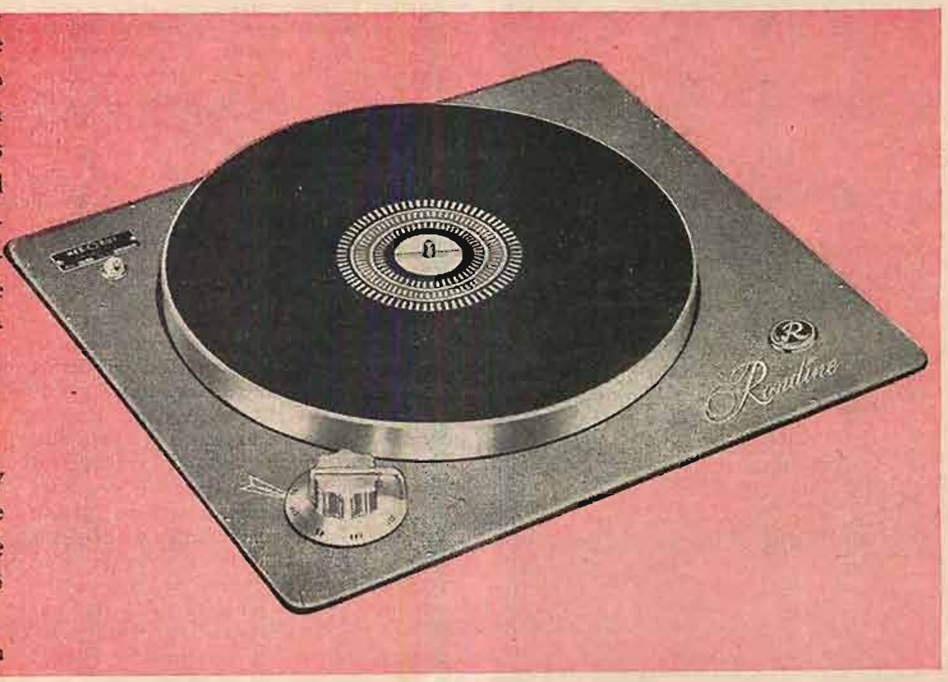
12-INCH 3-SPEED

precision turntables



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Makers of Fine Recording and Playback Equipment
Engineered for the Studio • Designed for the Home

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ABOUT MUSIC

HAROLD LAWRENCE

Is "Live" Music on the Way Out?

"For years the performer has been eliminating the composer. Now it's our turn!" This ominous statement by a contemporary American composer may not chill the spine of the American Federation of Musicians—yet. But it is symptomatic of a silent electronic revolution that, according to some, may well transform the very nature of our musical world.

A few years ago a film version of *Carmen* was produced in France. The names of the stars, set designer, producer, director, make-up artist and wardrobe mistress were paraded before our eyes in glittering letters. Then, in almost microscopic print, appeared the following credit: "Music by G. Bizet." In similar fashion the movie star system applies to the concert world in which the performer has been raised to an exalted postion and the composer is a sort of musical Cyrano de Bergerac. We refer to Gieseking's Debussy, Rubinstein's Chopin, Serkin's Beethoven and Landowska's Bach. Critics, musicians and laymen alike indulge in the rarified pastime of analyzing a Mozart symphony in the light of performances by Busch, Boult, Blech, Barbirolli, Beecham and van Beinum; or Krips, Krauss, Kleiber, Keilberth, Klemperer, Knappertsbusch, Koussevitzky and von Karajan. The critic preparing a review of a Brahms concerto for next morning's breakfast table or subway strap must of necessity confine his comments to the interpretation.

Music's middle man, the performer, has often been a thorn in the side of the composer. An inept or unsympathetic rendering has handicapped many a new musical work. Take the case of Handel. A young English singer named Gordon was rehearsing his only aria in *Flavio* with the composer at the harpsichord. When Gordon complained that the accompaniment was being played wrong, a violent quarrel ensued. Like the spoiled young nobleman in Shaw's *Misalliance*, Gordon threatened to jump up and down on the harpsichord until is was smashed to bits if Handel persisted in accompanying him. With sudden calm, Handel replied: "Oh, let me know when you will do that, and I will advertise it; for I am sure more people will come to see you jump than to hear you sing."

Shy, gentle César Franck lacked Handel's robust sense of humor. After a concert at which one of his works had been premiered, he was found by his son sitting in an armchair in a state of collapse. "The music is beautiful, believe me, my son;" Franck protested, "those performing people do not understand it."

Today's performing people, although on the whole technically more proficient than in 1869, frequently fall into the same category. At a recent recording session of a new symphony, the conductor planted no less than forty microphones around and within the orchestra. Where antiphonal effects were indicated in the score (that is, where woodwinds were pitted against brass, or strings against percussion) the results were incoherent and damaging to the composer's intentions. In a number of passages, the conductor—against the composer's advice—altered tempo and rhythm instructions. Even the orchestral musician had his say. The xylophone was to be played with soft sticks so as to blend with the other instruments. Protesting that he could not be heard, the xylophone player moved his instrument to a strategic place beneath one of the microphones and—to add insult to injury—performed his part with hard sticks. To the composer's dismay, each time the xylophone was struck, its tone stood out boldly and defiantly above the sound of the entire orchestra, even during *tutti* passages.

In moments like these, the composer must have thought how wonderful it would be if his music could be conveyed to the audience straight from his mind's ear and untouched by human hands. For thirty-odd years now, such a dream has gone beyond the stage of a Jules Verne fantasy, due primarily to the electro-musical research of another imaginative Frenchman, the composer Edgar Varèse. One of the most extraordinary minds of our age, Varèse came to the United States during World War I and has been studying every new development in electrical instruments and other scientific discoveries in the realm of sound. "We have at last," he said recently, "the right to hope for the sound-producing (*not* reproducing) machine which will free musical expression." Although Varèse jealously guards his experiments behind an electronic curtain, we know that his aim is to reconstruct and control the whole spectrum of sound. Seated at his "composing machine," the composer of the future will not only be able to find his lost chord, but orchestrate and record it simultaneously without once putting pen to paper. With the proper formulas at hand, any sound from anvils, Chinese blocks, string-drums, rattles, sirens and violins can be produced—as well as an infinite number and combination of new sounds. If the composer should feel the urge to shift gradually from horn to oboe, one timbre could be made to "melt" into the other. At current estimates, the

(*Continued on page 72*)

EDITOR'S REPORT

AUDIO VACATIONS ARE OVER

Nearly everyone seems to take a hiatus from indoor sports during the summer months, and construction of new equipment and the improvement of the old is usually relegated to the background while we do things that are more in keeping with the hot weather and with the normal human desire for physical relaxation. And while many of us would possibly rather spend our vacations at home with sufficient time to do a complete refurbishing job on our "systems," we are likely to be coerced into spending our time in the open air—getting sunburned and mosquito-bitten, and finding out about muscles we never dreamed of having.

But with the coming of September, new blood appears and our activities are stepped up—possibly because of the relaxation—and we begin anew with our continual striving for better sound. Equipment that has been on the drawing boards for the previous six months or so is introduced, simplifications and circuit innovations that intrigue and excite our interest are publicized, and—most important—the time is available to do the things we have been planning for months.

Among the interesting activities of the Fall months are the audio exhibits—the largest being the Audio Fair in October, but others of greater importance in their particular localities being the International Sight and Sound Exposition at the Palmer House in Chicago on September 30, October 1 and 2, and the New England High Fidelity Music Show at Hotel Touraine in Boston on October 22–23–24. Since the Chicago event comes first and since there is another issue between now and the other two shows, our most immediate concern is the one nearest at hand.

The first International Sight and Sound Exposition was held last year early in September during one of the hottest weeks that Chicago had experienced. In spite of the weather, however, many thousands of audio-fans attended and were suitably impressed by the year's new equipment. Surveys made at the time indicated that the typical visitor to the show was a "white-collar" married man with a good income, well within the age when he was making the major acquisitions to his home, and that he expected to spend somewhere between $250 and $1000 for his music system. The survey showed further that the average hi-fi enthusiast is relatviely new to this electronics hobby, has a better than average appreciation of music, and that he and his wife are well agreed as to the desirability of having high quality sound reproduction in their home.

With this survey as a guide, the second year's show is likely to be more specifically directed to the "typical" visitor, and is likely to present some innovations in entertainment, although plans are not complete at press time.

But regardless of entertainment and other sideline attractions, the real value of an audio show lies in the opportunity given to the public to study at first hand the latest models of speakers and enclosures, amplifiers, and equipment furniture, as well as to see—perhaps for the first time, in many instances—the time tested equipment which, while not "new" to most of our readers, has still not been seen and heard by those who are cautiously testing the temperature of the hi-fi hobby before jumping in wholeheartedly. So we look forward with considerable interest to the first show of the season, and we have already booked reservations to, at, and from the second International Sight and Sound Exposition. This year's show is open to the public—no admission charge—for three days, Thursday to Saturday, September 30 to October 2.

See you in Chicago?

. . . ONLY THE CHOICE OF THE RECORDS

Joe Dickey, one of our readers and an occasional contributor, resurrected a copy of Catalog No. 9 of the William B. Duck Co., a Toledo mail-order house back in 1915 when this catalog was published. This select bit of advertising copy appeared on page 267 of the catalog:

> "Of the capacity of the Victor for the lighter forms of entertainment, it might be said that catholicity of taste is one of the Victor's virtues. Just as the Genius of the Lamp, whose acquaintance we make in the story of 'Aladdin and the Wonderful Lamp,' worked with equal heart for the virtuous lad and for his wicked uncle, the Moorish magician, so the Victor will record, with equal impartiality, the highest achievement of a Caruso and the liveliest rag of the music hall comedian. It gives, in short, a variety of entertainment in the widest sense of the term, and looking through the catalog of Victor records, one will find that no decent taste remains uncared for; therefore it goes without saying that the greater includes the less and the instrument that will satisfactorily render Grand Opera or a symphony can be depended upon to do equally well with vaudeville or 'ragtime.' It is only a matter of the choice of records."

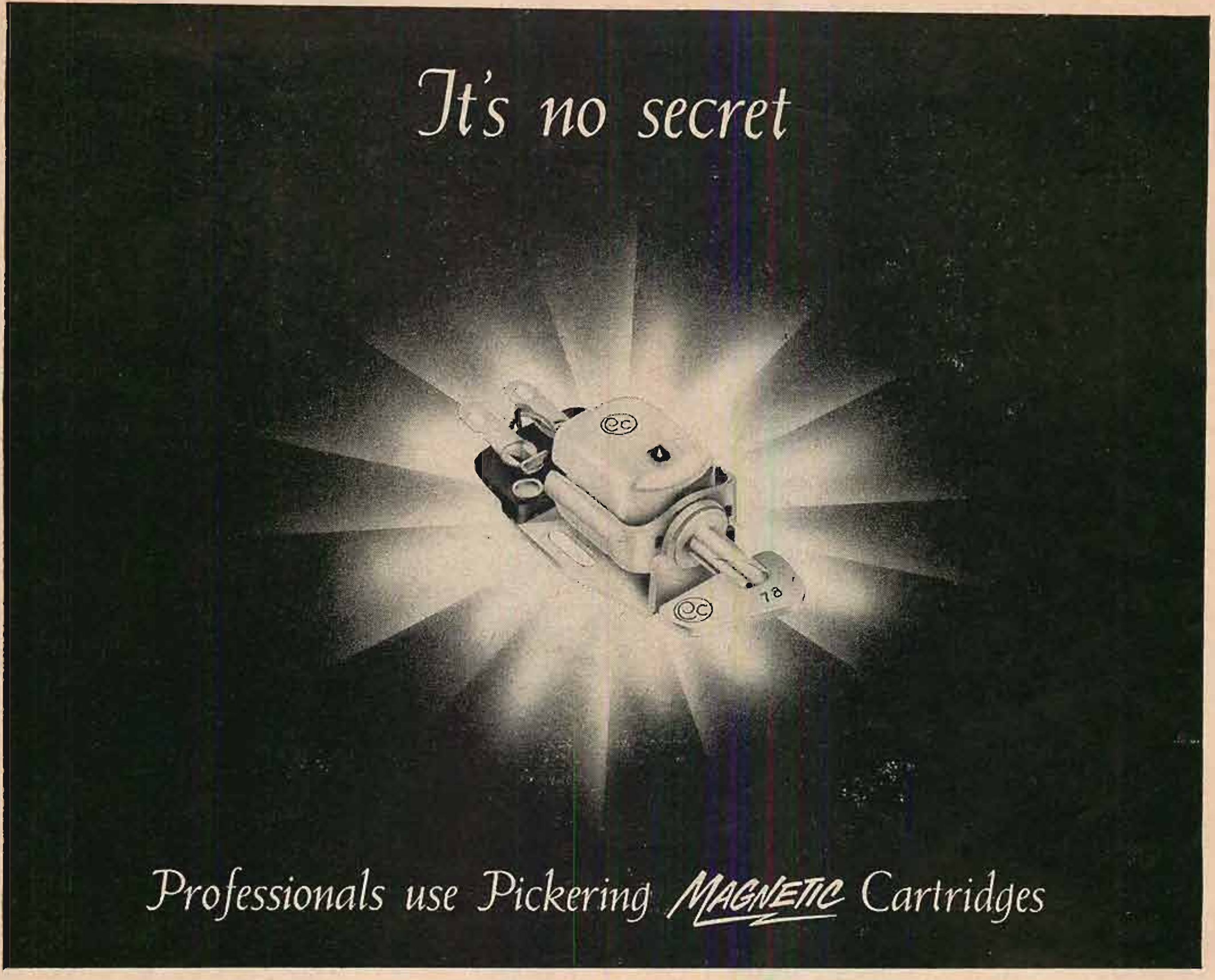
Knifing through the confusion that invariably attends the introduction of new items, we find this bit of logic:

> "And while it (the phonograph) will never supersede all other instruments of music, it should certainly supplement them all; for it fills a place made by itself alone—for which there is no substitute."

It would be enlightening to know what the author of that copy would think of his description were he to reread it now, almost forty years later. It still applies, and to a considerably greater degree, and *we* like it. We had those catalogs way back then, too, but not the foresight to save them, so we are greateful to Mr. Dickey for culling out these few lines.

SOUND REPRODUCTION COURSE

Edgar Villchur's course on "The High Fidelity Reproduction of Sound" will be given this Fall at the Division of General Education, New York University, Washington Square, New York City, on Wednesdays from 7:00 to 9:45 p.m. Registration begins on September 13. *(Continued on page 77)*



You're in the best of company if you use a Pickering MAGNETIC Cartridge. You have this in common with:

1. *Leading record companies who use Pickering Cartridges for quality control.*
2. *Leading FM/AM good music stations and network studios.*
3. *Leading manufacturers of professional equipment for radio stations, recording studios, wired music systems and automatic phonographs, who install Pickering Cartridges for the maximum performance of their equipment.*

Why Pickering MAGNETIC Pickups are the Choice of Recording and Broadcast Engineers!

"All modern disc recordings are made with MAGNETIC cutters. Within the geometrical and mechanical limitations of recording and reproducing equipment, a Pickering Pickup will re-generate an exact replica of MAGNETIC cutter response to the original program of music, speech or sound. This is a fundamentally inherent characteristic of the Pickering Pickup, supported by basic electromagnetic theory and countless precise laboratory measurements. This is why Pickering MAGNETIC Pickups provide the most nearly perfect coupling possible, between reproducing equipment and original program. This is why they sound cleaner . . . less distorted.

"Through the medium of the disc material, the reproducing system is effectively driven by the cutter electrical response itself."

PICKERING ***and company incorporated • Oceanside, L. I., New York***

PICKERING PROFESSIONAL AUDIO COMPONENTS

"For those who can hear the difference"

. . . Demonstrated and sold by Leading Radio Parts Distributors everywhere. For the one nearest you and for detailed literature; write Dept. A-5

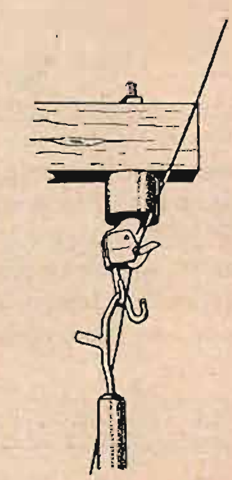
The pole that need not be climbed

Fastening wires with new tool.

Since telephony began, there has been just one way to install telephone wires on poles: have a trained man climb up and fasten them there. Now Bell Laboratories engineers have developed a special pole line for rural areas. The entire line can be erected without climbing a pole.

The whole job is done from the ground. Light-weight poles are quickly and easily erected. Newly created tools enable men to fasten wires to crossarms 10 to 25 feet over their heads.

This inexpensive line promises more service in sparsely populated places. From original design to testing, it exemplifies a Bell Telephone Laboratories team operation in widening telephone service and keeping costs down.



Key to the new "climbless" pole is this insulator. Ground crews use long-handled tools to place the wire in position and then lock it fast.

Bell Telephone Laboratories

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS

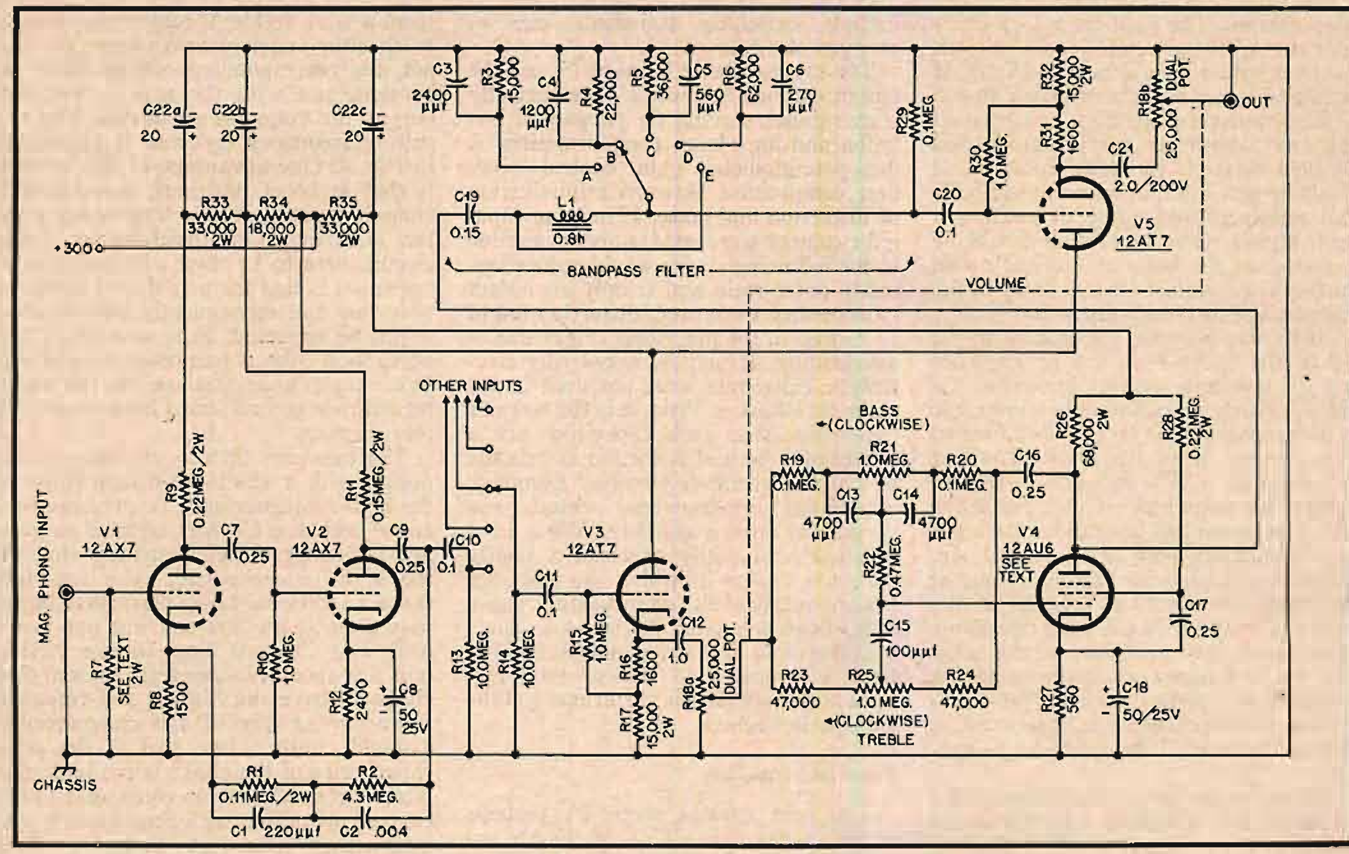


Fig. 2. Complete schematic diagram except for d.c. heater supply.

Versatile Control Unit For The Williamson

CHARLES R. MILLER*

A combination preamplifier, tone controls, and bandpass filter giving minimum noise and distortion and maximum convenience.

IN THE FIELD OF HOME MUSIC reproduction, the Williamson amplifier and its modifications have come to enjoy preeminence due to outstanding performance, but there has been no similar standardization in tone-control and preamplifier units intended to complement the Williamson. The unit described in this article is an attempt to meet that need.

Functionally, the unit is divided into five sections as shown in *Fig.* 1. First, it was decided that to preserve a high signal-to-noise ratio, all tubes were to be operated with direct current on the heaters, and secondly that all the sections must be capable of low-distortion performance matching the Williamson. The first specification can be met most easily by using all the heaters in series as the cathode-bias resistor of the power tubes, using a method to be described later. It was felt, further, that the second could be met only by using negative feedback on each stage. While it may be argued that the signal in low-level stages is so small that negative feedback is not needed, it has been shown that this is not the case.[1]

The complete circuit appears in *Fig.* 2. The design of the preamplifier V_1-V_2 is fairly conventional, with the equalizer values R_1, R_2, C_1, and C_2 being obtained by appropriate transformation of the networks given by Boegli[2,3] for record

* *The Graduate House, Mass. Inst. of Technology, Cambridge 39, Mass.*

[1] W. B. Bernard, "Distortion in voltage amplifiers," AUDIO ENGINEERING, Feb. 1953.

[2] C. P. Boegli, "A preamplifier for magnetic and crystal pickups," *Radio and Television News*, July 1950.

[3] C. P. Boegli, "An improved equalizer-preamp," *Radio and Television News*, April 1951.

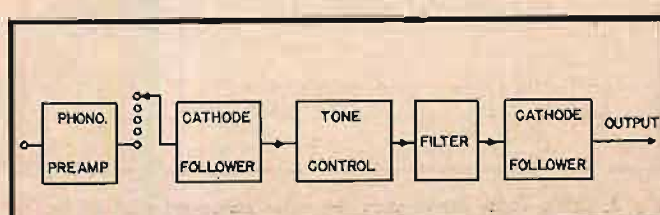


Fig. 1. Block diagram of the control unit.

compensation. The gain-frequency characteristics of the preamplifier for various equalizer values is as shown in *Fig.* 3. If simplicity is desired, the network shown as the compromise network can be used and any additional correction needed obtained through the tone controls. It should be noted that in no event are half-watt resistors used, these generating a much higher noise level than would be predicted on the basis of thermal noise. Furthermore, cathode bias is used in the second stage to reduce distortion[1]

There may be some question as to the use of the 12AX7 as the preamplifier tube for low-noise service instead of the 12AY7. Fairly extensive tests were made on the noise and hum level to be expected from various tubes. In particular, about two dozen 12AX7's and 12AY7's were checked for noise equivalent input at the grid. The equivalent hum and noise input were compared, both for a.c. and d.c. heater operation, with the only point of superiority of the 12AY7 being in the matter of hum with a.c. heater operation. With d.c. heater operation and the usual gain *vs.* frequency characteristics for phonograph equalization, the most important source of noise is flicker noise, presumably caused by cathode poisoning.[4]

Flicker noise varies inversely as the square of the frequency and hence the output due to flicker noise varies inversely as the cube of the frequency. For the tests mentioned, there was more variation within a given tube type than from one type to another. In any event, the average 12AX7 was better than the average 12AY7 for flicker noise. Representative 12AX7's in the preamplifier gave an unweighted signal-to-noise ratio of 68 db for a nominal 1 volt output (10 mv input at 1 kc). As predicted, the output noise spectrum had the sharply rising low-frequency characteristic typical of flicker noise. Hum level was so far below this noise as to be unmeasurable. In the complete schematic (*Fig.* 2) C_{10}, R_{15}, and R_{11} are for the purpose of eliminating switching transients due to changes in d.c. level.

The input cathode follower V_3 and the output cathode follower V_5 are perfectly conventional, serving the purpose of isolation and impedance transformation. A dual-potentiometer gain control gives best compromise between minimization of distortion and noise. If only an input gain control were used, noise generated in the following stages would reduce signal-to-noise ratio and if only an output gain control were used, distortion might be caused in the preceding stages due to overloading. It may be asked why electrolytic capacitors were not used in the cathode followers. First, it is the writer's experience that such capacitors are a source of noise and distortion and should be avoided whenever possible.[5] Secondly, a definite low-frequency cutoff was wanted to insure stability. Wow in a turntable can easily overload a poorly designed system in which the amplifier is very nearly at the motorboating point. It is idle to talk about flat response down to subaudible frequency unless the listener is prepared to "listen" with airtight seals between his ear drums and the loudspeaker cone.

Filter and Equalizer

The tone control stage V_4 perhaps needs explanation. This is simply an anode follower[6] with feedback voltage determined by the impedances between input, control grid, and plate. If the internal gain of the stage is infinite and the input impedance at the grid infinite, the over-all gain can be shown to be in the ratio Z_2/Z_1, where Z_2 is the impedance from plate to grid and Z_1 the impedance from input to grid. More simply, the actual input signal is determined by the setting of the two controls, R_{11} and R_{15}. Bass signals go through the upper section and treble through the lower. With either control arm nearer the input, the corresponding output signal is boosted, and with the arm nearer the output, the output is attenuated. The resulting frequency response is as shown in *Fig.* 4. One advantage of this system is that at boost positions, there is still enough negative feedback to insure very low distortion. One disadvantage if the circuit were to be used with a.c. heater operation is that the actual grid signal is very low and consequently hum trouble might be expected. Note one important precaution—the potentiometers used are linear-taper units and are not the usual logarithmic controls used in conventional tone circuits.

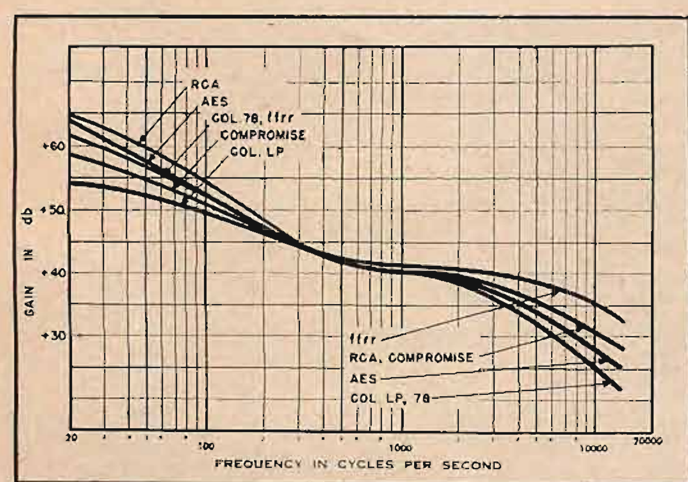
The bandpass filter is of conventional design with a 12-db-per-octave slope at the high-frequency end. To preserve balanced response C_{19} was selected to give low-frequency cutoff matching that at the high-frequency end, as it was felt that an additional 12-db-per-octave high-pass filter at the low end was not justified. The Chicago Transformer NSI-1 unit was specified since tests showed this choke to have the highest self-resonant frequency of any of the commercially available units. Note that if the self-capacitance of the choke is too high, the filter is converted from constant-*k* to *m*-derived operation, with consequently less satisfactory transient response. The values of resistance and capacitance were chosen for critical damping and not for maximally flat response. The resulting behavior is shown in *Fig.* 5.

The power supply for the control unit is somewhat unconventional. The heater current is taken from the main amplifier by using the cathode currents of the output tubes, about 15 ma drain from B+ as shown in *Fig.* 6. Previous tests on the Williamson have shown an almost constant current taken by the output tubes for any power level up to the overload point. To prevent a burnout of one of the heaters from pulling the cathode voltage up to B+, a neon lamp is inserted as shown. In normal operation the lamp is below 50 volts and thus will not fire or affect operation. Burnout of a heater is signified by the neon lamp glowing, at

[4] Valley and Wallman, "*Vacuum Tube Amplifiers,*" Radiation Lab Series, Vol. 18, McGraw-Hill, New York, 1948.

[5] J. E. Lilienfeld and C. R. Miller, "Distribution of conductivity within dielectric films on aluminum," *Jour. Electrochem. Soc.*, May 1953.

[6] P. J. Baxandall, "Negative feedback tone control," *Wireless World*, October 1952.



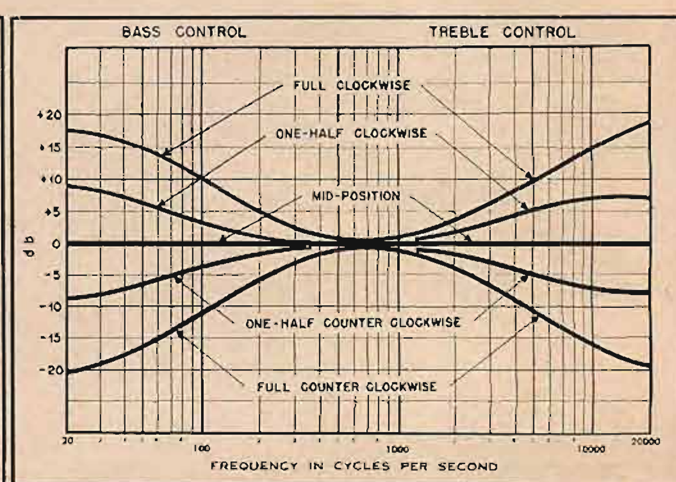
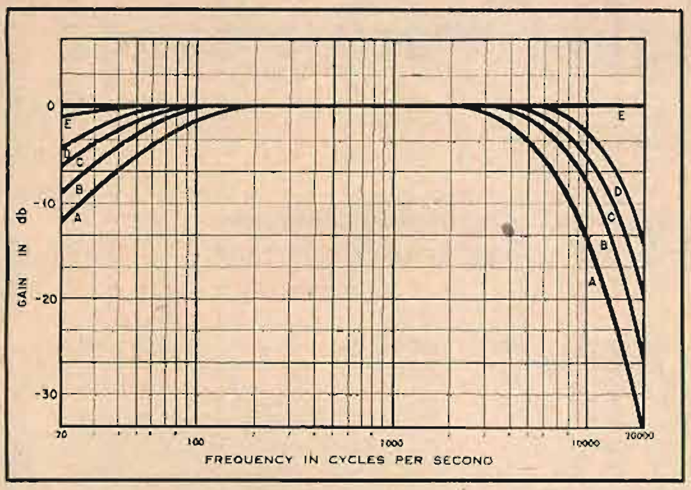


Fig. 3. (left). These curves show the equalization afforded by the various combinations of C_1-C_2-R_1-R_2. Fig. 4 (right). The range of tone control available from the circuit.



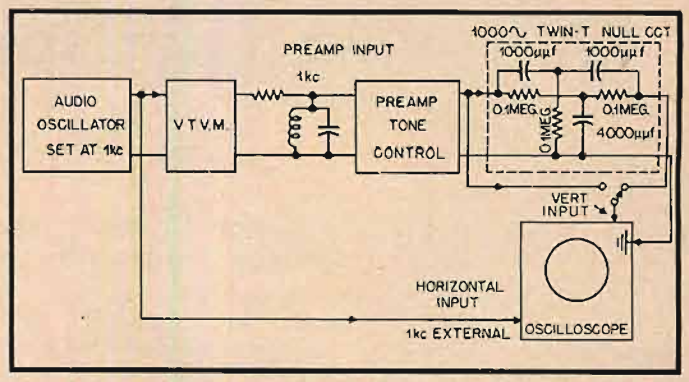


Fig. 5. (left). The five positions of the bandpass filter switch give these results.

Fig. 7. (above). Test setup for distortion measurements.

which time the system should of course be turned off and the trouble fixed. This scheme has the further advantage of preventing B+ from rising to a value destructive to the electrolytics if one of the heaters should burn out. The second feature of the power supply is that B+ for the control unit is taken from voltage-regulator tubes. This simple precaution will save a good deal of grief in trying to design for decoupling adequate to prevent motorboating. It is also usually more economical than the electrolytic capacitors needed to give the same low-frequency stability.

Final Results

To test the total distortion generated by the unit, an intermodulation analyzer would be best. Without access to such a unit, the following test procedure was adopted. Equipment layout was as shown in *Fig. 7*. With the tone controls set at flat position and the gain control at maximum, the signal from the GR Microvolter was raised until the output was at the desired level. At the design output level of 1 volt, the distortion was unmeasurable for any setting of the tone controls or the filter. For 10 volts output and maximum bandpass, the distortion was about 0.1 per cent. With 10 volts output and minimum bandpass, the distortion increased to 0.3 per cent. However, since 10 volts represents a value 20 db above overload for the main amplifier, it is felt that for normal operation, both harmonic and intermodulation distortion will be negligible. Since most of the distortion is caused by the filter loading the tone control output, this could be made negligible by insertion of a third cathode follower to drive the filter. For the 1-volt operating level, this was not deemed necessary.

The mechanical layout is quite normal. The entire control unit is built within an 8 × 12 × 3-inch chassis (see *Fig.* 8), with the tubes being arranged on a terminal board, which itself is shock mounted by means of grommets. To keep electrostatic coupling from getting hum into the signal circuits, the power switch and pilot light are external to the main chassis as shown in the photograph. There is thus no 60-cps source within the chassis. Magnetic coupling is prevented by the usual wiring practice of a ground bus connected to the chassis only at the input. The shorting switches used for the signal circuits are the new Centralab PA2000 series, which both are smaller and give better performance than the usual wafer type. The additional tube socket is for a proposed microphone preamplifier. When and if this is used, the 12AU6 tone-control tube will be replaced by a 6BH6, with a second 6BH6 for the microphone preamplifier. In any event, the total heater voltage will be 36 volts for the series string. The electrolytic capacitor used for filtering B+ within the control unit is mounted on a Mallory PS-6 socket for easy replacement. Ventilation holes are drilled in the bottom plate.

(*Continued on page 78*)

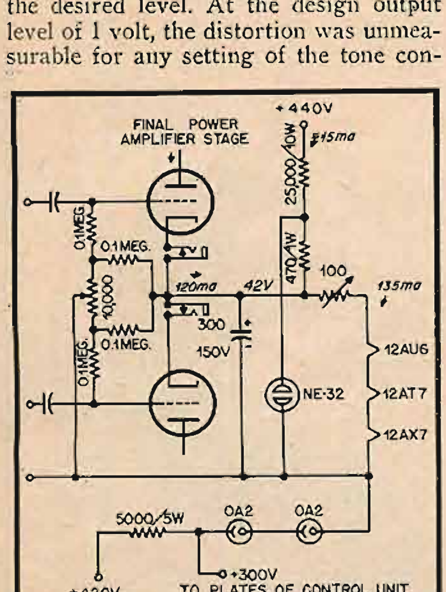
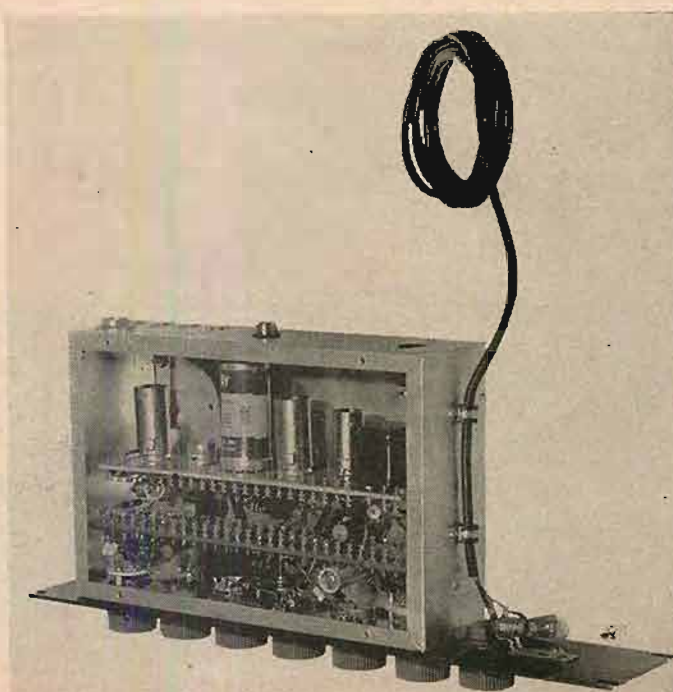


Fig. 6. D.c. for the heaters is taken in this manner from the cathode circuit of the final stage of the Williamson.

Fig. 8. Photo of the underside shows terminal-board construction.



Improving Loudspeaker Performance

DAVID B. WEEMS*

How to improve low-frequency response from inexpensive loudspeakers with the expenditure of less than a dollar and an hour or so of your time.

RECENT ARTICLES by Barritt[1] and Briggs[2] have described methods of increasing the compliance of the cone suspension of inexpensive speakers. The method proposed by Barritt consisted of "slotting" the rim of the cone and subsequently treating it with a plasticizer. Briggs suggested experimentation with a cloth surround and cutting away part of the spider assembly. Initial trials seemed to prove the latter method to be more effective but rather hazardous; also glue travel in the cloth sometimes prevents optimum compliance. After considerable experimentation was inspired by these ideas, the writer has evolved a system of alterations that not only seems to be superior in increasing the compliance of a speaker, but also may allow use of the unit not only as a woofer but also as a general-purpose speaker.

Benefits of High Compliance

Among the most important characteristics of the ideal speaker are wide-range frequency response and low distortion. The fundamental cone resonance of a speaker is closely associated with both its bass range and its distortion content at low frequencies, because the output falls off rapidly with an increase in intermodulation effects and frequency doubling below resonance. It is a well known fact that the proper baffling of a loudspeaker in such mountings as bass-reflex and horn-loaded enclosures lowers the resonant frequency, and an amplifier that presents a low impedance to the speaker will minimize the effects of resonance. We are concerned, however, with the qualities of the speaker itself and how we can improve them.

The fundamental resonant frequency of a loudspeaker may be determined mathematically from the formula:

$$f_r = \frac{1}{2\pi\sqrt{M_c C_{ms}}}$$

where f_r = resonant frequency of the speaker in cps,

M_c = mass of cone, voice coil, and air load in grams,

C_{ms} = compliance of the suspension system in centimeters per dyne.

Assuming a constant air load, examination of this formula shows that as either the mass or the compliance of a cone is increased, the resonant frequency is lowered. While increasing the mass of the cone lowers resonance, it also limits high-frequency response and results in a deterioration of transient ability. Increasing compliance thus seems to be the best approach toward lower fundamental cone resonance. High compliance also aids in obtaining wider range and lower distortion.

It may be argued that higher compliance in cheap units may produce greater intermodulation distortion due to the movement of the voice coil beyond the area of maximum flux density. There are several answers. The first is that at normal volume levels such movement will probably not occur. Secondly, if it does occur the use of multiple woofers will eliminate it and at the same time provide one of the most practical means available to the home constructor of accomplishing truly superior low-frequency reproduction. Finally, regardless of the theoretical possibility of excessive voice-coil movement, the net result of higher compliance for cheap speakers has been better sound. In speaker design we cannot always predict, like Old Man Mose, what will provide subjective enjoyment. With this premise firmly in mind and with courage in our hearts, we shall now proceed to the task of speaker improvement.

Procedure

The materials to be assembled are an inexpensive 8-to-12-inch speaker, plus (*Fig.* 1) a small piece of the softest, thinnest, and most pliable chamois available, radio solvent (optional), household glue, tweezers, small scalpel (optional), barber's scissors or other pointed scissors, a new razor blade, and an aluminum clothes sprinkler head. The chamois may require some shopping around because of the enormous variation of thickness and pliability, but usually the small, most inexpensive pieces found at the five and dime will include a few that have the desired characteristics. The aluminum sprinkler will only be required for certain very inexpensive units as will be described.

The operation should be performed on a clean bench or table. First, tear away the dust cover with the tweezers (*Fig.* 2), taking care not to disturb the voice-coil leads. Next, place shims of film negative or paper around the center pole to maintain the voice-coil form in position, as in *Fig.* 3. Usually four narrow shims located at equal intervals around the pole are sufficient. The solvent may then be used to saturate the juncture of the outer rim of the cone, the frame, and the

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[1] R. Cameron Barritt, "Speaker treatment for improved bass," AUDIO ENGINEERING, December 1952, p. 23.

[2] G. A. Briggs, "The loudspeaker," *High Fidelity*, Sept.–Oct. 1952, p. 39.

Fig. 1. Materials needed for treating speakers—chamois, solvent, cement, tweezers, scissors, razor blade, scalpel, and in some cases clothes-sprinkler head.

Fig. 2. Removing the dust cover with tweezers.

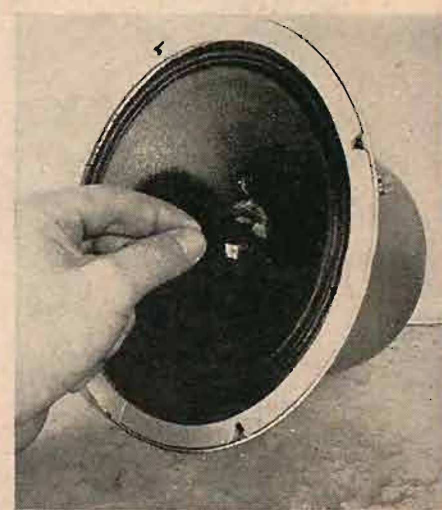

Fig. 3. Inserting shims to hold the voice coil in position.

Fig. 4. Slitting the outer edge of the cone to remove it from mechanical engagement with the frame.

gasket. While the solvent is acting on the glue, the rim of the cone may be cut away at the middle of the inside corrugation (*Fig.* 4) leaving a "lip" past the smooth part of the cone. The entire outer corrugations and gasket may now be lifted out. If solvent was not available, this part can be loosened with a knife after it is cut loose from the cone.

The spider should be cut away with either the scalpel or pointed scissors, leaving four strips about ½ to ¾ inch in width at equal intervals (see *Fig.* 5). Now attach four strips of Scotch tape to the outer rim of the cone, evenly spaced, and then fasten them to the frame without applying tension to the cone. If desired, the shims may be removed and the speaker tested for trueness of centering. If it will respond to loud musical passages that include low frequencies without rattling, the assumption may be made that the centering was adequately done, and the shims may be replaced as before.

The Scotch tape should be replaced, one piece at a time, by pieces of chamois about 2 inches wide (see *Fig.* 6). The chamois pieces should first be glued to the lip left when cutting away the rim of the cone, then to the frame. The chamois should be tightened just enough to remove wrinkles but not stretched. After this operation the speaker may be tested again.

Now the four large gaps around the cone rim may be filled by cutting large pieces of chamois to fit them. These large sections should be installed very loosely, leaving a deep wrinkle between the cone rim and the frame as shown in the end-product photo of *Fig.* 7. Their purpose is to eliminate the exchange of air between the rear and front of the cone, not to support and impede it; so they are left loose, allowing only the four narrow strips to suspend the cone. The gasket should be trimmed of original cone remnants and reglued into position. The dust cover may or may not be reused, depending on the ultimate purpose

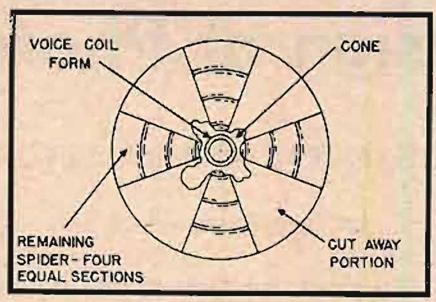

Fig. 5. The spider is cut away except for four sectors which hold it in position while allowing greater compliance.

of the speaker as described later. In every instance the glue should be used sparingly, especially on the cone. When the chamois is glued to the frame, the glue should be spread near the outer rim of the frame only; this will allow a longer chamois suspension and preserve its pliability.

When the job is completed, we have a cone that is suspended at four points by the spider, and at four points on soft chamois at the outer rim. It would be difficult to conceive of a more compliant suspension. An ordinary replacement speaker, purchased for about five dollars in a radio supply store was thus treated and then compared to a 15-inch speaker costing more than 10 times as much. The cheaper 12-inch unit appeared to be distinctly cleaner, although the overall response was admittedly somewhat rough and shrill due to inherent characteristics and the removal of cone resonance as a contributor of bass.

This phenomenon of shrillness may be removed by two general methods, the use of the speaker as a woofer only, or frequency correction of the speaker itself. The latter may be achieved by a mechanical means that the writer has found surprisingly effective and that seems to smooth the high range. It is to be recommended only for inexpensive speakers of the replacement class (and then only on 10 and 12-in. units), but these are the units that most need further alteration.

The method consists of gluing a small perforated aluminum dome over the center of the cone in place of the dust cover. This dome may be obtained from an aluminum clothes-sprinkler head. The sprinklers are obtainable from most variety stores for about a nickel. The rim that clamps the dome in place should be removed by inserting a sharp knife blade under it and lifting it away from the dome. A small amount of household glue should then be placed around the rim of the dome, and after positioning, a small weight on the dome will hold it in place until the glue has set. The speaker should now be ready to mount and try out.

Alternate Method

Some owners of speakers that do not have the usual felt dust covers so typical of the replacement speaker class may wish to adopt the chamois treatment. This is made possible by a slightly different technique. An example is the GE 1203A shown in *Fig.* 8.

(*Continued on page 71*)

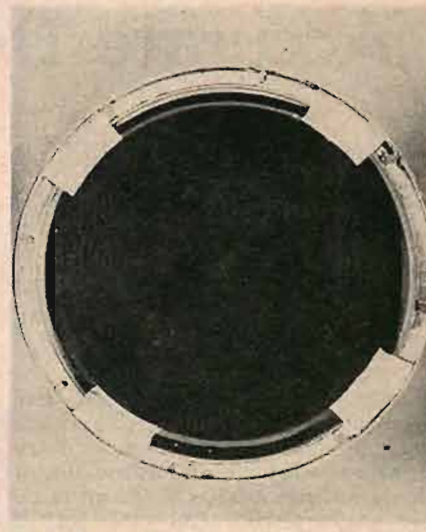

Fig. 6. Four strips of the soft chamois are glued in place to hold the cone centered.

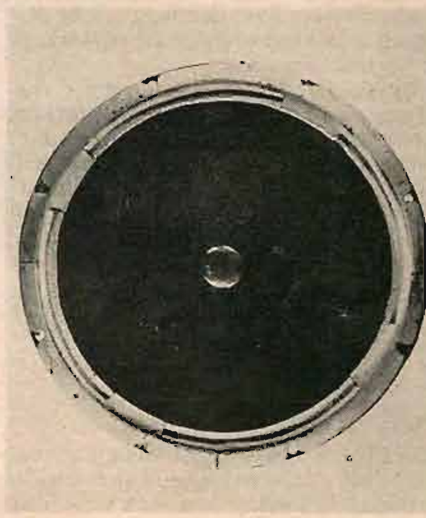

Fig. 7. Spaces between the four original chamois strips are filled with loosely hung chamois to help seal front off from rear air without restricting cone movement.

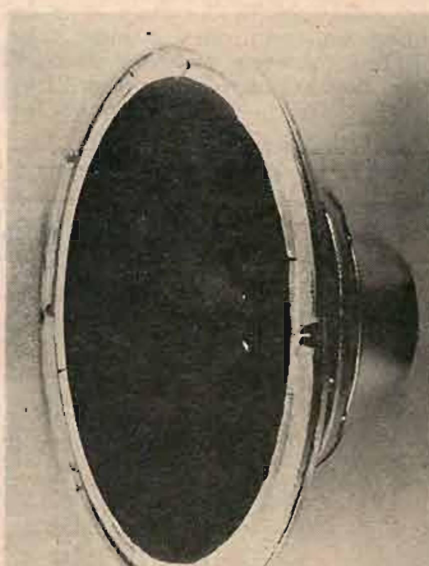

Fig. 8. A complete job done on a GE 1203A speaker.

Accurate Design of Phono Equalizers

CHARLES F. HEMPSTEAD AND HAMILTON BARHYDT*

In Two Parts—Part 2

Design of the treble section of the equalizer and a complete preamplifier designed by the authors.

There are three commonly used methods of obtaining treble rolloff equalization: an inverse-feedback circuit, an interstage R-C attenuator, or a low-resistance loading of the magnetic phonograph pickup. Only the last of these fulfills our requirements of high quality performance, economy, and simplicity of design. The disadvantages of the first two of these methods will be discussed briefly to bring out the advantages of the third method.

By simply shifting the turnover frequency to a higher value we can use the feedback equalizer already described to obtain treble rolloff. The response will be the same as that shown in *Fig.* 3[4] where f_3 replaces f_1, f_4 replaces f_2, and A_m/A_t replaces A_b/A_m. A_t is the minimum value of the amplification $A(f)$ at high frequencies, as shown in *Fig.* 1. The equation for the curve in the treble region is more conveniently written as

$$\frac{A(f)}{Am} = \sqrt{\frac{1 + (A_t/A_m\ f/f_3)^2}{1 + (f/f_3)^2}}.$$

Since the feedback factor cannot exceed unity, the minimum value of the amplification $A(f)$ for any frequency is slightly greater than unity. The output is fed back to the cathode of the first tube so that the load impedance which the feedback loop presents to the output of the amplifier becomes at high frequencies very nearly $A(f) \times R_k$, where R_k is the cathode resistor of the first tube. Since R_k is on the order of a few thousand ohms, the load impedance presented by the feedback loop becomes too low for the amplifier to drive without excessive distortion when $A(f)$ falls below about 5, thus limiting A_t to a value greater than 5. In order to provide treble equalization for Columbia LP recordings out to 12,000 cps with ½ db accuracy A_m/A_t must be 20. It would be convenient to combine the treble equalizer with the bass equalizer, using two reactances in one feedback loop, so as to reduce the number of vacuum tubes required. We have shown that to obtain proper bass equalization down to 30 cps requires A_b/A_m equal to 40 and that A_o/A_b of at least 2 is desirable. Thus, to build this feedback equalizer one would need an amplifier with a gain of at least

$$A_o = \frac{A_o}{A_b}\frac{A_t}{A_m}\frac{A_m}{A_b}A_t = 2 \times 40 \times 20 \times 5 = 8000.$$

This would require two pentode amplifiers driving a cathode-follower output stage.

A further disadvantage of this method is that it requires that the phonograph pickup be loaded so that its output is constant out to the highest frequency to be reproduced. In a recent article[5] Pickering discusses this problem. To obtain such a flat response it is necessary to use a large value of loading resistance, which makes the treble response very sensitive to capacitive loading. For flat response out to 12,000 cps with the GE cartridge, for example, the total shunting capacitance must be less than 50 μμf. Such a low capacitance is virtually impossible to obtain in practice since shielded wiring must be used and since triode tubes, which are usually used in audio amplifiers, present input capacitances frequently higher than 100 μμf due to the Miller effect. (Large amounts of inverse feedback introduced into the cathode circuit, however, reduce this effect.)

We turn our attention now to the interstage R-C attenuator equalizer. This type of equalizer is popular for treble rolloff since it has no loss below the treble frequencies and gives a full 6 db per octave attenuation above the turnover frequency; so it is not subject to the first set of limitations of the feedback equalizer just discussed. It does require, however, that the pickup be loaded to provide flat frequency response with the attendant disadvantages. Such an equalizer would have to be outside the feedback loop for bass equalization, but it could be fitted in elsewhere. If equalization is not applied before amplification though, the high-frequency components of the signal may be amplified to large amplitudes and produce distortion in a particularly annoying frequency range.

In order to avoid these disadvantages the authors feel that the best method of obtaining treble rolloff is by loading the pickup cartridge with a low resistance, providing proper treble equalization before any amplification and making the treble response relatively insensitive to shunt capacitance across the pickup. The turnover frequency is given approximately by

$$f_3 = \frac{R_L + R_G}{2\pi L}$$

where R_L is the load resistance, R_G is the series resistance of the pickup, and L is the series inductance of the pickup, as explained in Pickering's article.

If the effective inductance of the pickup were constant over the audio frequency range, then the treble rolloff provided by the low resistance loading would be 6 db per octave. There is considerable interwinding capacitance in the coils of the pickup, however, which causes a decrease in the effective inductance with increasing frequency, especially above 1,000 cps. In the case of the GE pickup the effective inductance at 10,000 cps is only 0.6 that at 1,000 cps. The result of this is that the slope of the roll-off obtained is somewhat less than 6 db per octave. Nevertheless good equalization can be obtained, fitting the desired curves to within 1 db, as shown in *Fig.* 4. It also conveniently turns out that as one goes to higher turnover frequencies the roll-

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[4] See Part 1, August 1954.

[5] N. Pickering, "Effect of load impedance on magnetic pickup response," Audio Engineering, March 1953, page 19.

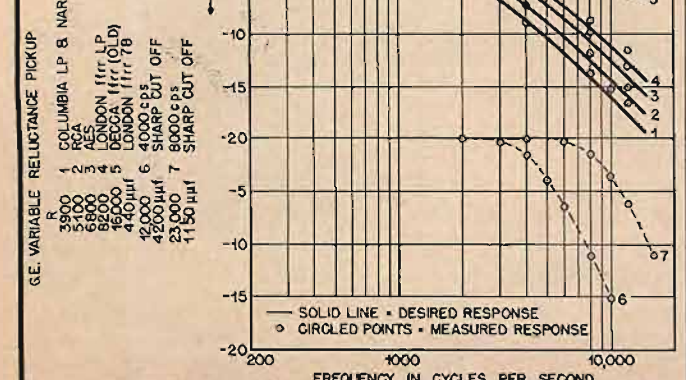


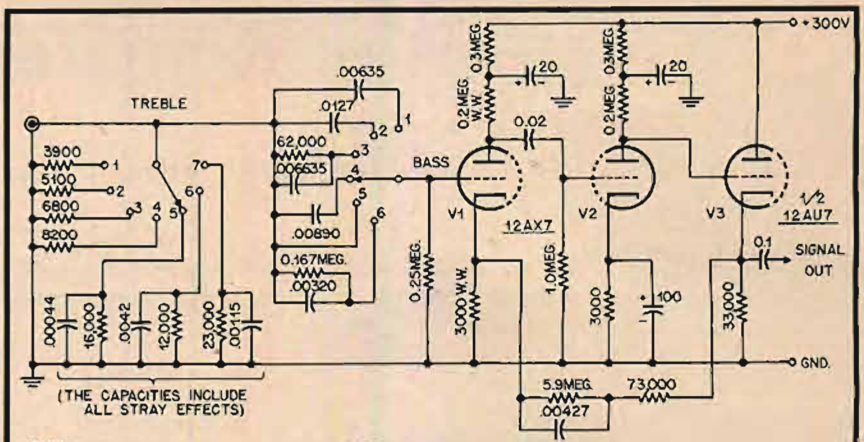
Fig. 4. Various treble rolloffs obtainable from the GE pickup with different values of load resistance. Two sharp cutoffs obtained with loads including paralleled R and C are also shown.

off rate decreases enough so that one can obtain good equalization for the Decca ffrr records, which require a 3 db per octave rolloff starting at 3,000 cps. These loading resistors can be shunted with up to 250 μμf with negligible effect on the response curves, affording ample allowance for shunt capacitance introduced by the shielded input cable and by the input capacitance of the preamplifier including the Miller effect. This type of equalizer can also be used to provide 12-db-per-octave scratch filters by placing a sufficiently large capacitance in shunt across the load resistor, as explained in Pickering's article. Two examples of this are shown in *Fig.* 4.

All the curves in *Fig.* 4 were obtained experimentally by the method outlined by Pickering and shown in his *Fig.* 16. The values of load resistance found experimentally by this method are the same as those recommended by GE[6] for the two cases, LP and AES, for which they give specific information. In private correspondence with the General Electric Company their engineers stated that this method should give results very close to those obtained from a true constant-velocity source. They pointed out that this method gives results more accurate than commercially available vinyl frequency records. These records have deviations as high as 4 db at the high-frequency end due to groove compliance which may vary considerably depending upon the exact groove dimensions, the number of plays on the stylus and the record, the ambient temperature, etc. The closest practical approach to an ideal constant-velocity source is a carefully recorded shellac record, not available to consumers.

If vinyl frequency records vary as much as 4 db in their high-frequency response, one would expect that all other vinyl microgroove recordings would also vary this much or even more. The high-frequency response of any one record will also vary considerably from the outside grooves to the inside grooves even though partial compensation for this effect may be made by special equalization during recording[7]. Hence attempting exact treble equalization is fruitless, and the listener should expect to have to use his treble tone control to compensate for variations of records from the ideal recording characteristics.

The circuit diagram of the preamplifier design finally arrived at by the authors is given in *Fig.* 5. Care must be taken in the construction of such a circuit in order to reduce the hum and noise to a satisfactorily low level, but many excellent articles considering these problems have been published[8] so they will not be discussed here. A_o will depend on the transconductance of the particular



TREBLE POSITION	RECORD	BASS POSITION	RECORD	(Ab/Am)
1	COL. LP & NARTB	1	COL. LP	5
2	RCA	2	RCA	10
3	AES	3	AES (400–)	—
4	LONDON ffrr LP	4	NARTB	7
5	DECCA ffrr & LONDON ffrr 78	5	500—	—
6	4kc SHARP CUT OFF	6	300—	—
7	8kc SHARP CUT OFF			

BOTH SWITCHES ARE SHORTING TYPE

Fig. 5. A complete preamplifier-equalizer, with variable characteristics, designed by the authors in accordance with their method.

12AX7 used, but the large amount of feedback used makes the circuit insensitive to reasonable variations in g_m. A typical value of A_o is 2,000, while A_m is 25. The application of a large amount of feedback around three stages requires some care to maintain stability. Direct coupling to the cathode follower reduces the number of phase-shifting networks inside the feedback loop. Large decoupling time constants are necessary and the coupling time constant between V_1 and V_2 is chosen to reduce the gain at frequencies below 20 cps. With conventional hum balancing methods when the heaters are operated on a.c. the hum and noise output is easily held below 2 millivolts rms, which is 42 db below the average output of the preamplifier when using a GE cartridge. The use of d.c. on the heaters reduces the hum by another 20 db or more.

The method of changing bass equalization is somewhat unconventional. Since a d.c. feedback path is used, there will inevitably be changes in the d.c. voltages across the feedback capacitors if these and their shunting resistors are switched. Conventional click suppression techniques are not sufficient to reduce the annoying clicks which appear at the output of the preamplifier in this case. To avoid this difficulty a fixed bass equalization having $f_2 = 500$ cps and $f_1 = 12.5$ cps (i.e., $A_b/A_m = 40$) is introduced into the feedback network. Other bass equalization characteristics are obtained by placing outside the feedback loop R-C equalizers to provide the small changes necessary. To shift the turnover frequency to other values, equalizers with characteristics shown in *Fig.* 6 are inserted, making f_1 (of this correction equalizer) = 500 cps and f_2 the new turnover frequency. To obtain low-frequency bass de-emphasis, such as in the Columbia LP characteristic, a simple R-C coupling circuit having the turnover frequency required for de-emphasis is used. The net result is equalization which is accurate to within 1 db down to 30 cps, while below 20 cps the gain drops off rapidly, giving good stability and low noise at low frequencies. The drop below 20 cps is caused by the lower turnover of the feedback equalizer and the choice of coupling time constants.

The treble equalization is obtained by low-resistance loading of the phonograph pickup as previously described. We would like to point out that the provision for RCA recordings is a 6 db per octave roll-off starting at 2,120 cps rather than the frequently used 2.5 db per octave at 1,000 cps, in accordance with the information in reference 1. All the treble equalizations are shown in *Fig.* 4. Two sharp cutoff positions are provided for old or scratchy records. It

(Continued on page 65)

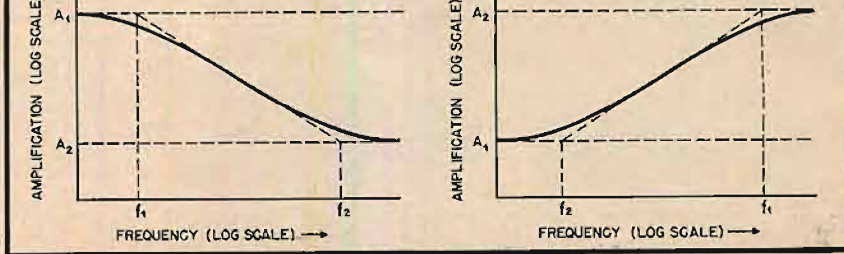


Fig. 6. Additional equalizers with responses as shown are inserted to shift turnover frequency.

[6] "Variable Reluctance Application Data," General Electric guide for the audio hobbyist.

[7] See reference 1 last month.

[8] R. H. Brown "High Fidelity Phonograph Preamplifier Design," AUDIO ENGINEERING, April 1953, page 19.

A Transistor Remote Amplifier

PAUL PENFIELD JR.*

Construction details of a completely portable, light-weight remote amplifier, which utilizes transistors for ruggedness, size, and economy.

RADIO STATION WAMF is a student-run extracurricular activity of Amherst College, and as such much of the programming is devoted to the interests of the college, both students and faculty. Although heard throughout the town of Amherst, its main responsibility lies toward the college. WAMF broadcasts all college football and most basketball and baseball games, both at home and away, play by play. In addition, lectures, musical programs, and other events of college interest are broadcast on the spot. To facilitate our rather extensive remote programming, we decided recently to build a second remote amplifier, with certain features not found in most commercial units of this type.

The most important "extra" wanted was operation from self-contained batteries. Although most of our remotes are done indoors or from press boxes, often it is difficult to find a power outlet, and on those occasional outdoor broadcasts, it usually turns out to be next to impossible. One nearby college has no 117-volt service at its baseball diamond, and we once found it necessary to run nearly 1,000 feet of drop line to reach our vantage point. Two microphone inputs of medium impedance seemed desirable for greater versatility; our previous remote amplifier had only one. The completed unit was to be as small and lightweight as practical for ease of handling and setting up.

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Figure 1 shows the outside view, with the cover open, of the completed remote amplifier, which we believe to be the first of its kind. Three Raytheon junction transistors and a 3V4 give ample power output. Transistor types CK-721 and CK-722 were both investigated, and it was found that the cheaper CK-722 was too noisy for this application. Transformer coupling between stages was not found to be necessary, in spite of the radically different input and output impedances of the grounded-emitter transistor. A vacuum tube was used in the output stage because high-power transistors were not on the market at time of construction. No doubt the presently available power transistors could have been used with much better efficiency and less weight.

The unit is housed in a 15 × 6 × 3-inch steel box left over from war-surplus purchases. No attempt was made to keep physical size down to a minimum; nevertheless it is smaller than most comparable commercial amplifiers. The batteries are housed in the right-hand third, as can be seen in *Fig*. 2. A hinged cover protects them. A spare "A" battery is generally carried with the amplifier in case of failure during a broadcast. Replacement takes only a few seconds, and the program can go on with a minimum of interruption. The 3V4 tube also faces into this compartment, for easy replacement.

All sheet-metal parts, with the exception of the case itself, are of aluminum, and were formed by hand. As can be seen in *Fig*. 2, the heavy components, notably the output transformer, are mounted near the center for good weight distribution. The hinged cover of the case protects the controls and the VU meter from accidental damage. A mechanical interlock prevents an absent-minded engineer from closing the cover with the power turned on. The mike connectors are of the Cannon P3 series, and the output binding posts are made by the Heath Company. These latter were mounted horizontally, providing a maximum of finger room, while still clearing the cover as it closes. All controls, soldering strips, wiring, and other parts are mounted on a subchassis, with only the shafts of the controls sticking through the outside panel. The structural parts are held in with sheet-metal screws, and the whole unit is removable, as seen in *Fig*. 2.

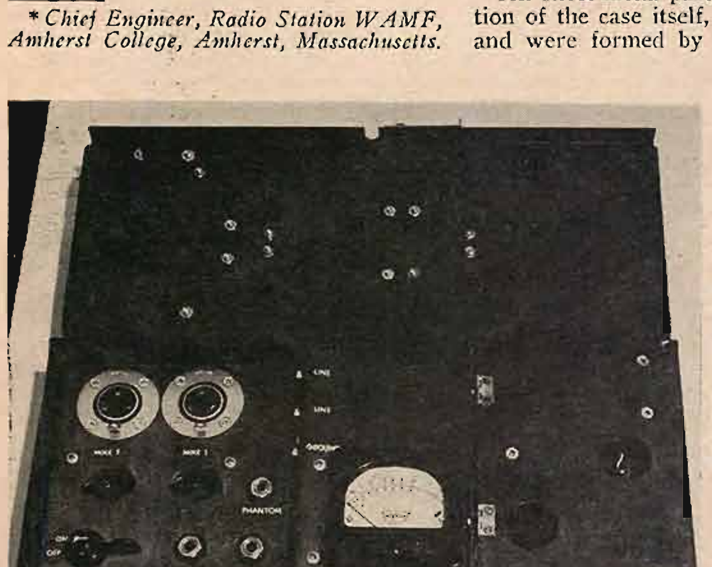


Fig. 1. Over-all view of the remote amplifier with the cover raised. A rugged canvas handle on the cover makes the unit truly portable. Note the battery compartment at the right.

The Circuit

Electronically, the use of transistors made construction possible using a minimum of parts. The circuit diagram is shown in *Fig*. 3.

A medium-impedance microphone can feed directly into a grounded-emitter transistor stage without too serious a mismatch. The unusually large size of the coupling capacitors C_1, C_2, C_3, C_4, C_5, and C_6 is necessary for good low-frequency response, due to the relatively low input impedance of the transistor stage. Values up to 50 μf, as used here, are not uncommon for this application. The lowest voltage rating is ample, of course, since the maximum voltage present in that part of the circuit is generated by the 4.5-volt transistor battery.

The base resistors R_1, R_4, and R_7, are chosen to give the correct base current. The load resistors R_2, R_5, and R_8, are a compromise between the relatively high output impedance of the transistor stage and a value low enough to allow sufficient collector current to pass.

The attenuators R_3 and R_6 were designed to present a constant impedance to the following stage, to prevent the setting of one control from affecting the attenuation of the other. The load resistor of the previous stage tends to upset this relationship to a certain extent; for best results a T-pad should be used. However space and financial considerations prevented their use in this particular model.

The final-stage tube required 4.5 volts peak to drive the grid, so a step-up transformer was used. A small UTC ouncer output transformer connected in reverse did the trick. No d.c. runs through this transformer. A high-quality output transformer, a Chicago BO-2, was used following the final stage.

Two earphone monitor outputs are provided and are isolated from the line by two 2,000-ohm resistors to prevent loading. Adequate earphone volume is obtained. Although no send-receive switch is incorporated in the amplifier, the monitor can receive talk-back from the studios, and the second monitor jack is for the announcer. The VU meter level is determined by resistors R_{10}, R_{11}, and R_{12}, which comprise both the series resistor and the attenuator required for meter operation at +8 VU. This is of course the maximum level allowed by the telephone company on their radio loops.

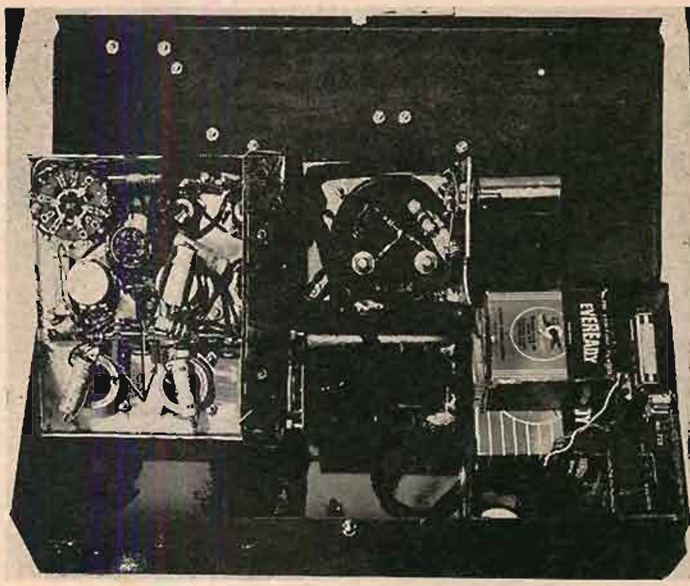


Fig. 2. Interior view of the amplifier. The chassis comes out in one piece.

Amplifier Performance

The amplifier was not specifically designed around high-fidelity standards; however a general review of its operating characteristics will prove of interest. Rough frequency response tests indicate that the unit is flat within ±2db from 50 to 15,000 cps. The harmonic distortion was measured on a null type of distortion meter and turned out to be less than two per cent at operating level, most of it second-order distortion. There is, of course, no hum problem with this battery-operated amplifier. However the noise becomes bothersome at times.

The operating signal-to-noise ratio is in the neighborhood of 50 db in one channel, and 43 db in the other. The difference is due to variations in the transistors themselves. The three CK-721 transistors were each tested for noise, and the noisiest one put in the second stage, where noise is less of a problem. In practice, the noise is just audible between spoken sentences. Whereas this is no problem at sports events, with the general high background noise, for lectures and concerts it has proved to be somewhat annoying.

Let the writer emphasize that this amplifier is not a "gadget." Transistors were used not because their use would be novel or educational, but because they presented the easiest solution to the problem at hand. The freedom from 117-volt power lines has made this remote amplifier more useful than first expected. During the traditional freshman-sophmore rivalry at Amherst College in 1953, one of the station announcers had the unit strapped to his back, and he wandered about during the riot trailing just one pair of wires behind him. The wire went to a tape recorder set up in a nearby building. Such a set-up could be useful during emergencies or for on-the-spot disaster reporting.

Handling Transistors

Not much has appeared in the litera- about the "care and feeding" of transistors. A few comments here on this important subject may prevent readers from making some of the same mistakes the writer has. Since transistors are still relatively costly, these comments are well worth reading. The transistors were adapted to plug into sockets. These are the 5-prong subminiature hearing-aid-tube sockets.

Much has been made of the claim that transistors have such a high life expectancy that they can be soldered or welded directly into place, without the use of sockets. However, the heat of a soldering iron applied to the leads is enough to burn out present transistors, as the writer found out by bitter experience. Holding the lead next to the body of the transistor with long-nosed pliers to conduct away the heat is helpful, but still does not solve the problem. Also, the leads have the unfortunate habit of breaking off, invariably (it seems) right at the body of the transistor. The simplest way around these two difficulties is to use a socket. Contacts 2 and 4 of the socket are removed simply by pulling them out, and contacts 1, 3, and 5 are left in for use. One end is painted red, to correspond with the red dot next to the collector lead of the transistor. The lead wires of the transistor are cut to a quarter of an inch to fit snugly into the socket.

Transistors burn out electrically very easily, and too low a value of base resistance will allow too much base current and thus too much collector current. Also, on p-n-p junction transistors like the CK-721 and CK-722, the B-supply is reversed from vacuum tube practice and so all polarized components like electrolytic capacitors and d.c. meters, must be connected in reverse. Being absent-minded and connecting the collector lead to the positive battery terminal instead of the negative terminal effectively biases the collector-base junction forward and instantly burns out the transistor.

At present the only obstacles to more widespread use of transistors in audio circuitry seem to be cost, availability, and noise. With each new transistor release, noise is becoming less and less of a problem. In a few years, the cost will undoubtedly dip to below the cost of comparable vacuum tubes, and transistors will become more plentiful, so it behooves every audio engineer to get in some experience with transistors before their use becomes widespread.

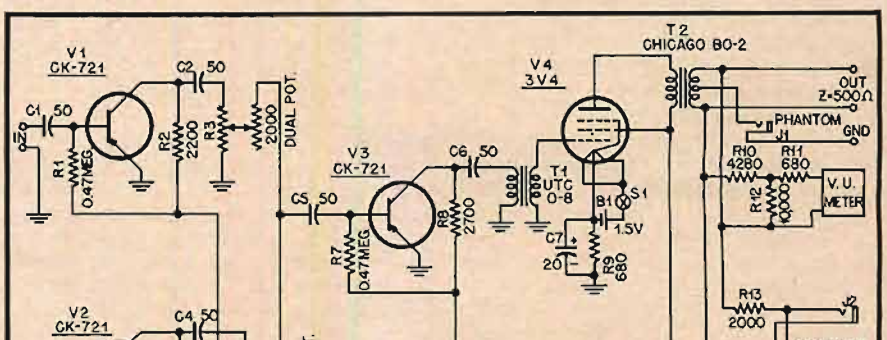
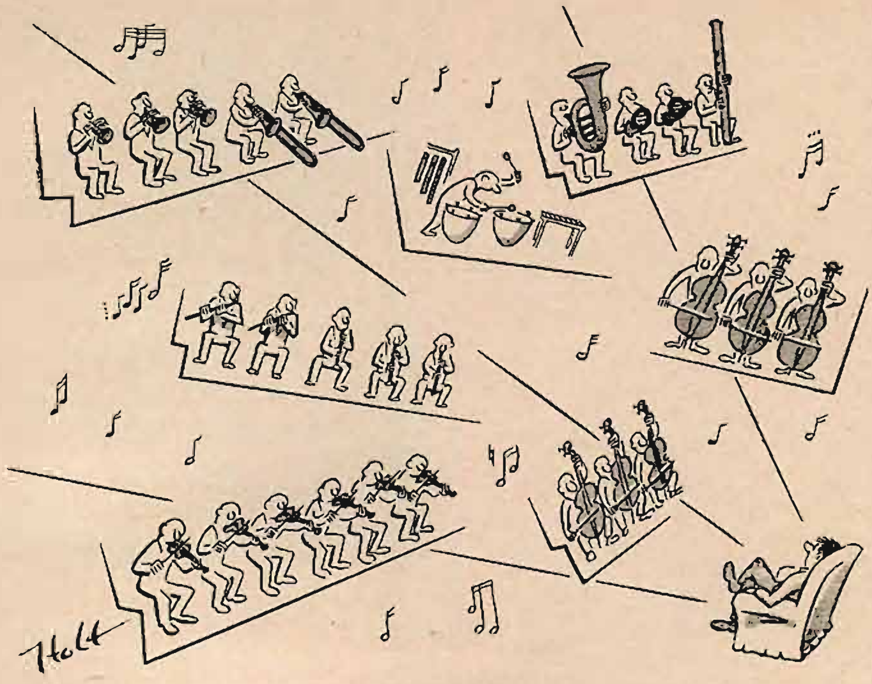


Fig. 3. Schematic diagram of the amplifier. Use of transistors makes construction possible using a minimum of parts. Two mike channels with independent attenuators are provided.



The orchestra & the lone listener.

From High Fidelity to Music

ZYGMUNT HOF*

Loudness controls may be the solution to music reproduction for those who must, for one reason or another, play their records at lower-than-normal volume, but for optimum listening the old adage that "music can have its original tone quality only when reproduced at its original volume" is the best rule.

FOR A LONG TIME I knew that Jim had a secret method of record reproduction. Now I am able to tell you that secret for I tracked him down and made him talk.

There were a great many music lovers in our town, all of them playing records at home with whatever equipment they could buy or construct. As they got together, meeting in the record and radio shops, those fellows who could afford a better reproducing system or a superior selection of records took their pride inviting their less lucky neighbors to private recorded concerts. That was a kind of social event: Every two or three weeks these musical hosts collected whatever chairs they could find and put them in rows before their loudspeaker. When the guests arrived, mostly on a Sunday afternoon, and settled down in those casually arranged chairs, they received a nicely printed program. It was remarkable how well the rules of the concert were observed: No talk, no refreshments, absolute quite and concentration on listening. It was pleasant but serious entertainment. When the host switched off the lights and the first bars from the speaker filled the room, everyone's face showed an expression like a gourmet's taking the first mouthful of a famous dish; these connoisseurs tasted, with wide open ears, both for tone quality and the substance of the recorded piece. Of course, at the end of the party, the visitors would not make any open remarks to the host but their appreciation of his concert could be evaluated from the attendance at the next occasion.

I knew a dozen or so of these private concert promoters personally, as they used to consult me on matters of equipment, and I guess there must have been at least a score of them in town. Some had quite a reputation as record hobbyists. But there was one outstanding among them, one I heard spoken of with admiration, one of whose recorded concerts were a series of acclaimed successes, and that was Jim. Some had sought my advice before. I had given it as honestly and as well as I could. I had helped them to construct and improve their audio system; I had told them how to manipulate it and its gadgets, which can often be quite confusing to beginners. They used to listen to my professional explanations, with patience, but they came back with doubts and questions again and again.

Naturally I was startled when these same people began, one after the other, to talk as if they had found perfection in recorded music, at last. What on earth had brought about that change? Perhaps they had found the perfect amplifier, I asked them. No, they had still their old equipment; some was cheap stuff, and some self-constructed, but they played it the way Jim did. And this was about all these ungrateful persons would tell me.

It was not easy to get in touch with Jim, of private concert fame. I had met one of his best friends, Rich Bill. He was the owner of several oil-wells and bought a complete new set of hi-fi equipment every two months. Every time he did so, at a price that never ran under four figures, he sent his previous outfit as a gift to a hospital or institution. Invariably, he had to spend hours afterwards with those people, explaining to the perplexed staff and doctors how to twist a dozen knobs.

Through Bill, I was introduced to Jim. We met in a comfortable corner of the "Audio and Steak" Shop, and I immediately began to question him.

Jim's equipment turned out to be one of those ordinary, commercially-built, medium-priced jobs. He had bought it

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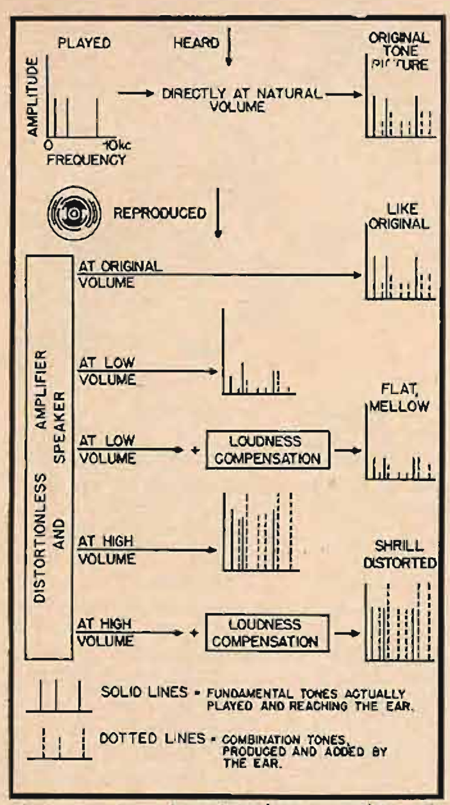
Illustrations by J. Gordon Holt



Music can have its original tone quality only when played at its original level.

in a radio store. I asked if he had changed anything. Maybe he had used one of the "distortionless circuits" that appeared in the literature; or did he use, perhaps, in his concerts such modern ideas as "stereophonic" listening?

If that means, said Jim, that one should hear the music as coming from different directions, then the fundamental problem was, whether the music came from a point source or from a widely dispersed body of players. Suppose it was a solo performance, then the music originated from a point, and it should appear to come from one point also, when reproduced from a record.

In the different case of a huge orchestra of a hundred or more players this body usually dwindled in a full-sized auditorium with several thousand seats, to the dimension of a spot and the ear had the impression that the music was coming from point rather than from a whole area. Of course, if one listened to the recording of a monster orchestra in one's own home, then the situation was reversed: The audience was a lone person, the orchestra a giant body. But the lone listener would not accept this superiority of the orchestra; he would prefer to imagine himself in a concert hall amidst thousands, when the orchestra looked like a small group far below. In either case, Jim did not see any need for stereophonic reproduction. Incidentally, its only effect upon Jim, and he had heard the most elaborate stereophonic demonstrations, had been that the music seemed to come from a distance.

I always go for the real music, said Jim. In this great battle of audio design and high fidelity we have forgotten what it is all for. What do we want from records and record reproduction? We want life-like music. But, first of all, do you know what music is?

Jim had caught me unprepared. Certainly I had an idea what music was. But I had my doubts if one could regard some super-modern compositions as what I understood music should be. I hesitated.

Music is sound with spirit and delight in it, he told me.

Said Jim: Good music is anything you should like to hear again. Very good music are those pieces you would hear all your life again and again. But if you say, "once, and never again", it's bad music. These rules are my guide when I choose the programs for my concerts. For I want to hear good music. Again, only if I know what I want to hear, can I play records in the correct manner. I want to hear music as it really sounds, natural music, with nothing artificial added.

But how do we know how the original music sounds? I asked.

Nothing easier than that, answered Jim. Do you see the couple over there? They are pupils of Uptown Music School. Violin and piano, mainly. Did you ever try to invite music students to give a performance at your home? Tell them you are going to play a record, Sonata so-and-so, played by famous So-and-so, and then they should play another item, but for the same instruments. Surely, they have time. They come and rehearse. While they play, I listen intensively, and with the sound of true music still in my ears, I adjust the controls of my audio system so that the record reproduction sounds exactly as the original music. My concerts are one half "live," one half "recorded" concerts.

You should see how pleased these local students from the conservatoriums are when they are able to show their talents, and the audience likes an improvised, fresh performance and gives them a warm appreciation.

You should see the revelation that comes upon those listeners when they get clear, real music into their speaker-tortured ears. Once they have heard how musical instruments actually sound in a room, they drop the usual misconceptions of tone quality because they have something to hold on and compare.

When I start playing the recorded part of a concert, I have "music" in mind and nothing else. So I hide the speaker. No round openings or machinery, or baffles are visible. I shut off the main lights. Only a spotlight is left to single out an object which symbolizes "music". A violin on a table, a flower-decorated bust of a famous composer, or an open score on a music stand, illuminated by a green beam, will occupy the sight of the listeners during the concert, will make them unconsciously forget that what they hear is a record, and keep their thoughts on "music."

Jim, don't try to fool me, I said. You haven't told me your top secret of record reproduction yet.

Well, said Jim, come in at rehearsing time, one hour before my next concert begins.

* * *

Hardly had I entered Jim's living room which was crowded with empty chairs of all styles, when Jim asked me at once to play a record. I turned the changer on and let it go. Immediately, the room was filled with beautiful chamber music. But the volume, as it was set, seemed unnecessarily loud to me, and when the music went into a crescendo, I followed a sudden urge and cut it down to what I regarded as a "tolerable" volume.

After the first movement Jim faded the record out and introduced a trio of musicians to me who had modestly stayed away in a corner. These gentlemen will now play the same item, he said, and, in a moment, the same beautiful melody as before filled the room.

Could it be, I thought, that three musicians make such a lot of noise? Can three instruments, without an amplifier, be as loud as that? I had never imagined a trio had such a volume. In fact, it was as loud as, . . . truly, as loud as the music from the record had been before I cut the volume down.

Does real music sound too loud to you? Jim asked. Turn those instruments low, if you can! That is music at its natural volume. Nothing to be corrected. Here is the crescendo. Can you bear it?

Operating the Hi-Fi Sound System

This is music, come free, out of the cage. It flies as high as it likes. And that's why it is beautiful.

The musicians had finished. Jim started the record once again. Turn the volume control up and down, he told me. I did.

Now listen carefully to the record. As you turn down the volume you come to a certain position of the control knob where it sounds like music. Beyond that point it is unnaturally loud, below it sounds rather flat. Now you are at the correct position. Stay there!

I noticed that the musicians had started to play simultaneously the same item. Jim flipped a switch. The record cut out and I could hear the musicians playing alone. I compared. There seemed no difference between record and live music. The same tone quality, the same loudness.

The room went quiet.—If you want to hear music from records, you have to obey a fundamental rule of record reproduction: "*Music Can Have Its Original Tone Quality Only If Played At Its Original Volume*", said Jim.

But isn't it possible to compensate for tone at a different volume? I asked.

No! said Jim. I shall prove it.

Suddenly I found myself in Jim's laboratory.

There were three audio oscillators, each one set to produce a different tone. The frequencies of the tones were one in the bass, one in the middle and one in the treble region of the spectrum. All three were fed together into an oscilloscope. I could see on the screen of the scope that the tones had the perfect, undistorted shape of sine waves.

Mark the amplitudes down!, said Jim. I did so, measuring the size of each tone on the screen.

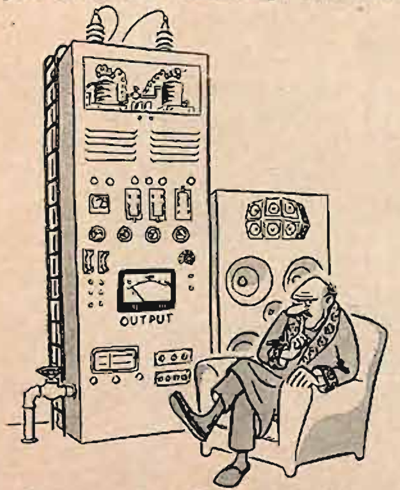
Jim connected the three oscillators to a speaker. What do you hear? he asked.

It sounds beautiful, I said. But I would not believe that it is only three tones that I hear. It is rather a combination of many tones.

Jim cut the volume of all three tones down. I could see the waves on the scope shrink, each an equal amount. How does it sound now? he asked.

It seems more like three tones alone, but it sounds flat, I said.

Jim turned the volume up. The waves on the scope grew each double as high as they had been in the first case. They still had a perfect shape. But the sound that I heard seemed composed of many tones and was shrill, unpleasant.



Grampa and the 200-watt Amplifier

I wonder why I hear more tones than I can see on the scope, I said. I wonder why I hear distortion right now, while the scope does not show it.

Said Jim: These are the facts of hearing: Exactly 200 years ago Tartini discovered that the ear adds to the tones which actually reach it, combinations of these same tones. About 100 years ago, Helmholtz showed by experiments, by mathematics, and by an analysis of the ear's mechanism that the combination tones produced in the ear were a fact; that they may give to music either a pleasant or unpleasant character; and that these combination tones, which we hear additionally, increase steeply with the intensity of the fundamental tones reaching the ear.

If music is to sound pleasant, therefore, it must be played with a certain intensity, at which enough combination tones are produced in the ear to give it a well flavored, easily accepted, smoothly consumed sensation. If the music is too low, less combination tones are produced in the ear, giving less stimuli to the nerves, and it sounds flat. But if the music is too loud, it sounds sharp and distorted. For as the fundamental tones, which reach the ear, become louder, the combination tones, which are produced from them in the ear, grow more and more in intensity and attack the ear in transient shocks. This is surely not pleasant to the ear.

Now I understand, I said, why one can hear distortion from an absolutely distortionless amplifier. When all other sources of distortion are eliminated, the ear alone can be the offender. To prove this, modern theory would say that the ear has a nonlinear transfer characteristic, owing to unsymmentry in its mechanism, and then the theory proceeds to run equations off a curved line.

Helmholtz did it with energy equations, said Jim. He set the three audio oscillators to the output, which I had measured first, when the combined sound was beautiful and pleasant, and connected them to a tape recorder. He made a steady recording of long duration and played it back on the oscilloscope and over the speaker. The reproduced tones were set to the same amplitude as the original ones and had the same perfect sine wave shape. The reproduction was beautiful, too, just as the original.

In other words, for all the tones to blend together in the ear, you *must* play the reproduction at the same level as the original

Returning to Jim's living room, I asked: Is this your top secret?

Yes, said Jim. The first and all-important thing to do when you adjust your amplifier controls, is to set the volume control to the original loudness of the reproduced item. A violin on a record sounds like a violin, if it is played just as loud as a real violin. A piano on a record sounds like a piano, if it is played just as loud as a real piano.

Still, I said, the instruments seem to loud that way.

This is your fault, said Jim, because you seldom go to live concerts. Cramped close to the loudspeaker, with the amplifier whispering, like noise-frightened grandpa, you are used to listen to a weak, ghost-like performance of music, satisfied to grasp only the idea of its contents. But in the concert hall, music is full of power, brilliance, vitality. Original music has its natural volume. Keep it at that, get used to it!

Well, I said. I could agree to play a small group of instruments or voices from records at their natural volume at home. But how about a big orchestra?

That's different, said Jim, because even a concert auditorium may be too small for a full orchestra. It depends rather on the acoustical design of the hall than on its dimensions whether a mass concert sounds well in it. What the listener desires in an orchestra performance is "distinction."

* * *

I shall never forget my first experience with modern acoustical architecture at the Royal Festival Hall in London. I had a seat far up in the rear but I could hear the voice of each instrument separately. I could distinguish each one of the instruments with its characteristic color, with every shade of its personality and partnership in the performance. And still, the orchestra was one body. I enjoyed this concert, because of the heavenly sound of the music, as I never did one before. And I have attended uncounted concerts during my life.

How do I adjust the volume when I play an orchestra record at home? Since, above all, I want to hear the different instruments distinctively, I choose a passage when only one instrument predominates and the volume control at once so that this one instrument sounds like the original. That should make the other instruments also sound like the original, if the recording is properly done.

As I saw Rich Bill entering at this moment, I said: It would be fine if it were necessary to adjust only one single control. By the way, Bill, how many controls have you got in your latest amplifier?

Let me see, answered Bill . . . Two for the equalizer, two tone controls, and a number of pushbuttons, and some switches, and . . .

Do you use all of them? I asked.

No, said Bill. I myself set the tone controls, etcetera, but the volume control is always adjusted by my wife.

Variable Damping Factor Control

CHARLES A. WILKINS*

The virtues of a high damping factor in an amplifier have been the subject of unending discussion. The circuit presented here enables the user to determine for himself the damping factor which will result in optimum reproduction through his own speaker system.

Enthusiasts of high-quality reproduction seem to hold either of two widely divergent opinions on the desirability of high damping for loudspeaker loads. Those in favor claim that a high damping factor (low amplifier output impedance) increases the magnetic damping of the motion of the voice coil thereby reducing spurious excursions caused by mechanical and acoustical resonances and improving the transient response, while those against claim that a high damping factor degrades either the high- or low-frequency response (or both) of the speaker thereby degrading the transient response.

Let us examine these claims by referring to the equivalent circuit of an enclosed-cabinet single-cone loudspeaker shown in *Fig.* 1. Constant-voltage generators are shown in the electrical equivalent circuits at (a) and (c), and a constant-force generator in the mechanical equivalent circuit at (b). Equation (*4*) represents the total resistance R_D acting in series with the reactive components of motional impedance Z_M to produce damping. Any increase in the value of R_D will increase the damping on motion of the speaker cone. Inspection of both Eq. (*4*) and (b) of *Fig.* 1 shows that an increase in radiation resistance R_A, mechanical resistance R_S, or gap flux density B will increase the damping. Conversely, a decrease in amplifier source resistance R_G or d.c. voice-coil resistance R_C will increase the damping. Horn loading will increase R_A. R_S is designed into the speaker and inspection of Eq. (*5*) shows that as R_S is increased the efficiency μ of the speaker decreases. This makes it desirable to have R_S as small as possible in relation to R_A if damping can be obtained from another source. B can be increased by using a larger more expensive magnet than is obtainable in speakers of moderate cost. The winding length l can be increased by using more turns of wire on the voice coil, but since there is only a limited amount of space in the voice-coil gap and resorting to smaller diameter wire will increase R_C, there is an optimum wire size and winding length beyond which little improvement can be gained. R_G can be decreased by decreasing the amplifier source resistance, and as far as damping is concerned, a decrease in R_G is *exactly* equivalent to increasing the gap flux density B.

The Bogen DO30A, which incorporates the damping factor control described in this article.

The damping factor of an amplifier is defined as

$$DF = \frac{Z_L}{R_G} \qquad (6)$$

where Z_L is the impedance of the amplifier load, and R_G is the amplifier source resistance. If the load is a speaker system $Z_L = Z_C + Z_M$ at high frequencies and $Z_L = R_C + Z_M$ at low frequencies. It is seen that DF increases as R_G decreases, and when R_G equals zero DF equals infinity. If R_G should be made a negative value, DF would also become negative.

Optimum Damping

It has been shown that a high DF is equivalent to higher magnetic damping

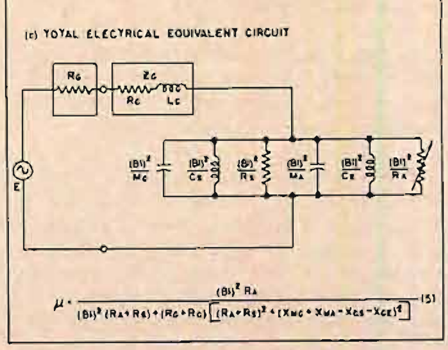


Fig. 1. Electrical and mechanical equivalent circuits of loudspeaker driven by amplifier.

of motional impedance Z_M and that given a DF sufficiently high the damping of Z_M may be made equivalent to *perfect* horn loading. The question that remains is how much damping can we use profitably? The ultimate limit is imposed by the occurrence of oscillation in the LCR circuit comprising Z_M. If R_D is made infinite, Z_M will become critically oscillatory. This condition can be produced by making R_G equal to $-R_C$ and corresponds to an amplifier DF of -1. This is the same as saying that R_C is exactly cancelled out by a negative R_G.

Another limit we can observe, if all that interests us is damping of cone or enclosure transients at resonance, is the reduction of the Q of Z_M at resonance. When the Q of a resonant circuit is made equal to 1, the frequency response is flat throughout the range of resonance but there is some transient overshoot. If the Q is made equal to 0.5, the circuit is said to be *critically damped* and there is no transient overshoot but the frequency response begins to droop below the range of resonance. This effect is shown in *Fig.* 2. The droop below resonance is explained by considering (b) of *Fig.* 1. The R_A of the speaker diaphragm (or apparent diaphragm at the horn mouth if the speaker is horn loaded) begins to decrease as the square of the wavelength below the critical wavelength (the wavelength that is equal to the circumference of the diaphragm). This effect alone will produce a 12 db/octave droop in sound output below the critical wavelength. The reactance of C_E, the compliance of the air in the enclosure, and C_S, the compliance of the cone suspension, become increasingly large below the fundamental resonant frequency and account for an additional 6 db/octave droop below resonance. (M_C is the mass of the cone and M_A is the mass of the air.) The Q of the resonant circuit can be decreased by increasing the value of either R_A or Z_E. An increase in R_A can be produced by horn loading and will result in a higher critical wavelength. On the other hand, an increase in Z_E will not alter the critical wavelength but will have the same effect on damping as horn loading. So we see that in a speaker system that has its critical wavelength at a higher frequency than its fundamental resonant frequency, the effect of resonance may be used to reinforce the response between these two critical frequencies. By making the Q equal to 1, we will

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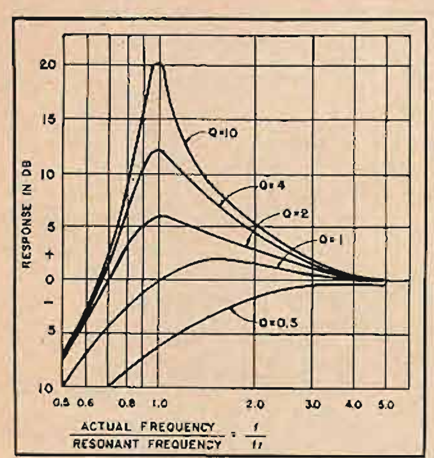


Fig. 2. Relative response of loudspeaker for different values of G.

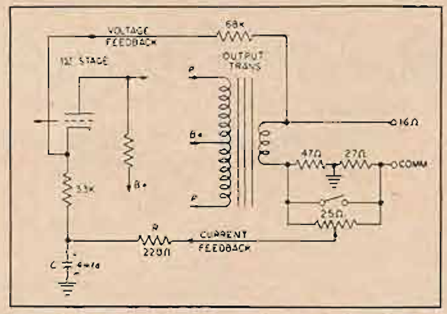


Fig. 3. Simplified schematic of the Bogen Variable Damping Factor circuit.

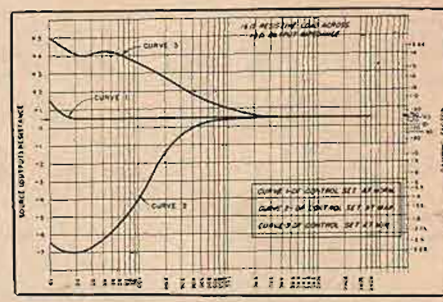


Fig. 4. Variation of amplifier source resistance permitted by DF control when using a resistive load.

achieve optimum flatness in the frequency response. The Q of the mechanical equivalent circuit of (b) in *Fig.* 1 may be expressed as

$$Q=\frac{X_M}{Z_E+R_A+R_S} \qquad (7a)$$

where X_M represents the total inductive reactance of (M_A+M_C). In the total electrical equivalent circuit of (c) in *Fig.* 1, the equivalent expression for the Q is

$$Q=\frac{\dfrac{(Bl)^2}{X_M}}{R_G+R_C+\dfrac{R_A}{(Bl)^2}+\dfrac{R_S}{(Bl)^2}} \qquad (7b)$$

If we have an *ideal* exponential horn of infinite length, infinite mouth area, and zero rate of flare, we can expect R_A to be infinite throughout the frequency range, making the critical wavelength infinite (zero cps). The effect of C_B and C_S will be eliminated, the Q at resonance will be reduced to zero, and the damping will be perfect. But since such an ideal condition is impossible, let us examine what will happen on the other hand if we take a less than perfect system (with or without horn loading), and make Z_E infinite by employing a *DF* of –1. The effect of C_B and C_S will be eliminated, the Q at resonance will be reduced to zero, the damping will be perfect, but the critical wavelength will remain unchanged. At frequencies below the critical wavelength, the response will droop at a rate of 12 db/octave. The critical wavelength can be made to occur at a sufficiently low frequency either by employing a speaker with an adequate diaphragm area, or by employing a horn with an adequate mouth area. For such a large area as would be needed, say, for a 30- to 50-cps cutoff, the horn offers the better solution—and the effect of infinite Z_E would be a great advantage in damping the violent resonances that occur in a less-than-perfect horn. There is, however, another mode of attacking the problem. The 12-db/octave droop could be equalized electrically if the critical wavelength occurs at too high a frequency. If we can reduce the distortion attendant with the degree of equalization that would be required to restore the low frequencies, this method would be a legitimate mode of attack. It will be shown later that a *DF* of –1 will result in a drastic reduction of all types of distortion in the speaker system.

High-Frequency Damping

The foregoing analysis, while based on the low-frequency range, is valid for the complete speaker range, providing allowances are made for the voice coil inductance L_C and for the coefficient of coupling between the voice coil and the resonances due to cone break-up. Generally speaking, the coupling between break-up resonances and voice coil is small, thereby minimizing the benefits deriving from a high *DF*. Horn loading of the cone for high frequencies appears to be the only means at our disposal for damping these resonances effectively. However, the voice-coil inductance L_C *may* have an effect in filtering out the extreme high frequencies as (R_G+R_C) is reduced. Of course, the magnitude of this effect depends upon the value of L_C. In some speakers tested L_C was sufficiently high in value to produce a roll-off within the passband of the speaker but in most speakers L_C was so small that its effect was limited to the range above the passband.

From this discussion, we have seen that there are as many optimum amplifier damping factors as there are different speakers, different enclosures, and different combinations of the two. This is a *fact*, regardless whether optimum *DF* is defined as that required to reduce the Q of the system to 1, or to 0.5, or that required to cancel out R_C. It follows that it would be of great benefit to incorporate a control into an amplifier which could be adjusted to optimize the *DF* for each individual speaker system. Such a *Variable Damping Factor* control has been incorporated into Bogen Models DB20-DF and DO30A. The bare bones of the circuit are shown in *Fig.* 3.

Circuit Description

The circuit employs a simple bridge circuit inserted into the common side of the output transformer secondary. A voltage is developed across the 0.47-ohm and the 0.27-ohm resistors that is proportional to the current flowing through the speaker load. This current-proportional voltage is sampled by the slider on the 25-ohm potentiometer and fed back through low-pass filter RC as current feedback to the cathode of the first stage where it is added with the over-all negative voltage feedback. At a certain position of the potentiometer slider, there will be no voltage developed between slider and ground and, therefore, no current feedback. On either side of this position the slider will sample either a positive or a negative current-proportional voltage depending whether the slider is moved toward the 0.47-ohm or the 0.27-ohm resistor, respectively. By this means the effective source resistance of the amplifier may be varied between wide limits in the positive (negative current feedback) as well as the negative (positive current feedback) direction. *Figure* 4 shows the range of variation plotted for both source resistance and *DF*. Inasmuch as these curves were taken for the purpose of calibrating the *DF* control, a 16-ohm resistive load was used across the 16-ohm secondary. With a speaker load, the range of variation will be a function of the R_C and Z_M of the speaker. For a speaker with a rated impedance of 16 ohms, the R_C will be much less than 16 ohms and the Z_M

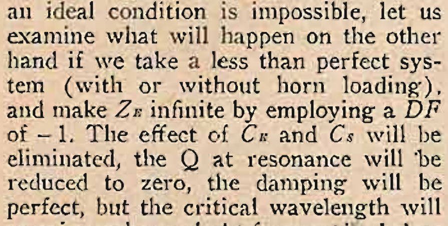


Fig. 5. Equivalent circuit of amplifier with positive current feedback driving loudspeaker load (for purpose of distortion analysis).

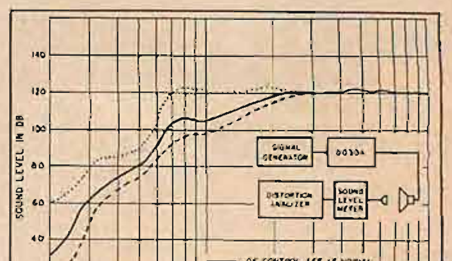
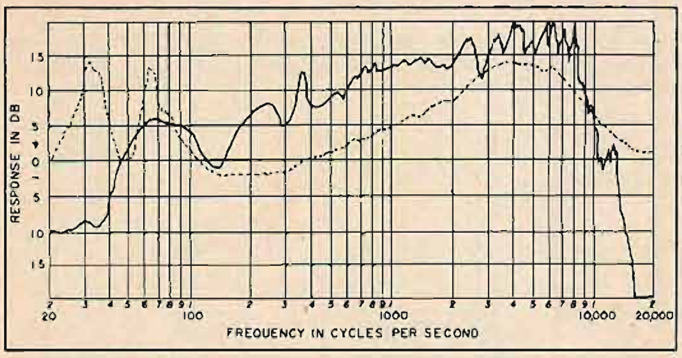


Fig. 6. Curves showing the effect of amplifier DF on distortion generated by loudspeaker system. 5% harmonic distortion contours are shown. (NORM. DF is equal to +30.)



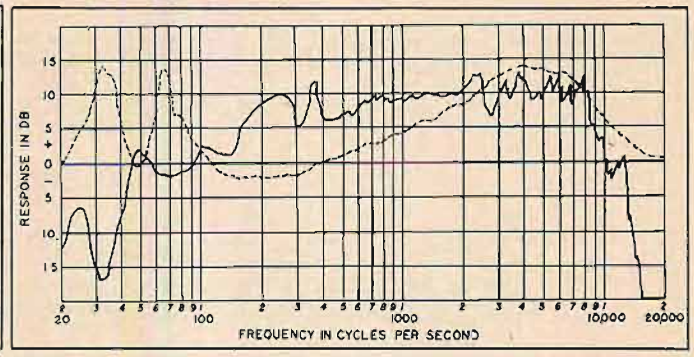


Fig. 8. (left). Sound pressure response of 15-in. coaxial speaker mounted in 8 cu. ft. bass-reflex enclosure with amplifier DF set at +3. Dotted line represents impedance of speaker. Fig. 9 (right). Sound pressure response of speaker of Fig. 8 with amplifier DF set at −1.2.

will be a function of frequency. So we can state that with a speaker load the action of the *DF* circuit is two-fold. With the *DF* control set to introduce negative current feedback, the source resistance is *greater* than the basic R_G of the amplifier (R_G with no current feedback) and the voice-coil drive voltage is *directly* proportional to the speaker system impedance. With the *DF* control set to introduce positive current feedback, the source resistance is *less* than the basic R_G of the amplifier and the voice-coil drive-voltage is *inversely* proportional to the speaker system impedance. The matter of degree depends on the *DF* control setting.

The RC filter limits the effect of the control to frequencies below 300 cps—(1), to avoid the possibility of the speaker oscillating at its frequency of minimum impedance (usually between 200 and 400 cps); (2), to restrict the damping to the low-frequency range where it is most needed and most effective; and (3), to avoid the possibility of the tweeter oscillating at its resonant frequency (if a tweeter is used).

The type of curves shown in *Fig.* 4 were found desirable to compensate for both the rise in low-frequency sound output produced with low damping and the roll-off produced with high damping by changing the *apparent* efficiency μ of the speaker system. This can be seen clearly by inspecting Eq. (*5*) in *Fig.* 1. If the term $(R_G - R_C)$ increases in value, the efficiency is reduced. Conversely, if $(R_G + R_C)$ decreases, efficiency is increased. However, this change in efficiency is only apparent since it requires that additional power be dissipated in $(R_G + R_C)$ for its accomplishment.

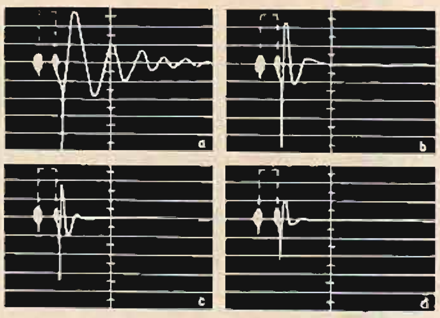


Fig. 7. Sound pressure waveforms showing the effect of amplifier DF on acoustical transient response of loudspeaker system. Solid line shows motion of speaker cone after application of square pulse (dashed line). (a) DF = +0.1, (b) DF = +3, (c) DF = ∞, and (d) DF = −1.2.

Distortion Reduction

One of the most important benefits gained from the use of positive current feedback is the drastic reduction of all types of distortion in the speaker system. *Figure* 5 shows the equivalent circuit of an amplifier driving a speaker load. E_o is the useful voltage developed across the radiation resistance R_A of the speaker system. Any non-linear element that produces distortion and frequency discrimination can be represented as an impedance Z in parallel with R_A. The current through R_A and Z develops a voltage across R_f. This voltage is added with the input signal voltage e_s as positive current-proportional feedback.

The total current through R_f is the sum of the useful current through R_A and the distortion current through Z

$$I = i_1 + i_2 \qquad (8)$$

The voltage developed across R_A and Z is

$$E_o = -A(e_s + IR_f) + IR_G + IR_C + IR_f \qquad (9)$$

which can be arranged as

$$E_o = -Ae_s + I(R_G + R_C) - IR_f(A-1) \qquad (10)$$

To make E_o a faithful replica of e_s we must make

$$E_o = -Ae_s \qquad (11)$$

This can be done by making

$$R_f(A-1) = R_G + R_C \qquad (12)$$

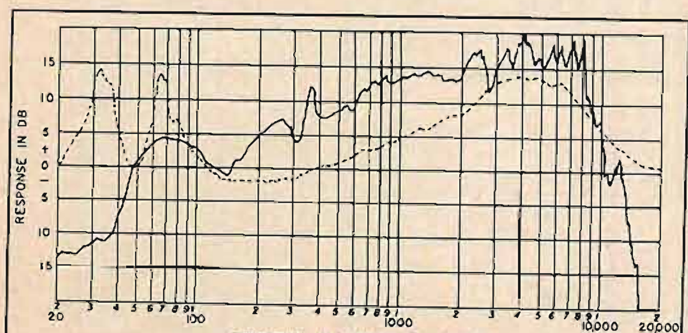
so that these two terms will cancel. The value of R_f required is

$$R_f = \frac{R_G + R_C}{A-1} \qquad (13)$$

and is the value that will produce a *DF* equal to −1 by making R_G sufficiently negative to cancel the effect of R_C and R_f. This also checks the conclusion made earlier that if Z_N were made infinite, the effects of C_N and C_S on the frequency response would be eliminated.

The curves of *Fig.* 6 show actual sound pressure measurements made on a typical 12-inch coaxial speaker housed in a 5 cu. ft. bass-reflex enclosure. The speaker was driven by a Bogen DO30A amplifier which was adjusted to give different damping factors. These curves represent 5 per cent harmonic distortion contours for different values of *DF* and show the effect of *DF* on maximum sound power obtainable at 5 per cent distortion in the low-frequency range. From *Fig.* 6 we see that with a *DF* of −1.2 this speaker can be driven about 30 db harder at 20 cps than is possible

(*Continued on page 66*)



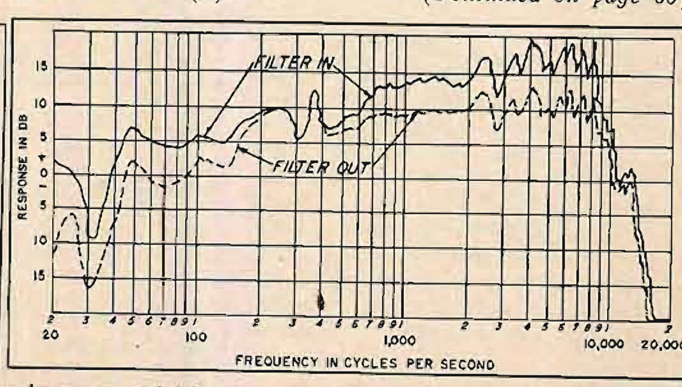


Fig. 10 (left). Sound pressure response of speaker system of Fig. 8 driven by commercial laboratory standard amplifier which has fixed DF of +10. Compare with Fig. 8. Fig. 11 (right). Sound pressure responses of speaker system of Fig. 8 showing effect of 300-cps filter. Dashed curve is same as solid curve of Fig. 9.

Damping of Loudspeaker Cabinet Panels

M. RETTINGER*

A discussion of the need for damping of enclosure panels and suggestions for realizing the required result. Considerable improvement in speaker performance can be obtained with relatively little expenditure of money or energy.

THE LOUDSPEAKER IN A CABINET often produces undesirable vibratory motion of the cabinet panels. It is well known that any surface excited into flexural vibration has families of resonant frequencies, so that the radiated spectrum is not the same as that produced by the primary signal forces. How to avoid the effect which reinforces certain frequencies and thus provides selective radiation is an old problem, and the usual recommendation for cure is to brace the enclosure walls. However, increasing the stiffness merely raises the resonant frequencies. True, the amplitudes of the higher resonant frequencies can be more easily damped; yet the total radiation may be more pronounced on account of the larger number of vibrating surfaces. Thus stiffening tends more to change the character of the radiation than to eliminate it.

Another undesirable effect of panel vibration is poor transient response of the radiated sound. This is produced by the long buildup and decay periods of the excited panels, compared to the short periods associated with a well constructed loudspeaker. The qualitative effect is one of poor vocal and instrumental definition, of blurriness of tone and lack of crispness and clarity. Such panels are spoken of as having a high mechanical Q or ratio of mechanical reactance to mechanical resistance.

Increasing the damping of a mechanical vibratile surface reduces its radiated sound output. A common example of damping is seen in the application of an undercoat, such as mastic or glassfiberboard, to automobile hoods, fenders, and door panels. Such materials act in two ways: (1) to convert vibratory energy into heat by mechanical resistance; and (2) to lower the vibration amplitude by providing a higher mechanical impedance.

It should be noted that damping is most effective at the resonant frequencies, since the larger bending amplitudes alternately stretch and compress the damping material, which thus dissipates the vibrational energy in its mechanical resistance. Adding mass to the panel causes it to vibrate with a smaller amplitude for the same applied exciting force. If the panel were mass-controlled, its velocity would be F/M where F is the vibromotive force and M is the mass of the panel.

* *RCA Victor Division, 1560 North Vine Street, Hollywood, California.*

Damping Panels

There are a number of ways by which damping can be added to a loudspeaker cabinet panel. One means consists in building the panel up in layers of wood, fastened together at numerous points by screws. Bending of the panels causes the sandwiched layers to rub against each other, thus creating frictional damping. Another means is to use laminated panels composed of alternate layers of plywood and felt, cork, rubber, or lead.

A convenient if perhaps not very rigorous way to determine the frictional coefficient or damping constant of such a compound structure is to take a sample of the material between thumb and forefinger of the left hand and rap it with the knuckles of the right hand or strike it with a stick and observe the duration of the resultant sound. A vibratile plate so excited behaves in much the same way that it would if excited by sound waves, and the duration of the noise produced is a fair measure of its damping properties. If it radiates a dull thud the damping is high, while a long ring would indicate low damping. Some experience, of course, is necessary to correlate the sound given off with the frictional resistance, particularly if measurements are to be made on a wide variety of test panels.

In the writer's experience, two types of cabinet panels have proven especially effective as a laminated structure to give damping of a high order. One consists of two ½-in.-thick plywood panels with a ¼-in.-thick neoprene layer sandwiched between them. The other consists of two such plywood panels with a sandwiched filler of corrugated, waffled, or honeycombed plastic of the type frequently used for aircraft panels. Using the damping material as a filler is far more effective than applying it to one side of the panel only, because as a filler it can act in shear, while applied to the exterior of a panel its action is less restrained.

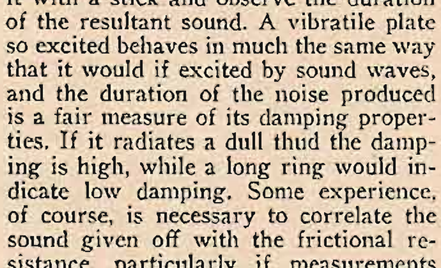


Fig. 1. Damped wave train resulting from stimulus to panel, showing two wave maxima a given number of cycles apart at which measurements are made and on which computations of logarithmic decrement are based.

If the damping material not used as a filler is sound absorbent, certain other desirable results occur, of course. These have frequently been discussed in connection with the interior acoustic treatment of loudspeaker cabinets. Briefly, such materials reduce the standing-wave effects in the enclosure and make for an acoustically larger volume. Some compromise may have to be effected in this respect in practice, because the economic aspect of a cabinet is also important. But from a purely idealistic point of view, the most effective way to damp a panel is to use the damper as a filler of the (compound) panel. If additional (sound-absorptive) material is required on the inside of the cabinet, this constitutes an additional requirement.

An exact evaluation of the damping quality of a material is not simple, however. What is usually done in the laboratory is to suspend the panel from the ceiling at one or two points by fine wires or cables. A ball of wood, rubber, or cork—a regulation baseball has been found very satisfactory for this purpose—also hung from the ceiling, is permitted to fall from a predetermined height to strike the panel, to which a vibration pickup has been fastened. It is important that this pickup be very light; otherwise it will itself act as a damper. The output of the pickup is displayed on an oscillograph, so that the successive reduced amplitudes of the transient wave-train can be measured. The quantity of interest is the ratio of successive amplitudes spaced a full cycle apart. Some books prefer to consider the amplitudes when spaced a half-cycle apart; but a study of successive amplitudes on the same side of the time axis appears more common.

What is known as the logarithmic decrement—the vital quality in all these tests—is given by

$$d = \log_e \frac{A_1}{A_2}$$

where A_1 is the first and A_2 the second measured amplitude. In practice, the evaluation of d does not usually comprise taking the logarithm of the ratio of two successive amplitudes (since they may be but slightly different to allow their exact determination), but consists of determining the ratio of two amplitudes which are a number N cycles apart. In that case (see *Fig.* 1)

$$d = \frac{1}{N} \log_e \frac{A_1}{A_N}$$

(Continued on page 64)

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Better Audio Specs Needed

NATHAN GROSSMAN*

A plea for greater clarification in the published specifications of amplifiers, loudspeakers, transformers. Fuller information could be given for all types of equipment.

A HI-FI ENTHUSIAST who desires to purchase audio equipment will find that the catalogues contain specifications which read somewhat as follows:

a. Amplifiers: x watts output; y% harmonic distortion; frequency response a to b cycles ±1½ db.; (some also include: n db. of inverse feedback);

b. Output transformers: z watts; frequency response a to b cycles ±1½ db.; impedance (primary) q ohms, (secondary) 4, 8, 16, etc., ohms; core size: $r'' \times s''$; weight: t lbs.; outer dimensions: $u'' \times v'' \times w''$;

c. Loudspeakers: diaphragm: g'' diameter; h watts; voice coil impedance: i ohms; frequency response j to k cycles ±5 db.; magnet: l ozs. alnico V;

d. Baffles: outer dimensions: $c'' \times d'' \times e''$; type: reflex, Helmholtz, etc.; cutout for loudspeaker: f'' in diameter.

Yet these specifications do not tell the prospective purchaser enough to enable him to know what will be the performance of the parts or components. They are not based on the same standard of excellence. They tell him nothing about the very important matter of the efficiency of the equipment.

While harmonic distortion produced in an amplifier is important, the usual specifications make no mention of the amount of distortion which is produced by the very mechanism which changes electrical energy into sound—the loudspeaker—and by the mechanism which couples the loudspeaker to the amplifier—the output transformer. Nevertheless, these two are capable of producing much more distortion than the amplifier itself.

When the term wattage is used in describing an amplifier, it means relatively undistorted power; whereas, when used in describing an output transformer or a loudspeaker, it means power handling capacity regardless of the harmonics which might be produced at the stated power.

When the specifications state that an amplifier produces 1 per cent harmonic distortion, it generally refers to measurements made at 400 or 1000 cps which is the frequency at which there is most frequently low harmonic distortion and best transfer of energy. Serious distortion of all kinds often develops below 400 and above 7000 cps and increases as the frequency being reproduced extends away from these. An amplifier which delivers 10 watts with 1 per cent harmonic distortion at 1000 cps may deliver only 4 watts (and possibly less) with a like amount of distortion at 50 cps. This is very serious as the greatest amount of program energy falls between 50 and 500 cps and compensation for Fletcher-Munson effects requires a considerable increase in power output with the decrease in frequency below 500 cps. In other words, the greatest demand for undistorted energy is just where the amplifier may perform the worst. It follows then that, except for the reproduction of speech, the maximum performance of an amplifier is determined by what it can do in the bass frequencies, so that a 10-watt amplifier is really only a 4-watt amplifier, if that is all the undistorted energy it can deliver in the bass frequencies.

For like reasons an amplifier whose frequency response shows a loss of 3 db in the bass should be rated at 50 per cent lower power output. The prospective purchaser who realizes this might save money by buying an amplifier which has no loss in the bass (to the cut-off frequency) than one which has a 100 per cent higher power output rating but with that amount of loss of response in the bass.

Where a manufacturer states that so many db of inverse feedback has been incorporated into the amplifier circuit, it refers again to a measurement made at 1000 cps. The very factors which produce increased distortion below 400 and above 7000 cps also decrease the amount of inverse feedback at these portions of the sound spectrum so that the ameliorative effects of such circuitry are often reduced by 50 per cent or more at the points at which they are most needed. It would be of considerable help to the uninitiated audio enthusiast to have the minimum amount of inverse feedback in the audio spectrum expressed.

Frequency Response

The frequency response curves published by manufacturers for output transformers are misleading unless there is mentioned in connection therewith the power tubes and the operating conditions under which the measurements were made. For example, a transformer with a 2500-ohm impedance when measured with a 6L6 and 6B4 at 250 volts on the plates will give less bass response for the former and less treble response for the latter. This difference in results is caused by the great difference in the plate impedance of these two types of tubes.

It is the current practice to make output transformers with primaries having an inductance of 7–8 henries (no d.c. load) when they are to be used in "standard" amplifiers and an inductance of 15–20 henries (no d.c. load) when they are to be used in "high fidelity" amplifiers, regardless of the type of amplifier or tubes with which they are to be used, whether for single ended or push-pull operation, or whether for tubes requiring as little as a 2500 ohm or as high as a 14,000 ohm nominal load impedance. These differences are accommodated by the turn ratios which make for different impedances reflected from the loudspeakers to which the secondaries are to be attached. The other differences amongst these transformers are in the core and wire sizes which make for different power handling capacities.

Tests made by this writer show that the low primary inductance of 7–8 henries is often productive of high harmonic distortion around 3000–4000 cps and of a kind which is not altogether responsive to the ameliorative effects of inverse feedback. These low primary inductances also cause high harmonic distortion and poor energy transfer in the bass frequencies. To obviate such effects the Williamson amplifier calls for a primary which has the high inductance of 100 henries or more.

Where an output transformer is used in a class AB_2 operation the leakage reactance of the transformer may be a serious source of intermodulation distortion.

Losses as high as 50 per cent may result from the insertion of the output transformer into the amplifier circuit. Imagine the frustration of the constructor seeking to build a 20-watt amplifier, and on using a poor quality transformer finds that it yields only 10 watts. These losses may be due to the design of the core and the d.c. resistance of the windings. The permeability of the core material as well as its size influence the power handling capacity and the ability to transfer energy. Moreover, a few hundred extra ohms of d.c. resistance in the primary may cause a 10 per cent lowering of the plate voltage, which in turn means a 20 per cent loss of power output. The d.c. resistance of both the primary and secondary windings changes the electrical energy of the amplifier from potential sound into the waste form of heat.

Loudspeakers

The relative inefficiency of the loudspeaker is what makes power amplifiers so necessary. Interestingly enough, according to some recent literature and the

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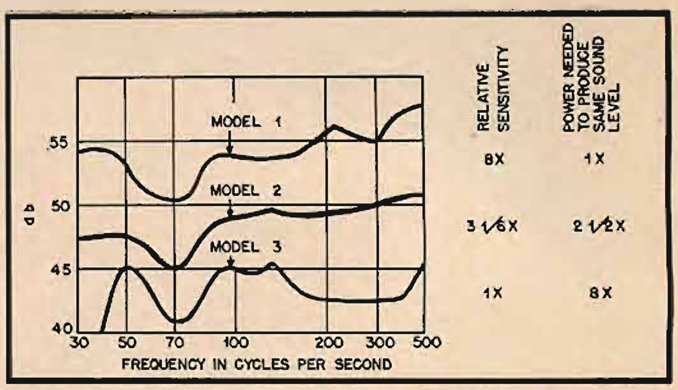
assertions of several manufacturers, higher loudspeaker efficiency seems to lower the amount of harmonic distortion generated by the sound transducer and to permit the amplifier to be operated at lower power levels, and so at lower levels of harmonic distortion.

If information were available as to the actual efficiency of the loudspeaker which is to be used in a sound system, the amount of power needed for satisfactory operation could be determined in advance. While none of the manufacturers publish the actual efficiency of the loudspeakers they produce, some do state that their products are "more efficient." One manufacturer has, however, published frequency response curves of a number of its models on a decibel scale from which a comparison of their relative efficiency can be made. *Figure* 1 shows the response curves of these loudspeakers and the relative amount of power which is needed for each to produce the same amount of acoustical power. Model #1 is a tweeter-woofer loudspeaker system, and models #2 and #3 are single loudspeakers especially designed for broad frequency response. Model #2 with a 7-watt amplifier will produce about the same acoustical power as model #3 with a 20-watt amplifier. The current difference in price between models #2 and #3 is about $25. The current difference in price between a good 7-watt amplifier and a good 20-watt amplifier is not less than $50. So, by purchasing the first mentioned combination there will result a saving of $25 without any loss of quality or volume.

An accurate judgment of a loudspeaker cannot be made from its frequency response curve without knowing its actual efficiency. *Figure* 2 shows the frequency response curves as published by the manufacturers of two loudspeakers of the same price, tone range, power handling capacity, and size of diaphragm. They are shown superimposed to facilitate comparison. It would appear that loudspeaker A has a better response than loudspeaker B in the tone range below 500 cps. Neither manufacturer stated the frequency which was taken as the reference point for decibel calculation. Should 350 cps be taken as the common reference point for such calculation, then the resulting curves when superimposed would be as in *Fig.* 3. This shows loudspeaker B to have a better bass response than loudspeaker A in the frequency range between 90 and 500 cps and below 50 cps. A direct listening comparison seems to indicate that the response of these two loudspeakers falls somewhere between *Figs.* 2 and 3. This is confirmed by the fact that loudspeaker B has a larger magnet by 40 per cent, and probably a magnetic flux density greater by that percentage, than loudspeaker A.

The size of the magnet employed is not the sole determinant of the magnetic flux density. The other factor is the amount of space across which the magnetic flux must flow. It is possible then to have loudspeakers with 9000–10,000 gauss units (the measure of magnetic flux density) with magnets ranging in size from 3 to 14 ozs. The larger magnets, however, permit more space to be available in the voice coil gap which increases the power handling capacity of the loudspeaker. Therefore, to be able to estimate the relative conversion efficiency of a loudspeaker it is more important to know the number of gauss units in its voice coil gap than to know the size of the magnet being used with it.

Fig. 1. Typical response curves of three different loudspeakers plotted against actual sound output for a fixed given input to show comparative efficiency.



From the standpoint of efficiency we should also know the d.c. resistance of the voice coil because a few extra ohms may mean a considerable loss of sound energy. The a.c. impedance of the voice coil is not an indicator of its d.c. resistance.

The present linearity standard for loudspeakers of ± 5-db variation in frequency response will not enable the prospective purchaser to know therefrom whether the loudspeaker under consideration will sound bassy, shrill, or just right. It is very important to know whether there is a ± 5 db (or sometimes even more) at 50 cps and at 12,000 cps. It is even more important to know the decibel differences in performance between these two frequencies and those at 1000 and 3000 cps. The performance at 1000 cps will determine the usual listening level. Should the efficiency of response at 50 cps drop 5 db from that at 1000, it will—because of Fletcher-Munson effects—be heard as a drop of 7 db, and will sound as if there were very little bass. For the same reason, a peak of 5 db in the bass will be heard as a 7-db rise, and will sound very bassy. Also, should the response at 3000 cps be higher than at 1000, there will be a tendency to cut down on the treble because the ear is most sensitive at about 3000 cps. Should the response of the loudspeaker in addition suffer from a 5-db drop at 12,000 cps, such cutting down of treble would increase this drop, which is further aggrevated by Fletcher-Munson effects, so that such a loudspeaker would sound as if the "edge" frequencies had practically disappeared.

Only recently has any manufacturer of loudspeaker baffles given any specifications as to the effect of its product on the tone range, harmonic distortion, and efficiency of loudspeakers which it is to house. Different types of baffles of the same size produce different amounts of harmonic distortion, and can either extend or cut off the tone range, and can either increase or decrease efficiency in specific bass frequencies. Baffles sometimes produce unintended effects. Thus, it has been observed that horn type tweeters of a certain manufacture lose in response to the "edge" frequencies when recessed in a compartment with their mouths completely behind the front line of the loudspeaker cabinet, and that they sound best when mounted with their mouths completely outside of the loudspeaker cabinets.

In view of the foregoing, specifications for audio equipment in addition to those generally mentioned should include:

a. For amplifiers: undistorted power output and ratio or factor of inverse feedback at 50, 1000, and 12,000 cps;

b. For output transformers: frequency response under specific operating conditions; per cent of harmonic distortion at 50, 1000, 4000, and 12,000 cps; amount of inductance and leakage reactance in the primary; per cent loss on insertion into amplifier circuit; d.c. resistance of windings; permeability of core;

c. For loudspeakers: per cent of harmonic distortion at 50, 1000, 3000, and 12,000 cps; actual efficiency; amount of magnetic flux density across voice coil gap; differences in response at 50, 1000, 3000, and 12,000 cps; d.c. resistance of voice coil;

d. For baffles: effect on frequency response, efficiency, and harmonic distortion of loudspeakers with which to be used.

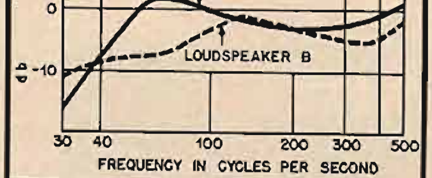


Fig. 2. Comparison between two loudspeakers plotted for equal output at 125 cps. Compare with Fig. 3.

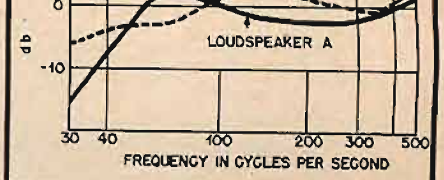


Fig. 3. Same loudspeakers as in Fig. 2 but plotted for equal output at 350 cps. Note difference such a plotting would cause.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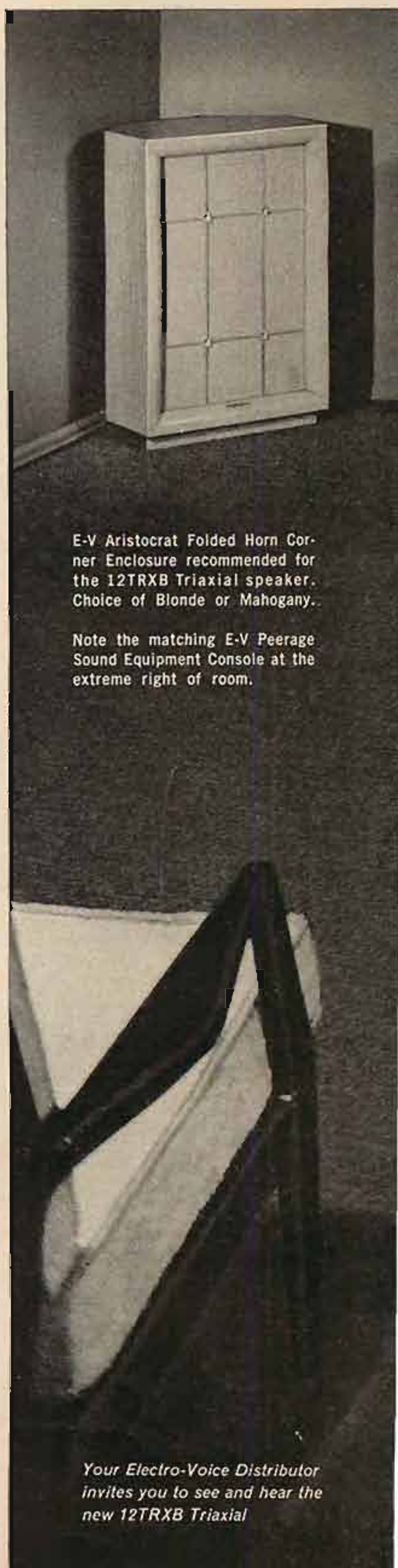

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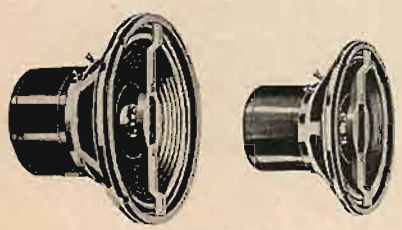

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Selecting and Improving FM Receivers

CHARLES ERWIN COHN*

The important characteristics to watch for in selecting the best tuner or receiver for your area and performance requirement, plus two modifications for decreasing noise and bettering the audio quality.

At the present time, an FM receiver or tuner is required equipment for the lover of serious music, since "quality" FM stations exist in most of the major cities. This equipment may range from the inexpensive table-model AM-FM combinations to large, deluxe, hi-fi tuners. Since not everybody can afford the best, the writer attempts in this article to show how to pick a good set in the desired price class, one suited to the buyer's needs. Simple improvements which cost little but can add much to any set will be described as well. Discussion will be restricted to the r.f. and detector circuits.

Before considering the selection and improvement of FM sets, we must decide just what is wanted. The requirements for any set can be summarized by the following four items, listed in approximate order of importance:

1. Good linearity and adequate i.f. bandwidth.
2. Adequate sensitivity for reception conditions.
3. Good AM rejection.
4. Freedom from drift.

The first of these qualities—good linearity and adequate i.f. bandwidth—is what makes for low distortion, and thus is a necessity for music listening. Fortunately, this quality is fairly easy to obtain in the usual superhet circuit, and thus is adequate in even the low-priced sets, provided they are properly aligned and are receiving ample signal. However, if a set does not have it, the receiver cannot be improved by any measure short of complete re-engineering. Therefore, when purchasing an FM set it is most important to check its linearity by a listening test. This should be done with a signal with high modulation (fortissimo passages) but the volume control should be turned down so that distortion produced in the audio stages (if it is not a hi-fi set) will not mask the distortion produced in FM detection.

* 7720 Marquette Ave., Chicago 49, Ill.

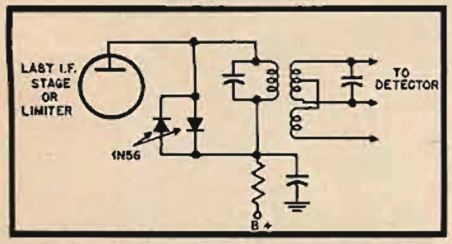

Fig. 1. Where the area is very noisy or the i.f. amplification is insufficient to saturate the limiters with the available signal, two crystal diodes make a very effective additional limiter.

The next quality—adequate sensitivity for requirements—means just that. You do not need a set with umpteen stages if you live two blocks from the station. In areas with plenty of signal strength, a large expensive set will provide no better performance than a small set, other things being equal. Also, sensitivity depends as much on the antenna as on the set itself, and a small sum spent on a good outdoor antenna can often make a much greater improvement than a greater amount spent on a more elaborate receiver. If you already have an outdoor or attic TV antenna you can try connecting it to the FM set; if it makes an improvement, a two-set coupler or changeover switch can be permanently installed. If it does not help, an outdoor FM antenna mounted on the same mast or tower will usually be of great benefit.

Noise Limiting

Since freedom from noise and interference is one of the major advantages claimed for FM, it is necessary that a receiver have good AM rejection in order to make full use of the medium. Conventionally, this is done either with limiting i.f. amplifiers or with the ratio detector. However, both of these systems have disadvantages. The limiter-discriminator circuit requires a multiplicity of i.f. circuits, while the ratio detector, although simple, is critical with respect to alignment and varies in efficiency with signal level. In general, the higher-priced sets use the limiter-discriminator circuit which is usually satisfactory when the signal strength is high enough.

However, the simple circuit shown in *Fig.* 1 can be applied to any set in which the AM rejection is not what it should be. It consists merely of two crystal diodes connected back to back across the primary of the ratio detector or discriminator transformer. Its operation depends on the nonlinear characteristics of the crystal diodes, and can be understood by reference to the current-voltge characteristic curve shown in *Fig. 2.*

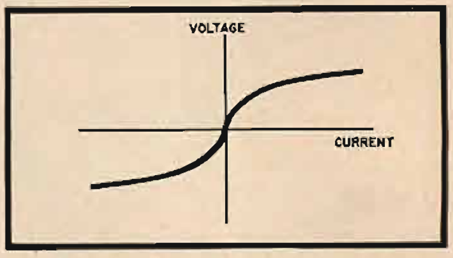

Fig. 2. This curve shows that a disproportionately large current flows through the diodes when the voltage across them increases beyond a small value. Above that value the diodes effectively short-circuit the discriminator transformer of Fig. 1 and provide limiting.

Since a pentode acts as a "constant-current" generator, it can be thought of as sending a current signal through the load circuit. For small signals, the resistance of the diodes is fairly high, and the effect is thus small. However, as the signal increases, the diode resistance decreases rapidly, so that after a certain point an increase in signal input does not cause a corresponding increase in output, which of course is the action of a limiter. The resistance of the 1N56 diode is about 100 ohms when the applied potential is 1 volt, so the action is evident. The 1N56 is the best diode to use in this circuit, because its high forward conductance gives a lower limiting threshhold.

Due to the complete absence of time constants, this circuit should give a better performance on ignition noise than the grid-bias limiter, and thus might be used to supplement it. The only disadvantage is low output, since it clamps all signals down to less than 0.1 volt at the detector input. This means that additional audio amplification will be required, the output from a ratio detector with this circuit becoming comparable to that from a magnetic pickup. Furthermore, the output from the discriminator will not be sufficient to operate tuning indicators or a.f.c. systems. However, audio amplification is cheap, and the sets which most need this circuit are the cheaper ones which do not have the frills. Another possible application of the circuit is to intercarrier TV sets, where an excellent reduction of buzz should be ob-

(*Continued on page 67*)

AA-902 PILOTONE AMPLIFIER $39.95

Williamson type Amplifier with special inter-leaved wound Output Transformer and push-pull output. Contains 5 tubes including rectifier, Frequency Response ± 1 db, 15 to 40,000 cycles at 10 watt output. Distortion less than 1% at 10 watts and less than .1% at 1 watt from 30 to 15,000 cycles. Provided with speaker output impedances of 4, 8 and 16 ohms. Underwriters Laboratories Approved.

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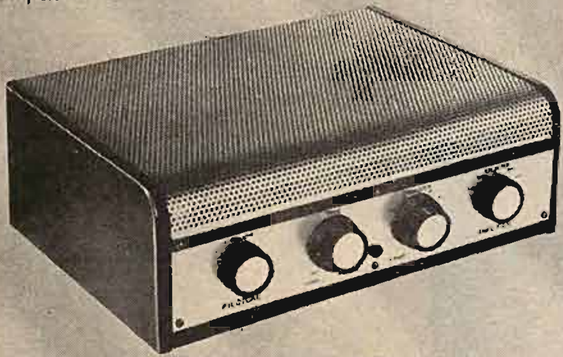

AA-420 PILOTONE AMPLIFIER $99.50

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Frequency Response: ± 0.1 db. 15 cps. to 20,000 cps. at rated output. Total Harmonic Distortion: Less than 1%. Intermodulation Distortion: Less than 2%. Hum and Noise Level: 90 db. below rated output. Potted output transformer constructed with interleaved winding for reduced leakage inductance.

AA-904 PILOTONE AMPLIFIER $89.50

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Audio Time—1954

September is Audio Time, when the Fall season commences in earnest and renewed interest manifests itself throughout the country. But October is Audio Fair time, and time for the Annual Convention of the Audio Engineering Society.

IT'S AUDIO FAIR TIME again! The dates, October 14 through 17—the place Manhattan's famous Hotel New Yorker. And as always, admission to everybody—music lovers, hobbyists, and professionals alike—is absolutely free.

The 1954 Fair will play host to the largest assembly of audio fans ever to gather for a single event, according to Harry N. Reizes, Fair manager. An estimated 30,000 visitors will come to view the latest developments in equipment as displayed by virtually every leading manufacturer in the Audio field.

In a departure from the arrangement which has prevailed at previous Audio Fairs, the 1954 event will include a Sunday in its schedule. "In this manner we hope to bring the Fair to many persons who are prevented by occupation from attending on week days," Mr. Reizes announced.

Although the Fair was conducted originally as an event of primary interest to music lovers, hi-fi hobbyists and professional audio engineers, it has become the principal buying mart for audio equipment on a commercial level as well. Registration records of the 1953 Fair included executives and purchasing agents representing major dealers and distributors from all parts of the U. S. as well as a number of foreign countries, and advance hotel registrations give assurance that attendance of wholesale buyers this year will be considerably greater.

Since its inception the Fair has been sponsored by the Audio Engineering Society, and is held in conjunction with the Society's annual convention. Together the two events have achieved world-wide recognition, and today are regarded internationally as the most prominent of the annual displays and forums devoted solely to the science of reproduced sound.

Although normally, and understandably, most exhibitors attach a top-secret classification to any information which might divulge the nature of their displays to competitors, the grapevine gossip indicates that visitors to the 1954 Fair will be in on the introductory showing of many new items which will establish milestones in audio history. Hi-Fi-in-Miniature will be the theme of one exhibit, another will feature the first public showing of a super-high-fidelity electrostatic speaker, while many others will emphasize economically-priced tape recorders which approach professional standards in performance.

Matching a new high in attendance will be a record-breaking number of exhibitors. Indicative of industry growth is the fact that the 1954 Fair will occupy four floors of the hotel as compared to the two floors which sufficed only two years ago.

Joining in announcement of the annual audio conclave, Jerry B. Minter, President of the Audio Engineering Society, announced that this year's Society convention will hear a greater variety of technical papers than has ever before been presented at a single gathering. The annual Society banquet will be held on the night of October 13, at which various awards for distinguished accomplishment will be presented to outstanding audio engineers.

Because Audio has become an accepted entity in the panorama of American life, the coined word "Audiorama" will express the theme around which the 1954 Fair will be conducted.

Officials of the Audio Engineering Society meet with Harry N. Reizes, manager of the Audio Fair, to complete arrangements for the 1954 event which will be conducted in conjunction with Society's annual convention. Shown left to right are C. R. Sawyer, AES president Jerry B. Minter, Mr. Reizes, and Walter O. Stanton. Sawyer and Stanton are AES governors.

Convention Papers

The preliminary list of papers to be presented at the convention shows a strong leaning toward subjects which are of greatest interest to the audiofan for the Saturday sessions—the more professional papers being scheduled for the first two days of the convention. The Thursday morning session is devoted to *Microphones,* with the following titles given as the tentative program:

"Cathode follower circuits applied to a microphone," by John K. Hilliard and James J. Noble, both of Altec Lansing Corporation;
"Microphones for informal use," by L. M. Wigington and R. M. Carrell, of Electronics Products Division, RCA;
"Uniaxial microphones," by Dr. Harry F. Olson, John Preston, and J. C. Bleazey, of RCA Laboratories;
"Design of a condenser microphone," by an engineer from Kellogg Switchboard Company; and
"A method for the quantitative measurement of wind noise sensitivity in microphones," by R. M. Carrell, Electronics Products Division, RCA.

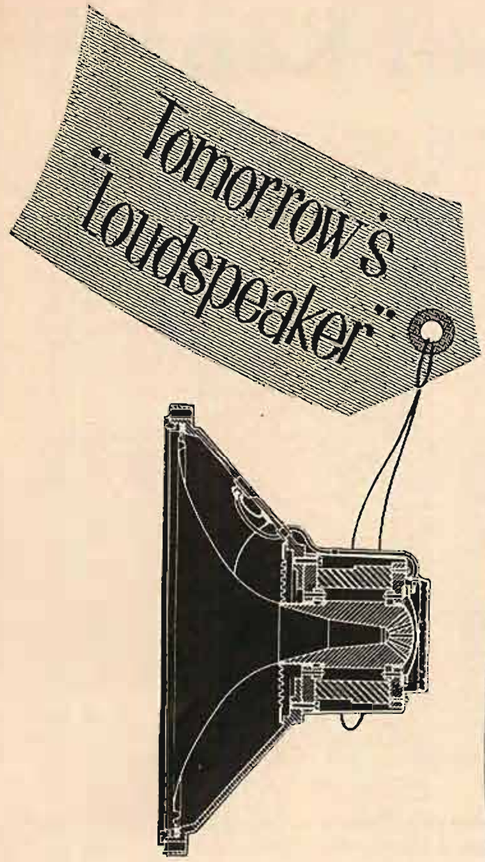
The Thursday afternoon session is devoted to *Miscellaneous and Tape Machines,* and the following titles are tentatively scheduled:

"A moving coil feedback disc recorder" by C. C. Davis, Westrex Corporation;
"An external automatic sweep generator for use with cathode ray oscilloscopes," by Alan Bloch, Audio Instrument Company;
"An experimental study of distortion," by C. J. LeBel, Audio Instrument Company;
"Transistorized magnetic tape recorder," by A. I. Aronson, Electronics Products Division, RCA;
"A new miniaturized tape recorder," by A. C. Travis, Jr., Broadcast Equipment Specialties Corp.;
"Design, development, and operating features of a new tape recording machine," by Robert Winston, Audio & Video Recording Company; and
"Definite stereophonic sound," by Col. R. H. Ranger, Rangertone, Inc.

Tape Media is the subject of the Friday morning session, and the tentative list of papers includes:

"Frequency modulation noise in magnetic tape," by Robert A. von Behren and Robert J. Youngquist, Minnesota Mining & Manufacturing Co.;
"Magnetic recording measurements," by Walter H. Erikson, Electronics Products Division, RCA;
"Defects in magnetic recording tape—their causes and cures," by Frank Radocy, Audio Devices, Inc.;
"Locating defects in magnetic recording tape," by Andreas Kramer, Audio Devices, Inc.; and
"New uses and new magnetic products in tape, film, and instrumental applications during the past two years," by E. W. Franck and E. Schmidt, Reeves Soundcraft Corp.

(*Continued on page 65*)



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Flux density, HF gap	15,000 gauss	18,000 gauss
Power handling capacity	15 watts	25 watts
Polar distribution for 60 degrees included angle	— 3 dB at 10,000 c.p.s.	— 4 dB at 10,000 c.p.s.
Intermodulation products	< 2%	< 2%

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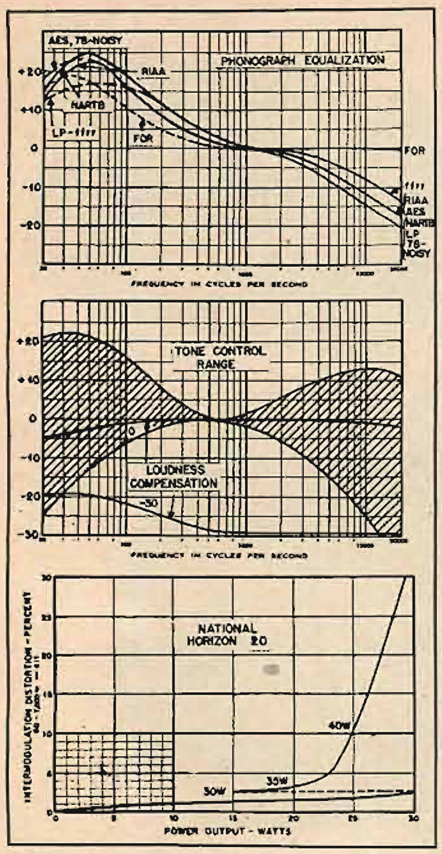


Equipment Report

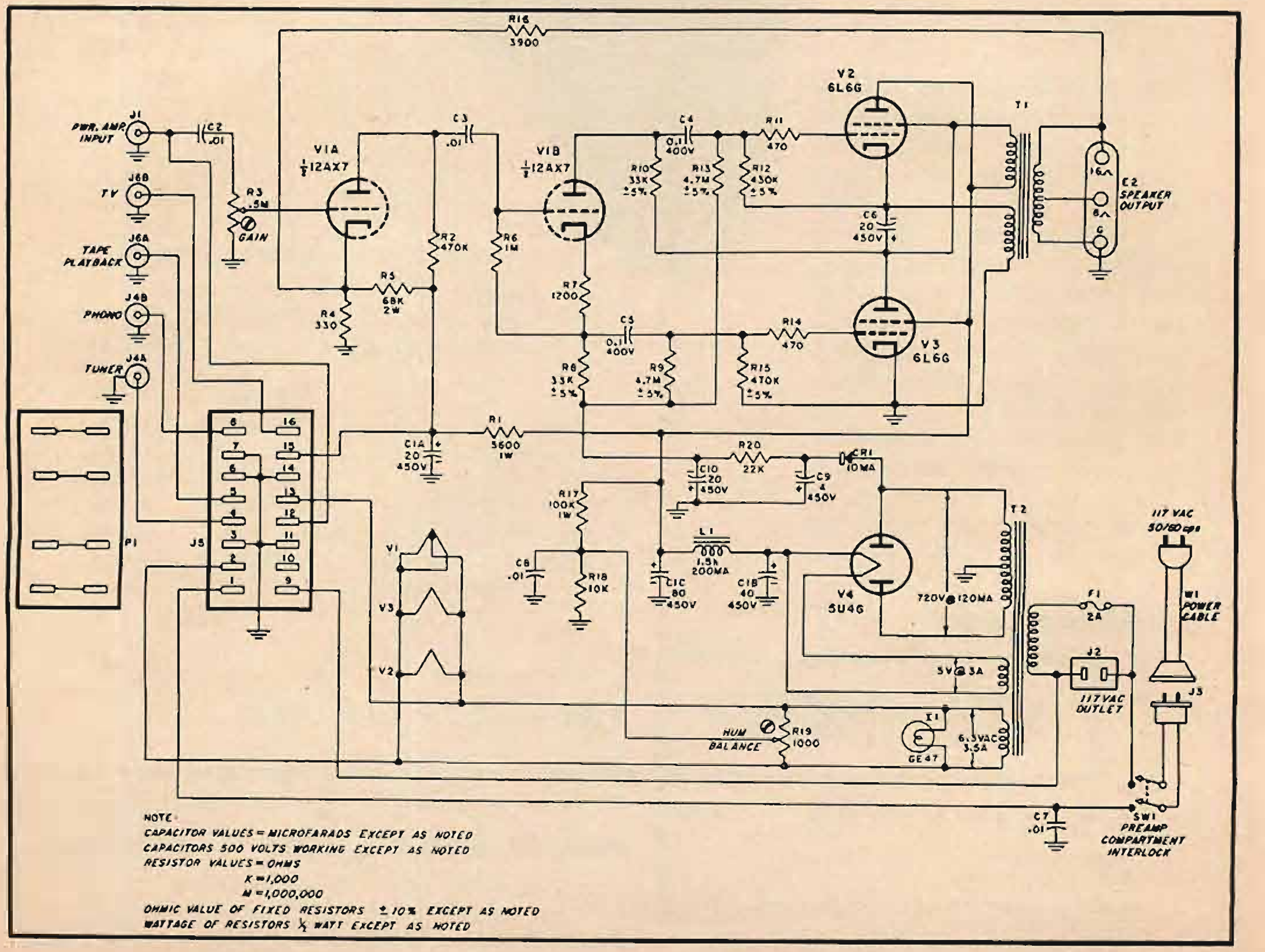
The National Company's Horizon 20 Amplifier, Horizon 5 Preamplifier, and Criterion AM-FM Tuner

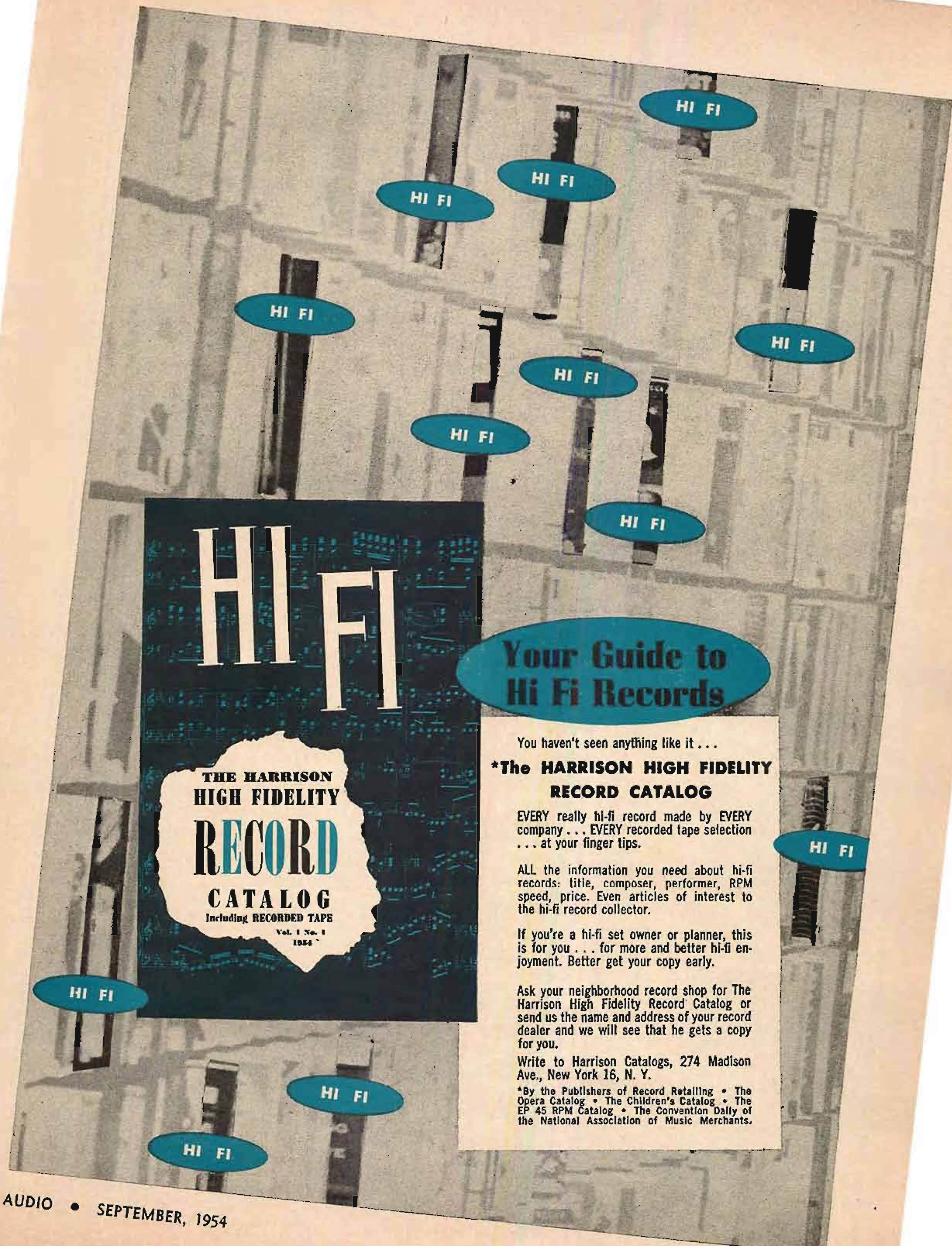
NATIONAL COMPANY, INC., long known for a high-quality line of amateur radio equipment, has entered the audio field with four individual units which reflect the company's experience in the "ham" field. Some of the constructional characteristics are more closely related to professional equipment than to home-type amplifiers and tuners, and on the whole the equipment is solidly built and exhibits good performance.

The Horizon 20—listed as a 20-watt amplifier—reaches an output of 37.5 watts before the intermodulation distortion becomes 5 per cent—the 2-per-cent point being at 24 watts. Thus it is seen that the 20-watt rating is conservative. On sine-wave signals, the slightest flattening of the waveform is noted at 29 watts at frequencies from 20 to 10,000 cps, with equivalent flattening being noted at 28 watts for 20,000 cps, 24 watts at 30,000 cps, and 15 watts at 50,000 cps. Square-wave response is excellent throughout the audio range, with a slight ringing noted at a frequency of 78 kc when power output is increased above about 20 watts.

The amplifier circuit is unusual in that the output stage does not operate as a conventional push-pull arrangement, but one output tube is plate loaded and the other is cathode loaded. The coupling between the output tubes is independent of the characteristics of the output transformer, which reduces certain forms of distortion. The amplifier can be used as a "package" of gain, with controls elsewhere if desired, or the Horizon 5 preamplifier may be plugged in to provide a completely controllable amplifier system suitable for phono, radio, or tape reproduction. When the preamplifier is not used, a satin-finished aluminum plate covers the opening, and either the plate or the preamplifier must be in place to actuate an interlock switch. The amplifier housing must be in place to furnish power to the transformer, much as with TV receivers. When the preamplifier is not being used, a shorting strip (P_1 in the schematic, *Fig.* 2) must be in place to energize the a.c. circuits. The unit is solidly built, well ventilated, and of attractive appearance. 1-watt output is obtained with an input signal of 0.3 volts, with an

Fig. 1 (left). Performance curves for the National Horizon 20 amplifier and the Horizon 5 preamplifier. Fig. 2 (below). Over-all schematic of the Horizon 20 amplifier.

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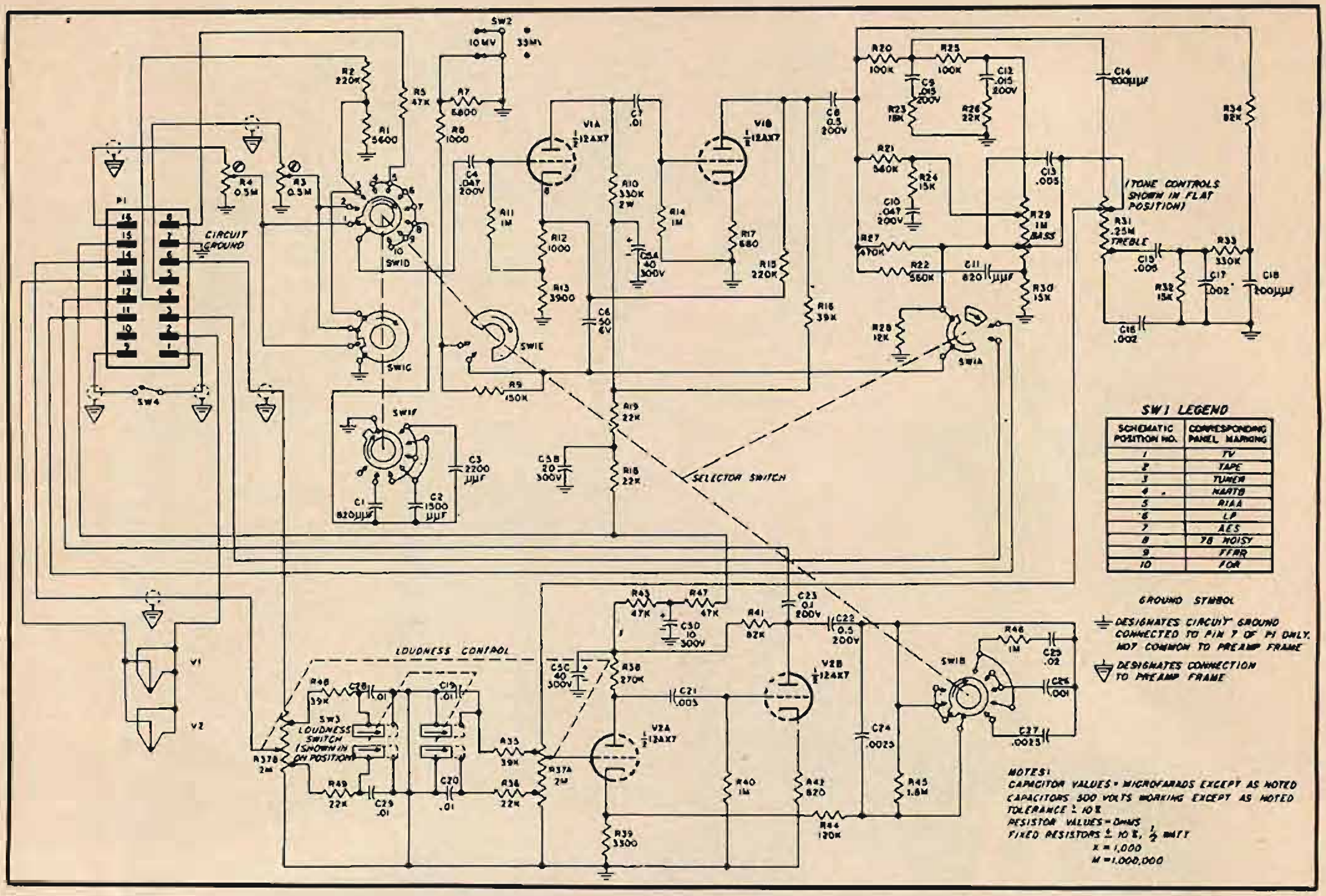

Fig. 3. Complete schematic of the Horizon 5 preamplifier.

input potentiometer being available to set the over-all gain of the amplifier to suit individual conditions. Intermodulation distortion for the complete power amplifier is shown in the bottom section of *Fig.* 1.

The Preamplifier

The Horizon 5 preamplifier, designed to plug into either the 20-watt power amplifier or into a similar opening on the tuner, is extremely compact yet provides adequate amplification, tone control, and circuit selection to meet today's requirements. Four inputs are provided—tuner, tape, TV, and phono. For a 0.3-volt output—which corresponds to a 1-watt output from the power amplifier—the tuner input is 0.22 volts, that from tape and TV is .003 volts with separately adjustable level controls. Phono input for the same output is .0019 volts, sufficiently sensitive for all modern pickups. A study of the circuit, *Fig.* 3, will show that the arrangement is somewhat unusual—the rolloffs being accomplished ahead of the first amplifier stage and the turnover control being located between the last two stages of the unit. The tone-control circuits are also unusual, but provide for different inflection points in the bass and treble controls as well as for greatly increased bass response without undue increase in distortion. Also unusual is the use of a dual volume control—one section being used for the AM portion of the tuner for binaural reception, and with no tone-control action being available. For other positions of the selector switch on the tuner, the tone-control action is available, as well as for phono, tape, and TV inputs.

The curves available for phono reproduction are shown in the top section of *Fig.* 1, while tone control action and loudness compensation are shown in the center section. A push-button switch on the front panel cuts loudness compensation in or out as desired. Much of the compactness of the control unit is the result of the use of printed circuits. For those applications where the preamplifier is to be used with other amplifiers or tuners, a plug and cable set is available to permit making the necessary connections.

The AM-FM Tuner

Numerous modern features not heretofore encountered in tuners are employed in the Criterion. A single intermediate amplifier is used for both AM and FM reception—which is not unusual—but this is the first model reviewed that can use the i.f. amplifier for both types of signals simultaneously. The FM section has a cascode r.f. amplifier, a mixer and oscillator, three i.f. amplifier stages, two limiter stages, and a counter-type detector (which can be shown to have some advantages over discriminators or ratio detectors). A built-in squelch circuit which is adjustable as to threshold cuts off the limiters entirely in the absence of a signal, thus eliminating interstation noise (it is not eliminated intrinsically in the counter-detector circuit). This gives an "in-out" character to the FM signals, and as the tuning knob is turned, stations are either heard properly tuned in, or else they are not heard at all. The counter detector is not as critical to tuning as is the discriminator, so no a.f.c. is necessary.

One output from the FM section is labeled MULTIPLEX, and is provided for use with this method of broadcasting when it comes into use. This output is ahead of the de-emphasis network, since the multiplex circuits provide their second channel somewhere around 35 kc. Another FM output is available on the FM BINAURAL jack at the tuner, while still another is at the TUNER OUTPUT jack when the selector switch is in any position except AM. A tape recorder input can be taken from the FM BINAURAL output jack, if desired, or separate outputs to two power amplifiers can be taken from the two BINAURAL outputs for this type of reception.

The AM section employs a pentode r.f. amplifier, a mixer-oscillator, two i.f. stages, and a diode detector. All outputs from the tuner (except FM MULTIPLEX) are through cathode followers ensuring low impedance and a minimum of effect from lead length.

The construction of the tuner is unusual in that almost all of the components are above the chassis. Underside is seen only the printed-circuit wiring, which makes a neat unit. It appears to be sturdily built, and it is undeniably attractive—although it may appear too professional for the hypercritical homemaker. There are many advantages, however, to a unit which provides both AM and FM outputs at the same time, each with a separate volume control as well as station selector. And with its high sensitivity and quiet operation, this tuner offers features which are undeniably desirable for many users. Both mechanically and electrically it is an interesting unit, and the reputation of its manufacturer ensures quality construction.

The Horizon 10 Amplifier

This unit, the fourth of the line, has not been measured, but is a 10-watt amplifier with a built-in preamplifier which is somewhat less flexible than the Horizon 5 preamplifier.

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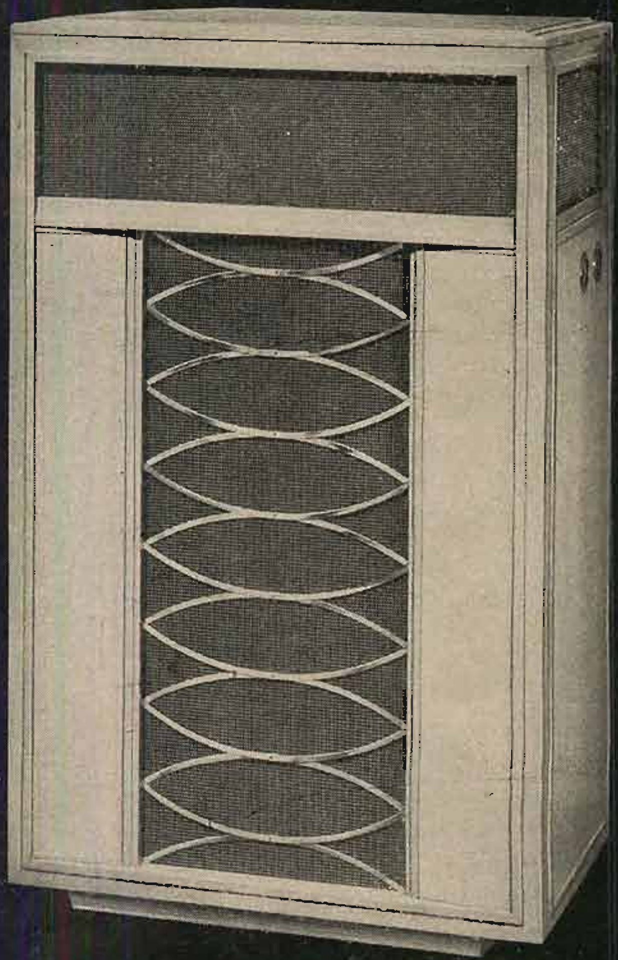

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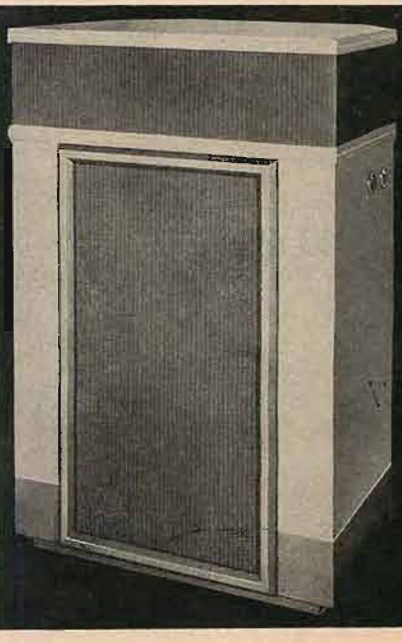

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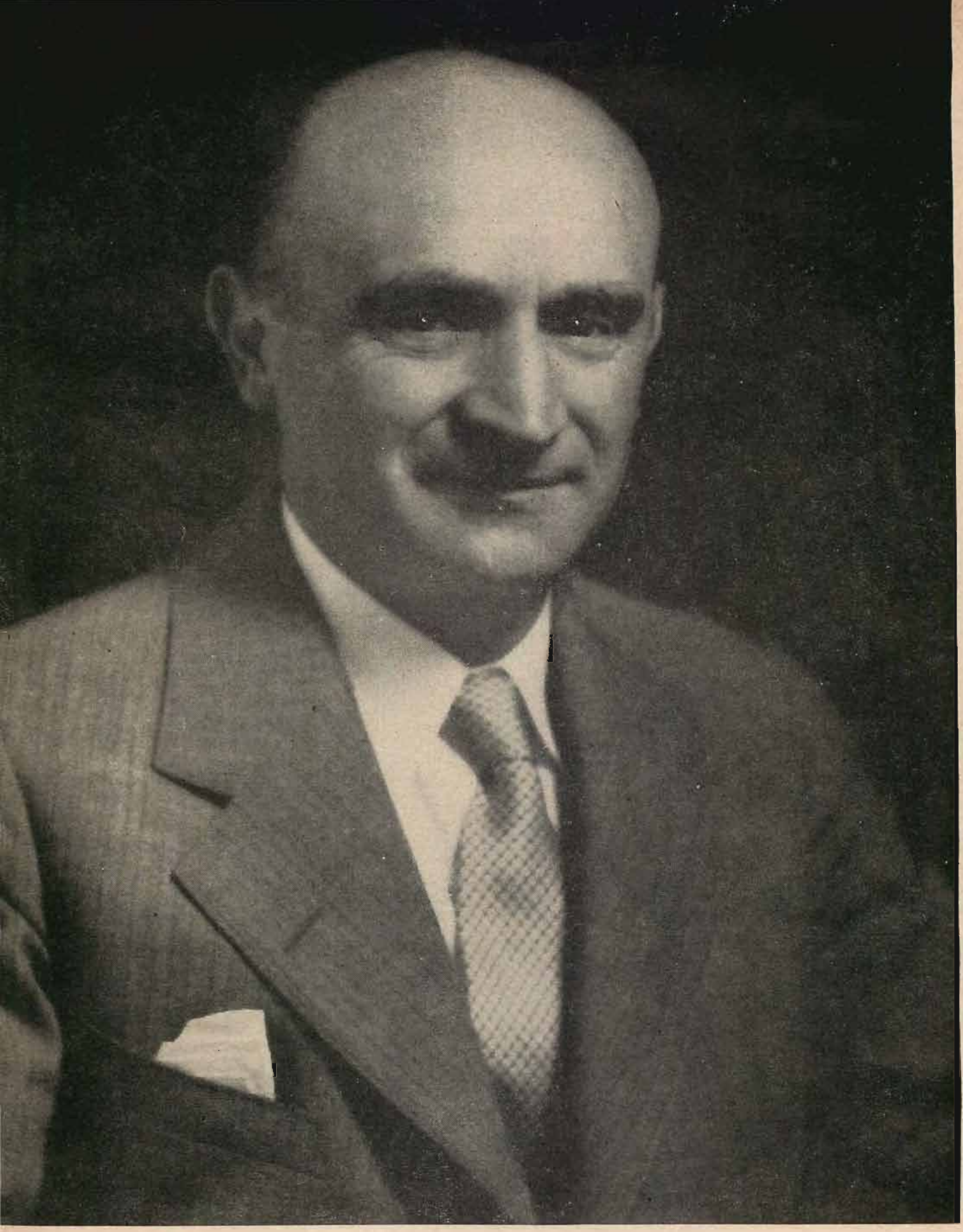

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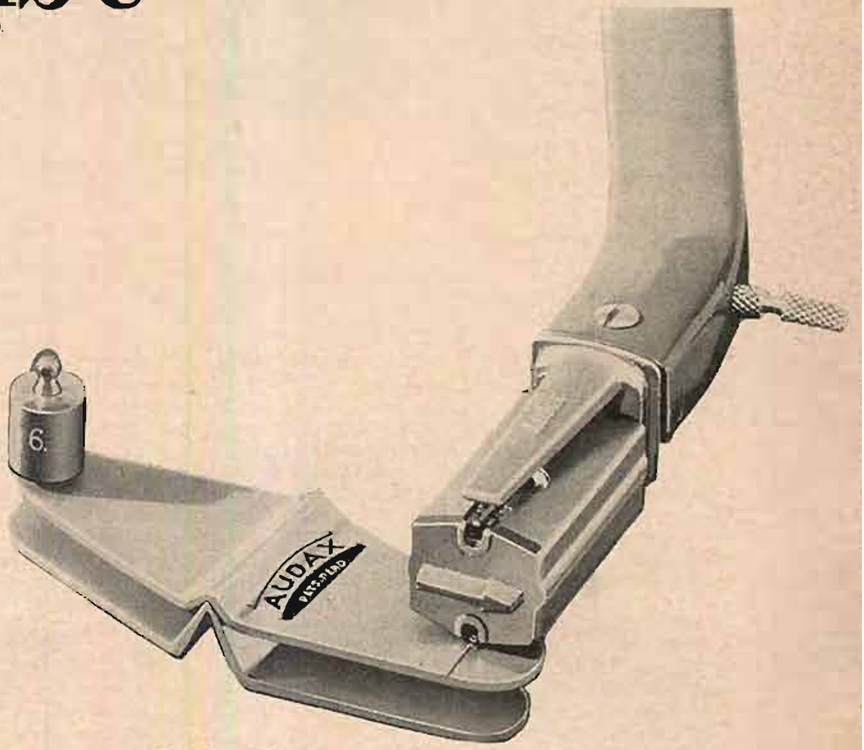

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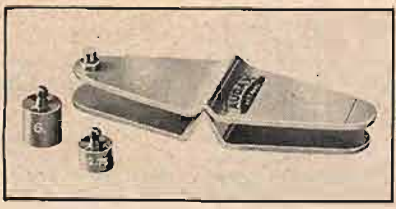

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Classics on Westminster

What is a small company to do when it begins to expand into a larger company? Westminster's expansion is an interesting example. This company was an early trail blazer in small-company LP with a superb series of recordings made mostly in Vienna that set unapproachably high standards of excellence, both in the performance and in the recording and processing techniques. That Westminster series still continues—classic sonatas, chamber music, divertimenti, small symphonies, the cream of central European older music, much of it not overly well known in this hemisphere until Westminster's recording made it "come alive." These Westminsters, now augmented by recordings from other musical centers on a similar plane of excellence, make up the finest collection of its kind in the whole field of recorded music, both as to recorded excellence and as to the authoritative musical standards.

But expansion has carried this company into other areas in various directions, and not always with the unfailing uniformity of excellence of the Vienna operation. Big conductors and standard symphonic repertory are the dangerous temptations for any small company about to get bigger—dangerous, because it is always a risky business to break into the big-time competition, any way you look at it.

Big conductor? Westminster's Scherchen did memorable Haydn, not to be surpassed, and he took Westminster slam into hi-fi with the famous Haydn "Military" Symphony, complete with huge drums and clashing cymbals. But the ambitious Scherchen Beethoven symphonies showed the conductor to be temperamental even among conductors, who are always temperamental. The Beethovens are without exception beautifully recorded, but the series, to this ear at least, is not musically on a par with its extensive big-company competition. Scherchen's monumental choral work series also stunningly recorded and designed to fill an impressive part of the Westminster coverage again to this ear suffers from the same eccentricities of a very strong-willed conductor. His Bach Mass, Handel Messiah, the long series of Bach Cantatas, do not set the authoritative musical standard that the Vienna chamber recordings have set.

Hi-fi? Westminster's British "Nixa" recordings are unsurpassed for arresting and exciting hi-fi sound. Vaughan-Williams' "The Wasp" and "King Cole," "Belshazzar's Feast" of Walton, Holst's "The Planets," belong in anybody's hi-fi collection of sensational audio. Add to these numerous Westminster semi-pops items, nothing much musically but recorded with top quality, and you'll find Westminster a leader in the hi-fi category—and for that matter, the Viennese records rate hi-fi tops, too, for fans who happen to love Schubert and Mozart and Beethoven and Brahms.

The ultimate temptation for a small company moving towards bigger things is a recording spot in the U.S. But symphonic recording over here costs a fortune as everybody knows. Westminster's first symphonic records from the National Symphony in Washington haven't offered much challenge to the super-powered competition hereabouts and the choice of repertory—so far—has been decidedly risky: the Brahms Violin Concerto, for instance, a type of piece that is strictly for the big operators; or the two Creston Symphonies, too modern for many hi-fi listeners and not of profound interest to the modern-minded. (Audio, July 1954) Better things may be in the offing, we can hope.

And so this department still votes Westminster's European small-ensembles series as its top offering, still unbeatable anywhere. Here are some recent examples:

Mozart: Serenade for 13 Wind Instruments, K. 361. Vienna Philharmonic Wind Group.
Westminster WL 5229

I'm ready to toss this one into the ring as the finest wind recording I've ever heard, bar none. The music is impressive, with no less than thirteen solo wind players instead of the usual four or five in the average work for wind solos, and though nominally it falls into Mozart's "light entertainment" category, this is actually a major Mozart opus with some extremely cogent musical thought beneath the pleasing exterior.

The recording by Westminster is remarkable. The combination of a big, warm liveness and exactly the right close-to mike pickup makes the group sound impressively large, as it should (larger, indeed, than many a full symphony sounds on records), and yet each instrument sounds forth with the most startlingly natural realism and presence, beautifully balanced against (or with) the ensemble. Maybe it was luck in the miking—but I doubt it; and I know that it takes hairbreadth precision mike placement to hit such an exact "resonance" of balance. Many a new hi-fi record, superficially impressive, sadly lacks this sort of balance between the total liveness and the individual elements. In this one you'll hear the "edge" to the wind tone, the peculiar reedy sound of clarinets and bassoons, the tubby sound of horns, as you've never heard them, with precisely the right amount of key-rattling and thumping to add presence without reaching to exaggeration. A beautifully exact musical ensemble and the expected highly musical, somewhat serious playing of the Viennese school make this record a superb value.

Beethoven: Wind Trio, op. 87; Variations on Mozart's "Reich mir die Hand" (La ci darem); Rondino in E Flat. Vienna Philharmonic Wind Group.
Westminster WL 5262

Here is a similar technique applied to smaller groups with equally fine results. The Beethoven Trio and the Variations, for two oboes and English horn, are recorded so as to bring out most wonderfully the peculiar high, thin, bright tone color of this oboe-family combination. As is wholly proper, the acoustics are such that the three instruments sound big and full and all-embracing. There is nothing inherently thin or weak about a trio of any sort, if it is heard in the proper surroundings of intimacy. One doesn't compose a symphony for small bedroom, nor does any musician write a trio for huge concert hall—as we hear them too often today. The splendid realism of this recording is musically strictly authentic and for that reason a lovely sound for any ear that can tell Yankee Doodle from Oh, Suzanna. Early Beethoven, beautifully written and performed, and the same goes for the short Rondino for a larger group of instruments.

Mozart: Divertimento #17 in D, K. 334. Vienna Konzerthaus Quartet, J. Hermann, string bass, H. & O. Berger, horns.
Westminster WL 5276

"In-between" music, not chamber music yet not quite symphonic, and this kind of ensemble makes the best sound of all for recording purposes. This version wisely strengthens the string quartet with a double bass at the bottom for a more orchestral sound; with the two horns and Westminster's usual warm liveness the results are as big and fat as you could ever want.

The music here is so typically Austrian that all four available LP versions (it's a popular Mozart work) are made in Vienna. In this version we find the expected rather serious, very musical Viennese kind of playing, the tempi always rather on the slow side. The strings are recorded close, in the usual warm liveness, the horns are full and resonant.

One movement of this work, oddly enough, has become a familiar salon piece heard in a million renditions from hotel orchestras and restaurant wired-music services. You'll recognize it at once.

Brahms: Clarinet Sonatas op. 120, #1 and #2. Leopold Wlach, Joerg Demus.
Westminster WL 5236

The music Brahms wrote for clarinet late in his life is his very best, combining his expert sense for musical contruction with an unusually free wealth of melody—the clarinet seemed to evoke this in Brahms. Pianist Demus is one of Westminster's special Viennese artists, introduced originally along with Badura-Skoda in a superb two-piano series. He is a brighter, more forceful pianist than Badura-Skoda and is very much at home in this forceful Brahms, playing a healthy, alive performance, energetic but not harsh. But the clarinet is reserved and a bit colorless, aided by a reticent recording that actually perserves the normal solo-piano balance with the piano out in

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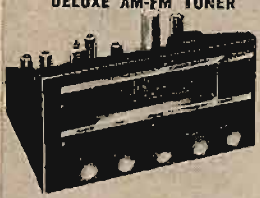

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All items available separately at individual net prices front. (Most recording engineers succumb to temptation and stick a mike under the soloist's nose, pushing the piano "accompaniment" into the background.) Westminster is right, even if the clarinet playing is not persuasive, and the piano is recorded with a full and rounded bass and a smooth over-all naturalness.

Debussy: Three Sonatas. J. Fournier, vl., G. Doyen, pf., A. Janigro, cello, C. Wanausek, fl., E. Weiss, vla., H. Jellinek, harp.
Westminster WL 5207

The profusion of names listed above will impress you with the instrumental variety in these strange last sonatas of Debussy, none for cello and piano, one for violin and piano, and the third for the odd combination of flute, viola, and harp. The most colorful and easiest to hear is the last-mentioned; the violin sonata is curiously episodic, hesitating outwardly, with Kreisler-like sweet-and-sour harmonies. The cello sonata, like most cello works, is not easy on first hearing but may come through later.

The taut, introspective, fragmentary music, like nothing else, is tonally opulent here. The performance, recorded in Vienna, has a certain softness that is not exactly ideal for the music. But as far as that goes, few performances ever manage to realize the full interest and sustain the odd mood of these sonatas from beginning to end. They are problem-pieces for the performer, strong stuff that easily falls apart in front of an audience (or a microphone). The basic trouble is the subtlety of rhythm, decidedly lacking in that typically Germanic "beat" to hang onto (for both audience and players) that helps many another piece through a performance. You won't find any better solution of the problem on records than this one.

Beethoven: Sonata #9 for Violin and Piano, op. 17 ("Kreutzer"); Sonata #2, opus 12, #2. Jean Fournier, violin, Ginette Doyen, piano. **Westminster WL 5275**

Two leading French artists record Beethoven, with pleasing results. The famous "Kreutzer" sonata does not have the fiery violence we are used to in many a big-name virtuoso performance, but the melodious aspect is beautifully taken care of and the rhythm is good. This is a strong performance, notably in the lovely variation movement. The pianist (lady) is forceful and masculine, the violin (man) is somewhat quavery and seems the more feminine of the two. Close-up violin recording but the balance of volume keeps it in proper balance with the warmly recorded piano—quite correctly. Westminster knows its sonata recording. This is one of a long list of sonatas in the Westminster catalogue.

Mozart: Piano Concerto #21 in C, K.467; #26 in D, K.537 ("Coronation"). Jeorg Demus; Vienna State Opera Orch., Horvath.
Westminster WL 5183

This Westminster doesn't come up to the usual very high Westminster musical standard for Mozarr, though I should add hastily that it's far ahead of a good many similar offerings on other labels. Demus is a top two-piano Mozart player in his recordings with Badura-Skoda on Westminster and an excellent Brahms-period player on his own (see above) but his solo Mozart is brighter and shallower than Badura-Skoda's. It is impeccably phrased and styled—Demus is too much at home in Vienna to make gross errors in style—but the musical depth seems to me to be lacking, the two concerti are not completely realized for their full musical values.

The perfectly dreadful cadenzas (Busoni) which Demus uses merely add to this impression. Why? Do pianists really think that people who buy Mozart records will take these horribly untasteful, out-of-style exhibtions of poor musicianship, inserted in the midst of such superb music?

French

Chausson: Poem of Love and the Sea. French Art Songs. Gladys Swarthout; RCA Victor Symphony, Monteux. G. Trovillo, pf., B. Greenhouse, cello, Gloria Agostini, harp.
RCA Victor LM 1793

What a sense of style the French have! More important, even, than content. No other nation can turn out mediocre music of such compelling and beautiful proportions, no composer can write plain hot air and get away with it the way the Frenchman does.

Here is a little-known work for soprano and orchestra by Chausson that is a stunning example of French vocal writing, and that old trouper, Gladys Swarthout, does a heart-warming job with it in the best French tradition, which has always been her forte. The music is a long, tragic-sounding love song, out of the school of César Franck but also much like the colorful early impressionism of Debussy and Ravel; it swells and dies away in a lushly colored swirl of mystic romance, the vocal line beautifully placed with its French text against the impressionistic orchestral background—it should send shivers down the most callous musical spine, and I love it.

It isn't until afterwards that you realize how little has been said, all in all, and you understand that for all its persuasiveness, this is something less than great music. And yet—does it matter? For in France one does not judge art in the Germanic manner, heavily, for architecture and "depth." In France it is lightness that counts, in music as in food, the perfection of style, the impeccable technique and the unerring performance. It is the very subtlety of all this that brings tears to the Frenchman's eyes and to ours as well. From Couperin to Poulenc, from Gretry to Berlioz and Offenbach, the French have never allowed a crude or sloppy touch to spoil either the composition or the performance of their music.

Where else, then, could a long-time artist such as Swarthout, her great voice still functioning musically if not with the power it once had, find for herself a more perfect medium? The music is not trying on the vocal physique—not for an old trouper, in any case. It is of the sort where style counts far more than lung power, and Swarthout, aided by a beautifully placed close-up mike, is absolutely radiant. Radiant even when, rather startingly, she lapses now and then into an old trouper's baritone range. It only adds to the musical potency. Gorgeously impressionistic orchestral backing from Frenchman Pierre Monteux, who never did a better job of enlivening little-known music for your and my delighted consumption. A good recording.

The art songs on the reverse, with piano, are essentially fill to round out the LP, and are varyingly effective according to the difficulty of the music. Close studio recording here robs the great voice of some of its magic, and technical difficulties arise. But the songs with cello and harp by Berlioz (Romeo and Juliet) and Hahn are lovely. Singing students will want this side for study. Representative items from the singer's repertory.

Note that the Chausson work is reminiscent of Ravel's early "Sheherezade" and Debussy's "De-

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Saint-Saëns: Four Symphonic Poems. (Phaeton, Jeunesse d'Hercule, Le Rouet d'Omphale, Danse Macabre). Orch. Concerts Colonne, Fourestier.
Angel 35058

Here is French style all over again—verbose, long-winded music but so handsomely and gracefully built that one cannot really condemn it for what it is, music a lot less than great and full of a considerable volume of warm air. Two of the tone poems are familiar, the well known "Danse Macabre" and the "Rouet d'Omphale," the other two are to most of us in the States quite unknown, though French undoubtedly keep them in local circulation.

If you are looking for cogency, economy, modesty of expression, if you want depth, sincerity, don't listen to old Saint-Saëns, who turned out his slick music as an apple tree bears apples; he just couldn't help it and he didn't worry himself one bit about it one way or the other. Indeed, he fairly basked in his own prolificness, where Brahms tortured himself over every composition, for fear it was not great enough. Again it is the impeccable sense of style and musical consistency that keeps this music alive in spite of its noisy, bombastic big-time style (nothing impressionistic about this), where the equivalent German tone poems of Liszt (a much more profound musical mind) sound incredibly banal and blatant for our ears today. Your first reaction to Saint-Saëns may be "what errant bombast;" but on second playing it comes off a lot better. One does not even play some of Liszt's tone poems a second time.

Excellent French performance and superb hi-fi recording by Angel recommend this record to both musicians and hi-fi fans, warm air or no.

Debussy: La Mer. Ravel: Rapsodie Espagnole. Philharmonic Orch., Von Karajan.
Angel 35081

A paradox, this disc, and not exactly a successful one. The ultra-Latin music is played with an Austrian conductor and a British orchestra and, however nice the orchestral sound, the music is rather remarkably off-style, we run into this phenomenon quite frequently on records—German music played without comprehension by French or Italian groups, French music mishandled in the most subtle and devastating way by Germans or Austrians. (Only a freak like Gieseking, great German player of French music, breaks and proves the rule.) An incredibly bad Beethoven 8th—or was it the 2nd—by Monteux comes to mind; I remember, too, a recent "Meistersinger" overture by the French conductor Paul Paray that was the oddest Wagner I ever hope to hear. But Debussy and Ravel in the tradition of Schubert and Strauss is equally odd.

I can't describe in a few words just what goes wrong in Von Karajan's beautifully accurate French music. It's all there, but the sense doesn't come through; a thousand and one details of emphasis, of intended color and mood are misinterpreted, the larger pattern, the whole colorful Latin intent, is lost and the music gropes for direction in the midst of its own lush orchestral expression. Effect after effect falls flat, or rises too high, or just isn't there. A quite remarkably subtle example of musical misunderstanding.

Good sound and superb recording, just the same, and it may be well worth your while to listen here, as a study in interpretation.

French Music for the Theatre (Dukas: Sorcerer's Apprentice. Fauré: Pelleas et Mélisande. Roussel: The Spider's Feast). Detroit Symphony, Paray.
Mercury MG 50035

Back in France again—even though the source is Detroit. Paul Paray is "in" on French music and one can spot his assurance in these works, in spite of a kind of good humored eccentricity of approach that makes every Paray record a new surprise. The familiar "Sorcerer" here gets a weighty, slow-tempo treatment that brings out the horror-appeal of the famous story as expressed in the score, plays down the skittish will-o'-the-wisp magician stuff. Mercury's by-now-familiar close-up one-mike recording adds a certain almost harsh realism that finishes the redecoration of the music—heavy, crisp, percussion, stridently edgy brass, sharply clear strings, hi-fi.

Fauré's melodiously sweet "Pelleas" music is the be t item on the record for my ear as Paray conducts it. The Roussel "Spider" score is instrumentally colorful and neatly modern in its language but somehow I find my mind wandering before it gets far. From the period of Ravel, Roussel's music is pale and contrived alongside Ravel himself, though expertly enough written.

Fauré: Ballade for Piano and Orch.; Impromptu #3; Theme and Vars. for Piano. Poulenc: Nocturnes; Mouvements Perpetuels. Grant Johannesen, piano; Netherlands Philharmonic, Goehr.
Concert Hall CHS 1181

Grant Johannesen, American pianist, is a natural Romantic. His subdued lyricism is just right for the somewhat perfumed music of Fauré. The familiar Ballade has had more outspoken performances, but this one has a lovely sound and a nicely soft atmosphere with the conscientious Dutch backing of the Netherlands Philharmonic under the conscientiously competent Goehr, who has done some fine conducting for Concert Hall in earlier releases.

But Johannesen is out of his element in the snazzy Poulenc piano works. The Nocturnes, to be sure, are brooding and night-filled and they appropriate a goodly portion of Chopinesque schmaltz; but the intention, I am sure, was half-humorous, seriously satirical in the prevailing French manner of the 20's and 30's; Johannesen plays them, each and every one, most soulfully and expressively. Musical, but seriously out of style.

The proof is in the little Mouvement Perpetuels—for if the Nocturnes were, by their very title entitled to at least some romance in the playng, the Perpetual Motions are the purest nose-thumbing French vulgarity! This pianist's solemnly lyric treatment of their strided little dissonances is something hard to believe. As well play Pine Top's Boogie in the style of Victor Herbert!

Poulenc: Les Mamelles de Tiresias. Solos, chorus, orch. Opéra-Comique de Paris, Cluytens.
Angel 35090

French opera! Here is where you'll find the best evidence of the French love of consistency and style. The recordings we've had, to date, of French-performed French opera are far ahead of anything we can do in the States, with our inevitable mixtures of artists from every country, conductors, orchestras, stage designers each with his own background. In France, opera is given by French-trained artists who sing together with similar tone and style, who have had the same training, feel the same way. Try the wonderful "Tales of Hoffman" of Offenbach in the Opéra-Comique performance on Columbia (SL-106) or the "Carmen" of the same group (SL-109)—or try this modern French work. As the ads say, you'll be amazed. Delighted, too.

Poulenc, now in respectable middle age, was once the delightful bad boy of the gaudy French 1920's and 30's. In those days, avante garde art was not only radical, nose-thumbing, eccentric, shocking—it was also wonderfully alive, full of humor and extremely skillful beneath its cacaphonous exterior. Now that the shock-power has worn off, the humor and the skill are apparent.

"Les Mamelles" has not only a title that had best be left untranslated but a text which, like so many French effusions, while perfectly acceptable in its own language and highly amusing to boot, is unthinkable in English. We just don't have the vocabulary for it. This is a high-handed and giddy farce about a man whose wife decided to be a feminist and outlaw the making of children among her kind, whereupon her husband, dressed in skirts, finds a way to produce vast numbers of children of the most amazing kinds, full grown and ready to go to work for him, all without the aid of the female sex. The biology of this is somewhat obscure, the implications for an analytical mind very Freudian and weighty. But the music blithely ignores all such considerations and weaves its light-footed and melodious way through a passel of surrealist high-jinks, a kind of modern Offenbach effect.

For Poulenc, the music is unexpectedly lyric and lovely. The man is a born opera composer, though little have we known it. Those who have enjoyed his recent Concerto for Two Pianos (RCA Victor LM 1048) or the Concerto for Organ, Strings and Tympani, with E. Power Biggs (Col. ML 4329) will be much pleased with this music—as will all who appreciate fine singing, beautifully apt vocal writing, and French opera in general—the Opéra-Comique in particular.

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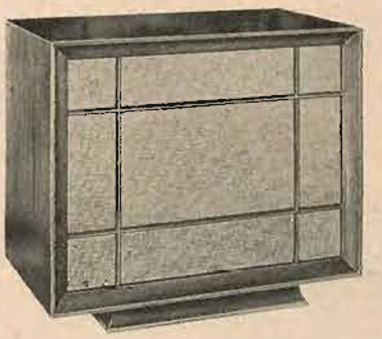

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AUDIO ETC.

Edward Tatnall Canby

1. Tape from Tubes.

No human being who has anything else to do (like playing records and figuring out what's good about them) could ever keep up with all the straws that fly in the Audio wind these days. A department like this one just keeps its eyes and ears open for what comes along, and maybe its main value is in flagging down these items (to change my metaphor to railroading) which flash by for an instant—yet in that instant show up as important as all get out. Such items don't come by every day and the huge number of big-talk items that go past, signifying nothing really very new, is something hard to believe.

Reminds me of that New Yorker cartoon of last summer with the East-of-the-Curtain family watching a TV commercial—*"Folks, be sure to go right out and buy one, now."* They do.

If we all went right out and took every word about the new audio sensations seriously we'd be in a pretty pickle. Most of us, however, know the American language pretty well. We hang onto ourselves long enough to think twice, if not thrice, before getting steamed up. Except, once in awhile, when something *really* significant turns up. . . .

Like, for instance, the casual clipping somebody sent me a few days that still has me gasping. It was an article on Interpretation of Old Music (Lang) and right up my musical alley . . . but on the back of the last page was a part of a column by R. D. Darrell on tape duplication that made me sit up with a bang. He was writing up a new electronic tape playback head developed by Dr. Melvin Skellett. If what he says is from the horse's mouth, this is a really big thing and I have to flag it down quick and pass it on to you, though it's not my scoop.

You see, though magnetic tape has removed that major obstacle to ideally perfect sound reproduction, the mechanical motion of the cutting and playback stylus—reducing the problem of mass in effect to zero—the playback tape still must *Do Work* as it generates tiny voltages in the head's wire coil. Because of this, tape playback speeds have been limited, in spite of much improvement. The work done (derived from the forward mechanical motion of the tape and acting as an infinitesimal brake on the tape transport) gets involved with distortion especially when tapes are played at high speeds.

I'm not enough of a electronics man to catch the details but I get the idea and so must you. Why high tape speeds? For tape duplication. The higher the usable playback speed the faster can tape duplicates be made.

As long as the tape playback head is essentially a generator, producing varying signals according to the varying strength of the passing magnetic fields on the tape, complications are bound to develop, not only when the generator is run at high speeds and the work is done too fast. Distortion.

No Work

The new tape "head" which Mr. Darrell describes is a tube, instead of a coil. If I am right, it operates in very much the same manner as a TV picture tube (though he doesn't say so): a beam of electrons is *deflected* by the passing taped magnetic fields. A wholly different principle, and its most direct difference is that *it no longer involves the generation of a current,* however tiny, and so it does no work. Instead, the only "work" that is accomplished is the mere deflection of an electron beam—which takes enormously less effort than the *generation* of an actual current. This, I would guess, is a form of amplification, a control circuit that does not itself provide the energy for the tiny signal current.

Therefore—no distortions due to the speed of tape passage which, I gather, could ideally be as fast as the speed of light without bothering the internal operation of the system. As fast as the beam in a TV tube. Superb transients in practice, tape may be whisked past this playback head as fast as is physically possible without the slightest effect upon the quality of the transferred signal. Terrific.

Quality, you see, may be vastly improved by this new system. The whole problem of reverse induction of an opposing current that occurs in any generator and tends, in tape as elsewhere, to louse up transient response, is eliminated in this head. The electron beam deflects instantaneously, weightlessly, and if I understand this thing, without resistance. Transients, no matter how fast, are passed on perfectly.

Now some readers may be saying that tape is supposed already to have removed all the important impediments to the transferal of a sound signal. Not all. Yes, the relatively huge impediments of the mechanical stylus and the record groove are gone, and tape sounds just that much the better for it. But we still have electrical troubles in the system, on a smaller scale, and we still have the mechanical speaker to content with. Even taped sounds are far from perfect.

Indeed, what is remarkable, it seems to me, is the fidelity with which we can play plain old discs right now, in spite of the presence of three major mechanical motor-generator elements—cutting head, playback head, and loudspeaker—plus a fourth element, the plastic of the record itself. (Not to mention, of course, the infinite mechanical complexities of speaker enclosures and room acoustics—to which we may also add the earlier complications introduced by the microphone-generator.) All these major complexes of physical mass and working-current distort the pure signal before it gets to us from the LP record. They have been reduced to a fabulously low point.

Present-type tape reproduction reduces them significantly more, even so, by removing the mechanical element in disc cutting and playback. Given otherwise equal situations, we can still detect the AB difference between a tape playback and a disc—though it is astonishingly slight.

With the new electron-beam tape playback, one more remaining tiny source of distortion is removed with the elimination of the playback-generator in the usual playing head. The difference at ordinary tape speeds surely cannot be audibly noticeable, though the removal of background head noise and the lower-level recording are tremendous advantages. Most of us, I suspect, could not possibly tell a standard top-quality tape playback from the same via the new head, nor will most trained audio ears spot the clearer sound that should result nor the better signal-to-noise ratio. Good tape is mighty good these days.

But that's not the whole story. As you can understand, first, the difference in *speeded-up* playback, for mass tape copying, becomes vital, and indeed this would seem to offer a major missing link in the teetering balance between discs-for-the-public and tape-for-the-public in the years to come. The subtler advantages inherent in the system, notably the low recording level required, should supplement this and, as I see it now from the outside, could eventually affect every kind of tape playback from super-professional copying all the way down to the lowly home playback unit than can make or break the market for tape in the home.

I owe my entire information at this moment to the alert Mr. Darrell and am happy to throw him the credit for this article's inspiration. As of now, I am not clear on several points of detail—I couldn't wait. I am not clear from him as to whether there is any application of this new principle to tape *recording*, though as best I can figure it there is not. (The beam deflection principle is not reversible as is that of the motor-generator now used for recording and playback.) This is strictly a playback head, a revolutionary one; but indirectly it will affect recording, as already noted.

I also don't know what stage of development has been achieved in the new tape playback "tube" nor how many practical bugs in performance and production have yet to be overcome. Probably many. But it's enough to know that the thing exists and is revolutionary in principle. We'll probably hear more about it, and I suggest you keep a corner of the mind on the alert for it, if and when.

2. FM Sensitivity

Since I got a Fisher Model 50-R FM-AM tuner I have learned some surprising things about FM listening, as of now. During the summer I was in the country with this remarkable tuner, roughly 100 miles from New York City and 30 miles from any other reasonably big town—which, in New England, is real isolated. In that country spot I discovered how important FM sensitivity is.

Too many people still think that FM reception is for the big cities only, that you can't get stations more than twenty or thirty miles away, that except in the city you are limited to whatever tiny local FM outlet that may be on the air four or five hours a day, evenings—so why bother with FM? That is certainly true if you have an FM set of average sensitivity and even more so if yours is one of those turned out at a low price a few years back, or is the FM section of many a medium priced commercial radio.

At noon on one summer Monday, when a good proportion of FM stations could be counted on to be off the air (many operate evenings only) I turned on my Fisher with its simple folded dipole plastic-and-wire antenna stuck up on the wall with thumb tacks. I logged *twenty five* FM stations that came in well enough for entirely comfortable radio listening, and didn't count a half-dozen others that could have been followed through the white-noise hiss if something important had to be heard. (Even a loud FM hiss is less obscuring and less tiring on the ear than the irregular popping of AM static in summer.)

You'll note in the audio hi-fi catalogues that tuners are now pretty regularly given sensitivity ratings in the specs, usually so many microvolts for 30 db quieting of the FM inter-station hiss. (Some ratings are for 20 db quieting). I was astonished to find what a wide range of sensitivity is still found among the new FM and FM-AM tuners, from a listed 10 microvolts all the way down to 2, which by my arithmetic would be five times as sensitive. (Anyway, a lot more sensitive.) In the city, sensitivity is not overly important. But if you want some superb country listening at great distances, then the new sets with very high sensitivity are definitely for you. Among these, the Fisher ranks very near the top and I must say from some months' personal experience that it is a superb instrument of its sort, though possibly its competition which I haven't happened to try is just as good.

Adjustable AFC

Another crucial factor, in case you haven't paid much attention to it, is AFC, automatic frequency control, present on almost, but not quite all of the newer FM tuners. AFC is the gadget that conquers the old and distressing tendency towards drift that used to bother us so in FM and, indeed, did a lot to give early FM a bad black eye with the automatic-loving public. AFC draws each station in, so to speak, and hangs onto it either way, as you move the dial pointer away from dead-center. (*Some FM circuits do not require AFC—National's, for example.* ED.)

AFC, of course, must be "defeated," as the quaint engineering terminology has it, when you don't want it to hang on too tenaciously and thus cover up small stations that nestle close to big ones. Most sets have an AFC "defeat" switch, for this purpose. The Fisher goes further with an AFC "volume control" as well, which regulates the degree of tenaciousness from zero to a lot. Very useful. With the AFC control full on, the tuner will hang onto a station for a good half-inch either way, right over and on top of several neighboring ones; when it finally lets go with a pop, it latches onto the next station. But from that extreme, it can be regulated to fit exactly the strength of the stations you customarily tune in. Thus in the country where many stations are weak and lie close together, a very small amount of AFC will hang onto any one of them, to keep you in tune, but will allow you to break away to the next station a fraction of an inch beyond and latch onto that for best steadiness. It works even for groups of extremely weak stations with scarcely any signal at all. If you run into a periodic fading situation, where first one, then another station is stronger you can always "defeat" the AFC entirely and keep tuned in one spot. (All good tuners now are very steady, once warmed up.) Yes, definitely, I suggest *variable* AFC for good country listening. (*Adjustable AFC is also available on the new Pilot AF-860 tuner.* ED.)

Incidentally, one lovely present virtue of FM listening in New England was an unexpected pleasure—automatic commercial-canceling. No—this is not a feature of Avery Fisher's versatile tuner. It's built into our local stations thanks to the prevalent WQXR network tie-ins that cover this Eastern area with FM from New York City, via micro-wave links.

New Yorkers will be sick with envy when I say that, up in Connecticut, I can listen to WQXR's entire musical program via FM and every commercial is neatly removed! Oh, those lovely, long, palpitating heavenly FM silences, all 60-db-down of them! The local benefactor, (probably unwilling) is FM station WRRH of Beacon, N.Y., which rebroadcasts the New York program minus the WQXR commercials that, Heaven be blessed, didn't pay for our area. Now, everybody, go quick and get a super-sensitive, variable-AFC FM tuner and set yourself up quick for blissful FM listening. Static-free, and hi-fi too. Worth moving to the country for, I'd say.

Incidentally, too, for the first time in history I was able to hear my own FM program, 100 miles away on New York's local FM station WNYC; also heard it at the other end of Connecticut, some 125 miles from the city. Judging by my mail, very few listeners to WNYC live further than 30 miles or so away, and the station assumes its main audience to be strictly in the city of New York itself. Think what will happen, then, when FM sensitivity really increases all along the receiver line. It's bound to occur, and FM has here one more hopeful prospect for the future, contrasting with the somewhat dismal past.

3. The Real, Honest-to-Goodness Organ

One of the most exciting records I have played in a long time is "The King of Instruments," a 12-inch LP record that features an illustrated lecture on the new developments in the so-called "classic" organ by the man who practically single-handed brought about the present revolution in organ building in this country now in its full tide, Mr. G. Donald Harrison of Aeolian-Skinner. (Available from Aeolian-Skinner Organ Co., Boston 25, Mass., $5 postpaid.) This disc is required listening, to my mind, for all readers of the recent disquisition "Plans for a Pipeless Organ" which I wrote in this magazine last January, and for all who have any interest in the workings of a true organ, or in the construction of any and all electronic instruments of organ-like character.

The account is by Mr. Harrison himself, who lectures to us, his words frequently supplemented by the most enchanting fragments of organ playing I have ever heard. Though Harrison is not exactly a master of mike technique and his speech is obviously read, and sounds so, the wide-awake mind will be entirely willing to concentrate on his words for their sheer interest. He takes us through the main divisions of organ tone on the first side and the beginning of the second, then launches into the special organ "stops," their construction and use (illustrated, of course) and finally goes into the mixtures and mutations, where color-blending of whole groups of pipes is used. Here was the most important meat of the whole lecture for my ear.

"Matching"

I had not been clear before, but am now, as to the difference between mutations, extra-color pipes used to add color to individual solo stops, and the mixture ranks which are designed to brighten up a whole keyboard full of musical sound. These last, astonishingly enough, are tailored individually by pitch *to the building itself;* added to their own keyboard, they reinforce different partials and at different volumes all the way from bottom to top of the scale according to the acoustical qualities of the building, compensating for weak spots, resonances in the hall and so on, to "match" the organ tone to its acoustical surroundings and produce an even and balanced scale throughout the pitch range. Move the organ and you must re-match the mixtures to the new location.

If you want to know why the true or wind organ is not likely to be replaced by any electronic equivalent except for practical compromise purposes, you will find the reasons implied here. Mr. Harrison doesn't say it in so many words, but his careful and detailed exposition of the business of acoustical sound-making via organ pipes brings out the enormous complexity of organ tone and, even more, the tremendous subtlety of the tone-mixing process in organ building and organ registration. Absolutely fascinating.

If you have been inclined to scoff at the revival of the older organ practices, the "Baroque" or "classic" organ, Mr. Harrison's talk will give you the straight dope most revealingly. The most dramatic musical examples in the whole record are where a passage of music is played first with the carefully calculated acoustics of the "classic" organ tone, then with a typical "Romantic" 19th century registration—to show how with the first, every detail of the music is audible and clear, where in the second the same notes come forth in a grand and confusing blur, musically meaningless. That, my friends, is what organ design, organ building, and organ playing is all about.

(Since this review was written, Vol. 2 of the King of the Instruments series has been received. This record—available from the same source and at the same price—contains three chorals by Bach, and six other classic organ selections by Davies, Bach, Alain, Langlais, and Sowerby. Quality of reproduction is excellent, and the music will be reviewed in the November issue. Ed.)

NEW LITERATURE

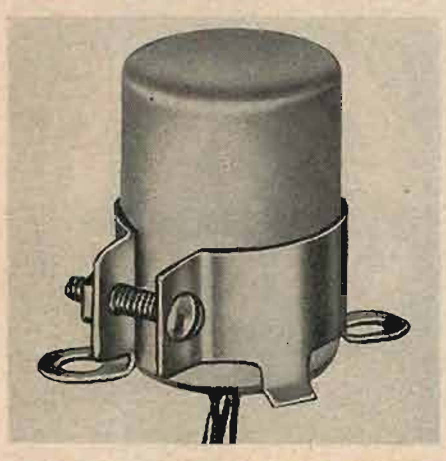
(from page 12)

• **Duotone, Inc.**, Keyport, N. J., is distributing to jobbers and dealers a new catalog which cross-references more than 400 cartridges, together with the type of stylus required for each. Other cross-references include styli of virtually all manufacturers. A stylus replacement guide lists the cartridge manufacturer's stylus number, point size, material from which the point is made, an illustration of the stylus, Duotone's replacement number, the cartridge number, list price, and an illustration of the cartridge. Request for copy must be accompanied by a remittance of twenty-five cents to cover handling.

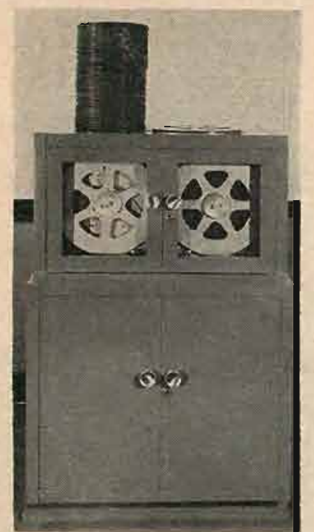
• **National Cine Equipment, Inc.**, 209 W. 48th St., New York 36, N. Y., has recently published a 28-page catalog which greatly eases the selection of equipment for the production of 16- and 35-mm TV and motion picture films. Included among the catalog listings are professional lighting equipment, cameras and accessories, synchronizers, recorders, animation equipment, booms, sound equipment, and various other devices and accessories. Augmenting the descriptive pages is an extensive price list on equipment rentals, in which the company specializes. Copy must be requested on company letterhead.

NEW PRODUCTS

• **Miniature Input Transformer.** A new addition to the UTC "Ouncer" series of high-fidelity transformers is the Type O-16 input transformer designed to operate from a low-impedance microphone or line to grid, providing a 1:200 step-up impedance ratio. Frequency response is within 1 db from 30 to 20,000 cps. The primary is center-tapped, balanced to 1 per cent, and is suitable for sources of 150, 200, 250, 500, or 600 ohms. With 250-ohm source, secondary impedance is 50,000 ohms. Minimum hum pickup is assured through the use of two heavy-gauge Hipermalloy shields. Over-all dimensions are 1½" x 1½" x 1 1/16" including orientable mounting bracket. For detailed information write to United Transformer Company, 150 Varick St., N. Y. 13, N. Y.



• **Eight-Hour Tape Reproducer.** The new Magnecord continuous music reproducer, designed primarily to furnish appropriate background music for diversified audiences, will also be available with optional equipment for "dubbing in" commercial announcements and institutional messages for department stores, factories, and similar establishments. It will be merchandised in conjunction with lease rights to the RCA Victor library of recorded music.



Exclusive U. S. and Canadian distribution rights to this library were recently secured by Magnecord for commercial lease and non-broadcast purposes. The basic unit consists of a continuous tape reproducer and a 10-watt high-fidelity amplifier. Optional equipment includes a high-fidelity speaker system and an automatic Program Master. The latter provides automatic control for any desired operating schedule. Eight-hour reels may be played at pre-determined intervals, for specified periods of time, or for continuous cycles of eight hours each. Initially, an assortment of 20 reels of 8 hours each of unrepetitive music will be available. Magnecord, Inc., 225 W. Ohio St., Chicago, 10, Ill.

• **Speaker System.** A unique method of speaker loading, known as the Acoustical Spiral, is featured in the newly-introduced Isotone high-fidelity speaker systems. In essence, the spiral is a continuous air column designed to enhance low-note definition. Damping is excellent. At present

the Isotone is available in two models and in a variety of finishes. Full information, together with the names of dealers and representatives, may be obtained by writing Isotone Acoustic Spiralways, Inc., 666 E. 164th St., New York 56, N. Y.

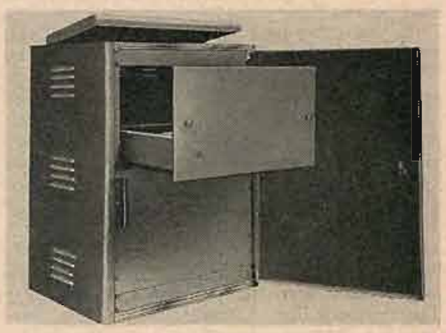
• **Economy Cabinets.** Intended for the space- and budget-conscious music lovers, a new selection of high-fidelity console cabinets and kits known as "Genesee Juniors" have been introduced by the Angle Genesee Corporation, 107 Norris Drive, Rochester, N. Y. Although smaller

in size and less expensive than the company's regular line of enclosures, the Juniors offer the same high standards of workmanship and quality. Three-quarter-inch lumber-core plywood is used throughout, corners are mitered and splined, and shelves and panels are removable. Equipment cabinets and speaker enclosures are available finished or unfinished. Technical information and prices will be supplied on request.

• **Tape Protector.** The problem of keeping recording tape neatly and tightly wound on its reel is solved by the new Pro-Tex reel clip which may be snapped into place without removing the tape from the recorder. It may be used similarly with

8-mm. motion picture film. It is durably made of non-magnetic metal and affords ample space for subject identification. Free circular will be sent on request to Pro-Tex Reel Band Company, 211 Film Building, Cleveland 14, Ohio.

• **Desk Cabinet Racks.** Manufacturers, as well as users of industrial audio equipment, will find many advantages in the

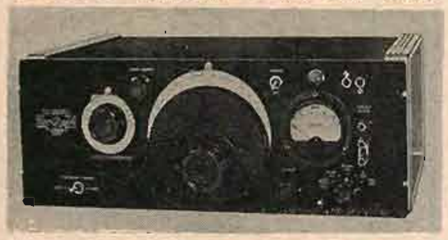


new line of desk cabinet racks recently introduced by Premier Metal Products Co., 3160 Webster Ave., Bronx 67, N. Y. Among the major improvements in the new line is a sliding drawer which facilitates servicing and maintenance of equipment. Cabinet depth is 18 in. Available in 10 sizes, the racks are made of #16 gauge cold rolled steel, finished in either black or gray wrinkle. Mounting brackets are supplied for wall mounting where desired.

• **Tape Playback Unit.** The new Bell tape playback unit brings the advantages of tape-recorded music to nearly everyone owning a 78-rpm phonograph. Designed for use with any single-speed turntable and with many automatic changers, the unit derives its power from the turntable motor. In operation the playback is positioned over the turntable and plugged directly into the tape input of any high fidelity amplifier, or into the phono input of any radio-phonograph equipped with a standard magnetic pickup. It may be fed

into crystal inputs through use of a companion preamplifier, the Bell Model 2246. The unit is available for operation at either 3.75 or 7.5 ips. Reel capacity is 5 in. Adjustable support legs compensate for variations in turntable height. Frequency response of the 7.5-ips model is 50 to 10,000 cps. Both models are equipped with dual-track heads. Bell Sound Systems, Inc., 555 Marion Road, Columbus 7, Ohio.

• **Audio Generator.** An extended frequency range, an improved amplifier, and the addition of an output attenuator and voltmeter are important new features of the General Radio Type 1304-B beat-frequency audio generator. Output frequency extends from 20 to 40,000 cps in two ranges with a calibration accuracy of ± (1% + 0.5 cycle). Frequency stability is excellent with the drift from a cold start less than 7 cps in the first hour of operation and essentially complete within two hours.



The output amplifier uses a new single-ended push-pull circuit and supplies one watt into a 600-ohm load with less than 0.25 per cent distortion between 100 and 10,000 cps. The new 1304-B provides a calibrated output voltage with output level being indicated by a meter and an attenuator setting in both volts and dbm. General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass.

• **Variable Time Delay.** The Echo-Vox is a portable instrument designed to provide a wide and continuously variable time delay at audio frequencies. Among its applications is that of properly phasing speakers in auditoriums, stadiums, and other large areas where objectionable echoes exist. It may also be used to achieve the opposite effect where conditions are such that introduction of slight

echo enhances the acoustical properties of the area. Input impedance is 600 ohms. Output impedance affords a choice of 600, 8, and 3.4 ohms. Single-echo time delay is continuously variable from 100 to 500 milliseconds. Maximum power output is 25 watts for speaker drive. Kay Electric Company, Pine Brook, N. J.

• **FM Booster.** Entirely automatic in operation, the new Electro-Voice Model 3005 FM booster increases signal strength more than 10 times (20 db) throughout the 88-to-108-mc FM spectrum. Use of the unit does not entail any additional controls. Integral thermal relay is provided so that the booster can be turned on or

off at the FM tuner without circuit modifications. Hi-lo gain switch permits limiting the gain of the unit when strong signals are encountered. Both input and output have 300-ohm impedance. For full information write Electro-Voice, Inc., Buchanan, Mich., requesting Bulletin 202.

(Continued on page 68)

DAMPING OF CABINET PANELS

(from page 34)

where A_1 is the first and A_N the *n*th amplitude.

It is, of course, also possible to excite the panel acoustically with a loudspeaker placed near it, and to record the output from a vibration pickup fastened to the panel as the frequency is varied. This might be termed a steady-state transmission measurement (with and without the damping material applied to the panel). Or the vibration pickup may be fastened directly to a wall of the cabinet with the speaker excited sinusoidally by an oscillator. *Figure* 2 shows a measurement made in this manner, first without and then with the damping material applied to the interior of the enclosure. Since the vibration pickup was inertia-operated, its output was first transmitted to an integrating network to obtain a measure of the change in panel deflection amplitude.

Measurements on various types of woods show that the logarithmic decrement of ¼-in. panels is as follows:

WOOD	LOGARITHMIC DECREMENT
Pine	.02
Beech	.03
Plywood	.04

The superiority of the plywood as a material with high internal damping is readily evident from these figures, which pertain to untreated surfaces. When a mastic compound is applied to them and permitted to harden, the values can be still further increased.

The above tests require considerable laboratory facilities, and hence cannot be readily carried out by the average music lover, home owner, or hi-fi enthusiast. A number of less complicated tests have been proposed to show up the resonant vibrations of a speaker cabinet panel. Thus, ripples in a glass of water set on the enclosure can be generated, and fine sand, salt, or sugar crystals sprinkled on the panel can be made to form patterns, so-called Kundt's figures. However, relatively large panel amplitudes are required to achieve noticeable results with these tests. A rather simple procedure consists in placing two pencils on the panel, and a light tin can filled with lead shot on top of the pencils. When the speaker is driven with an oscillator, the lead shot will rattle in the tin pan very audibly when the undamped panel is set into vibration at the resonant frequencies. After properly damping the panel, and properly energizing the speaker again with the same current used previously, no rattling of the lead shot should occur.

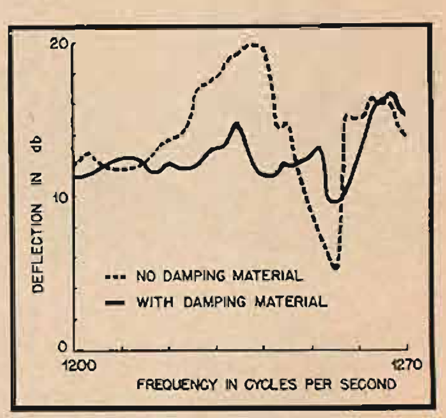


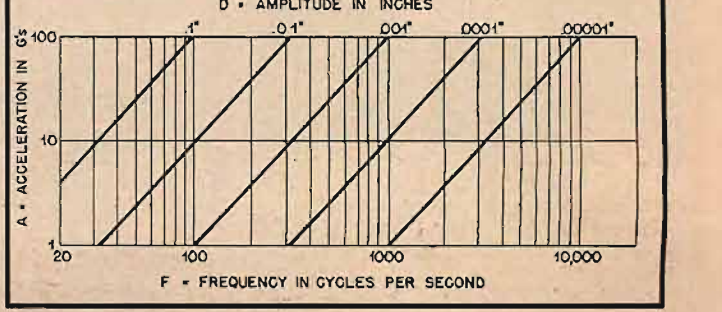
Fig. 2. The effect of resonance on a panel is much decreased when damping material is used as a filler.

Figure 3 shows the acceleration for various cone amplitudes. It is seen, for instance, that at 100 cps, a cone vibrating with an amplitude of 0.1 in. undergoes an acceleration of 100 G's. Since a modern dive bomber can rarely exceed 10 G's without shattering, the acceleration for loudspeaker diaphragms is very large indeed.

For the same reason, there are great forces acting also on a speaker enclosure which is closely coupled to the speaker. One means of reducing the transmission of these forces into the speaker panels is to employ a damping material such as a rubber or cork gasket between the speaker and the cabinet. If the speaker is not very heavy, the gasket may be cemented to both the speaker and the cabinet, and the speaker thereby more effectively isolated from the cabinet.[1]

[1] RCA makes a speaker cone with a rubber damping ring. This ring should not be used for cementing the speaker to the cabinet, because the ring is intended for another purpose.

Fig. 3. This chart shows the acceleration required at various frequencies to produce given cone excursion amplitudes. Accelerations are very large and the movements "hit" cabinet panels very hard, so that panel resonances produce maximum effects.



AUDIO TIME

(from page 44)

Records and Record Manufacturing is the title of the Friday afternoon session, which is scheduled to include the following papers:

"Quality control in record manufacturing," by E. H. Uecke, Capitol Records, Inc.;
"Record quality and its relation to manufacturing," by Dr. A. Max, RCA Victor Division;
"Geometrical considerations of the record groove and reproducing stylus," by William S. Bachman, Columbia Records, Inc.;
"Speculations on the cause and prevention of needle wear and noise in the phonograph playback process," by Dr. Frederick V. Hunt, Harvard University; and
"An evaluation of record stylus pressure considerations," by Dr. A. Max, RCA Victor Division.

The Saturday sessions are primarily devoted to subjects which are of greatest to the layman, *Pickups,* and *Loudspeakers.* The tentative list of papers for the morning session is as follows:

"A discussion of present day developments in magnetic phonograph pickups," by Walter O. Stanton, Pickering & Company, Inc.;
"Phonograph pickup measurements," by John M. Salani, Electronics Products Division, RCA;
"Advantages and problems of full frequency phonograph records," by Paul Weathers, Weathers Industries, Inc.;
"A twin lever ceramic cartridge," by B. B. Bauer, L. Gunter, Jr., and E. Seeler, Shure Brothers, Inc.;
"Amplifiers for music reproduction," by Hermon H. Scott and Herbert P. Kent, Hermon Hosmer Scott, Inc.

The afternoon program is:

"Correlation of listening tests with transient measurements on loudspeakers," by Murlan S. Corrington, RCA Victor Television Division;
"Acoustical calibration of loudspeakers at the higher frequencies," by John K. Hilliard, Altec Lansing Corporation;
"Recent developments in high fidelity loudspeakers," by Dr. Harry F. Olson, John Preston, and Everett G. May, RCA Laboratories Division;
"An electrostatic loudspeaker development," Arthur A. Janszen, Engineering Consultant.

Two additional papers are scheduled, but titles were not available at press time. One, to be given at the Saturday morning session is by Theodore Lindenberg, of Pickering & Company, Inc.; the other is to be given at the afternoon session by Paul W. Klipsch, of Klipsch & Associates.

PHONO EQUALIZERS

(from page 25)

is to be stressed that this particular treble equalizer is designed for use with the GE Variable Reluctance pickup. This type of equalizer can be used with the Audak and Pickering pickups, although the values of the components used will have to be changed. These values can best be found by experiment as described earlier in this article and in reference 4. All the resistors and capacitors in both equalizer circuits should have values within 5 per cent of those stated in *Fig.* 5 for optimum results.

VARIABLE DAMPING FACTOR CONTROL

(from page 33)

with a fairly average *DF* of +30 *or* about 40 db harder than is possible with a *DF* of +3 (representative of triodes with no negative feedback)—with no increase in distortion! We repeat: this is a typical speaker system, not specially selected. The reduction of distortion below 200 cps is even more drastic for contours of high distortion. The value of 5 per cent was selected as the maximum that can be tolerated in a high-quality system.

Figure 7 shows the *acoustical* transient response of the speaker system to a square pulse (dashed line) for different damping factors. The ringing (hang-over) is at 55 cps. As the *DF* is increased the wave-train decays more rapidly, the amplitude of the ringing decreases, and overshoot decreases.

The effect of *DF* on the sound-pressure response of a typical 15-inch coaxial speaker housed in an 8 cu. ft. bass-reflex enclosure is shown in *Figs.* 8, 9, and 10. The response curves were taken with a 10 ft. axial free-space between speaker and microphone at a reference level of 5 watts at 300 cps. The impedance curve of the speaker system is superimposed as a dashed curve on *Figs.* 8, 9, and 10 to visualize the effect of impedance as discussed earlier. It may be seen clearly in *Fig.* 8 that with a low positive *DF*, the response curve follows the impedance curve. *Figure* 9 shows that with a high *DF*, the response curve has an inverse relationship with the impedance curve. *Figure* 10 is included for comparison and shows the response curve of the speaker fed by a commercial laboratory standard amplifier that has a fixed *DF* of +10. Note the similarity between *Fig.* 10 and *Fig.* 8. Incidentally, the harmonic distortion generated at 30 cps by the speaker measured 95 per cent in *Figs.* 8 and 10 and only 20 per cent in *Fig.* 9 for equal sound levels. The curves of *Figs.* 8 and 9 were taken with the 300-cps RC filter out of the circuit. *Figure* 11 shows that the essential effect of the 300-cps filter on sound pressure response is to raise the over-all level and improve sound output below 25 cps.

Summary

In conclusion, let us summarize the benefits of adjusting the *DF* to optimize the performance of *each* speaker system.

1. Improved transient response from damping the low-frequency speaker and enclosure resonances by reducing the Q to 1 or less.

2. Flatter low-frequency response from complete damping of speaker-system resonances.

3. Extended low-frequency response by cancelling the droop caused by C_E and C_s below the fundamental resonance if extremely high *DF* is employed.

4. Drastic reduction of low-frequency distortion caused by any non-linearities in the speaker system if extremely high *DF* is employed.

5. Increased power handling capacity of the speaker system by eliminating low-frequency resonance peaks. The maxim of the chain and its weakest link holds true. If the speaker system has a resonant peak, the system will be over-driven at the frequency of the peak before being over-driven at other frequencies. A reduction or elimination of peaks by adjusting the *DF* to reduce the Q of the fundamental speaker and enclosure resonances to 1 or less will increase the over-all power-handling capacity of the system.

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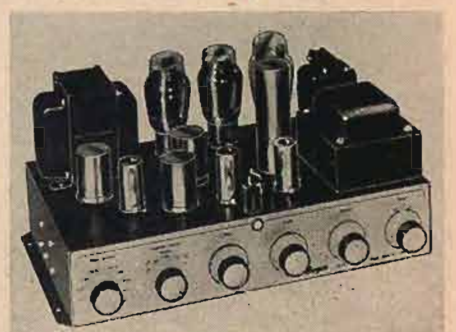

Fig. 12. Bogen DB20DF—A complete self-contained amplifier incorporating damping factor control.

IMPROVING FM RECEIVERS

(from page 42)

tained. This latter is especially useful if a TV set is to be incorporated into a home music system, where the higher fidelity can make intercarrier buzz very annoying.

Realignment should not be required after installation of this circuit, provided no adjustments have been tampered with. In fact, the diodes should be disconnected during alignment in order to get usable readings. Needless to say, its effectiveness goes up with increasing signal, and the signal voltage at the primary with the device disconnected should be at least 1 volt for good operation. Some noise will remain with this device in operation, but it is most likely FM noise and therefore unavoidable; all random noise has an FM as well as an AM component.

Drift Reduction

The final requirement of an FM set, freedom from drift, is not as essential as the first three but is nevertheless important for easy, trouble-free operation. In fact, it is so important that many of the more expensive hi-fi tuners feature complicated circuits to obtain it. However, even in expensive sets there is much that can be done to reduce drift to tolerable proportions. Since drift is inextricably tied up with the general design of the set, much of what is said here applies primarily to the design of new sets, but there are many improvements that can be made to existing ones.

To begin with, let us examine the mechanism of drift. The most prevalent and most annoying type, warmup drift, is caused by the increase in dielectric constant due to temperature rise of the few pieces of dielectric which are part of the oscillator tuned circuit. This includes the oscillator tube base and socket as well as the insulation of the tuning capacitor.

The dielectric receives heat from different sources with different time characteristics, The first source is the heating of the oscillator tube itself, which comes to equilibrium in a minute or so. Second is the heat produced by other tubes in the vicinity of the oscillator which take a little longer for thermal equilibrium, about 5 minutes. The last source is the heating of the power transformer and other massive components on the chassis, which may take as much as a half hour to come to equilibrium.

From the above discussion, the approaches to the drift problem become clear. Drift due to the heating of the oscillator tube itself is obviously unavoidable, but due to its short time constant it is not too objectionable. However, the writer has found that the use of a polystyrene socket for the oscillator tube can make this drift practically negligible.

The second source of drift—heat from other tubes—is also to some extent inherent, but can be minimized by the use of a more open layout on the chassis. As with the above source, nothing much can be done with an existing set, but these are points to watch if you build your own.

The third source of drift, the slow heating of massive components, is the most bothersome, since due to its long time constant it requires continual retuning for a long period. However, unlike the previously described two causes, this type of drift can be easily eliminated on an existing set, as in most sets the only component producing such drift is the power transformer. Therefore, the obvious cure is to mount the power supply on a separate chassis, which can easily be done even by the average home experimenter. Even high quality sets can be improved by this measure. Also, if the set is a complete receiver instead of a tuner, it will be helpful to move the power output stage as well.

Consideration must be given to drift, not only in the design of a set as covered above, but also in its installation. The cabinet or other enclosure used should give ample clearance at top and sides to permit free circulation of air and the back should be left open. If a separate power-supply chassis is used, as recommended above, it should be mounted separately, away from the tuner enclosure. By the same token, if the tuner is mounted in a console with other equipment, it should not be mounted near the amplifier, and particularly not above it.

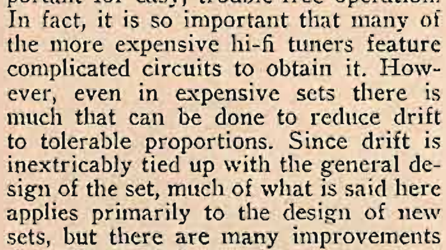

Fig. 3. Taking output of an FM tuner across the de-emphasis capacitor allows the capacitor to swamp the capacitance of a reasonable length of line. A blocking capacitor should be placed in the high side of the line at the first amplifier grid since the detector output contains a d.c. component.

Output Connection

Many times one of the better table-model AM-FM sets satisfies all the requirements for hi-fi FM reception with the exception of its audio section, and thus would be useful as an inexpensive tuner for an economy system. Many schemes have been proposed for bringing out the audio, but the simplest and also probably the best way is to conect the audio output across the de-emphasis capacitor, as shown in *Fig.* 3. Here the low-quality audio stages are bypassed,

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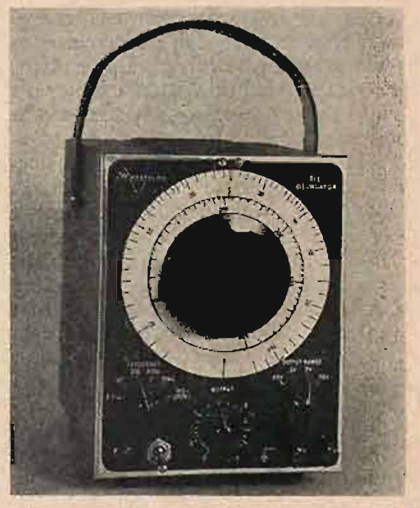
and the relatively large de-emphasis capacitor swamps out the cable capacitance and thus minimizes the effect of a long cable. (Of course, if the cable capacitance is large, this capacitor should be reduced in value to compensate.)

The volume control in the receiver will, of course, be inoperative, but if the amplifier has one that does not matter. When the set is used as a tuner, the audio stages should be disabled by cutting off their B-voltage. This scheme is also applicable for connecting TV sets to a hi-fi system, although in a TV receiver B-voltage should be left on the audio stages, since that current drain is required for proper operation of the rest of the circuit and drift is not such a problem, especially with an intercarrier set. However, the speaker voice coil should be shorted for silence.

NEW PRODUCTS

(from page 63)

• **Extended-Range Miniature Oscillator.** Despite its small size the new Waveforms Model 512 oscillator performs virtually all of the functions normally expected only of much larger counterparts. Frequency range is 0.9 cps to 500 kc, covered in five decade ranges with an additional bandspread range for ease of tuning at high frequencies. A 4-step attenuator provides calibrated output from 50 volts

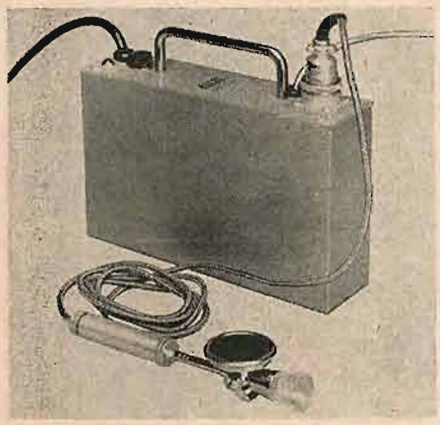


to 5 mv. with a maximum power of 2 watts into a 600-ohm load. Source impedance is under 50 ohms and distortion is less than 0.1 per cent over most of the audio range. Vernier drive provides 14-ins. of scale length per range. Output remains constant within 0.5 db throughout the tuning range. The 512 measures 7¼"h x 6¼"w x 8"d and weighs 12 lbs. Technical sheet may be obtained from Waveforms, Inc., 333 Sixth Ave., New York 14, N. Y.

• **High-Accuracy VTVM.** All frequencies from 10 cps to 4mc are covered by the new Hewlett-Packard Model 400D vacuum-tube voltmeter which measures voltages from 0.1 mv to 300 volts with accuracy of 2 per cent up to 1 mc. Input impedance is 10 megohms, so that for all practical purposes circuits under test are not loaded. Ranges are selected by a panel switch which changes sensitivity in 10-db steps. This, plus calibration of the 4-in. meter directly in decibels, permits direct readings without calculation or conversion between minus 72 dbm and plus 52 dbm. Readings are always on the upper portion of the scale where maximum accuracy is obtained. A new circuit further simplifies operation by virtually eliminating switching transients. In addition to featuring gain, response, and output level, the 400D also measures hum and noise directly, serves as an audio level meter and high-gain broad-band amplifier, and

may be used for measuring coil "Q", capacitance and resonance. For complete details write Hewlett-Packard Co., Dept. P, 395 Page Mill Road, Palo Alto, Calif.

• **Medical Microphone System.** Developed specially for research and for diagnosis and teaching of cardiology, this new Altec Lansing development is a specialized version of the company's condenser-type "Lipstik" microphone. All types of heart sounds may be picked up and fed into a recorder, headset, or loudspeaker. The microphone is designed to accommodate a standard Rieger Bowles stethoscope head. Short time stability of the unit is 0.1 db, and over long periods of time maximum deviation is 0.25 db. Other features which make the system particularly desirable to the medical profession in-



clude the sterilization factor—it being possible to sterlize the microphone in dry heat at 350 deg. F.—as well as wide frequency range and unusual sensitivity. Normal heart sounds produce approximately 0.1 volt output. Designated Type M-16, the system already is in use in a number of prominent medical centers, among them Georgetown University, Washington, D. C., where Dr. Proctor Harvey has made a series of tape recordings of various heart sounds for teaching purposes. Descriptive literature is available upon request to Altec Lansing Corporation, 161 Sixth Ave., New York 13, N. Y.

• **Hi-Fi Converter.** In response to the unique requirements of high-fidelity music systems, Carter Motor Company, 2648 N. Maplewood Ave., Chicago 47, Ill., is now producing a specially-designed converter. Designated the Type DR1025C5PX Custom Converter, the unit is designed to deliver 125 v.a.c. with 120 v.d.c. input at a load of only 50 watts. Due to exceptional regulation, the output voltage drops only to 105 volts with 110-volt d.c. input at full 250-watt load. These a.c. limits coincide with equipment ratings. A frequency control with frequency meter is included, allowing the user to adjust exactly to 60 cps. for record players and tape recorders. Filter is available to give noise-free tuner reception. Efficiency is approximately 60 per cent at 250 watts. The converter is built on a 500-watt frame to give a long life of trouble-free operation. Requests for complete information should be directed to Dept. 6 at the above address.

RECORDS

(from page 56)

Modern in the Raw

Charles Ives: Symphony #2. Vienna Orchestra, F. Charles Adler. **SPA-39**

Charles Ives: "A Set of Pieces" for Orch. and Piano. Milhaud: Fantasie Pastorale. Stell Andersen; Vienna State Opera Orch., Sternberg.

Oceanic OCS 31 (10")

Charles Ives, the insurance man from Danbury, Conn., who is now the very idol of a considerable segment of American musical opinion, was a very strong man who, quite independently (he lived off insurance), composed very odd music in the early years of this century that seems, now, to have forecast all sorts of modern trends. It did, without a doubt; polytonality, piano tone-clusters, American folk-style symphonic themes, violent dissonance and a lot more.

But as music, Mr. Ives' compositions are poles away from the French ideal of consistency—Ives, of all American composers, is the most chaotic as to style, ingredients, organization, aim or what-have-you! Ives is always exciting to hear; he was too strong a man ever to be uniformly dull. But the hodge-podge of this and that, the bewildering mixture of "modern" and ultra-old-fashioned, of American gospel hymns and pseudo-Wagner, of crumbling dissonance and saccharine consonance, is hard to believe. The plain fact is that Ives was both a revolutionary and a purveyor of ultra-conventional platitudes; he was a prophet of things to come and simultaneously a mirror of the times he lived in, musically speaking. It's not popular to say so now, but I'm sure any experienced ear will find a lot more undigested Wagner, Brahms, Mahler, Strauss, Liszt in Ives than the modern. The very trade-mark of Ives is—in extreme contrast to all things French—the absence of any consistency, of any style, the admittance of anything anywhere, anyhow, if it struck his fancy.

Strong stuff—especially in relation to the consistent platitudes of imitation that his respectable American contemporaries of 1900 were turning out, according to the then rules! You'll be arrested by many a moment in the early 2nd Symphony (1897–1901), sometimes for its beauty and originality, more often for its stomach-shifting leaps from one thing to another, from passages of Wagnerian schmaltz, without a second's pause, into New England Square dance tunes. The final passage, after a Mahler-like development right out of Germany but based on "Oh Suzanna," outdoes the end of the "Meistersinger" overture (and imitates it very neatly) on "Columbia, the Gem of the Ocean." Whew! An excellent job of recording, particularly effective on side 2.

The "Set of Pieces" by Ives typifies his later work, alternating the most extreme dissonance, the most violent whanging of clumps of keys on the piano (very prophetic) with some first-rate movie music right in tune with the 1950's, a half-century ahead of its time. Yes, we owe a lot to Ives, but we need strong stomachs to take his oysters-and-sugar, clams-and-chocolate-cake concoctions.

Milhaud? He's French. The trifling little Fantasie, probably tossed off in an odd moment, is a gem of utterly consistent, beautifully written dullness. Charming, like strawberry soufflé, after Ives. I hate to say so, but I think I'll take the clams.

Arias Sung and Acted. (From Aida, La Boheme, Madame Butterfly, I Pagliacci, Rigoletto, La Traviata.) Joseph Cotten, Dennis King, Deborah Kerr; Bjoerling, Warren, Merrill, Albanese, RCA Victor Orch., Weissman.

RCA Victor LM 1801

This unique RCA experiment in opera (see Audio, April) a slightly dizzy idea but interesting in the working out: the text of each aria is first acted by the professional actors, then sung by the singers. The result is quite strange, for what comes through most forcefully is the utter remoteness of the operatic and dramatic ways of telling a story, though both are intended for the stage. It is, in fact, rather a shock to hear these words acted in stage (or radio-TV-film) style, naturalistic, slangy, modern, of today. Somehow one expects the spoken words to have the never-never-land flavor of the operas themselves. Even opera in English, when sung, manages to preserve the old-style melodramatic manner thanks to the music itself. But minus the music, the whole operatic illusion vanishes and with it a good deal of the atmosphere that makes sense out of the stories.

Frankly, I doubt if most operatic libretti could stand up to plain acting, even those derived from actual stage plays—for these are usually changed to fit the opera conventions. Nevertheless, this is an interesting experiment, equally interesting for the opera specialist and those who don't konw what opera is all about. The budget performance, doubling up on the roles, is competent in the musical end if lacking in vocal variety; the acting is straightforward and professional but without particular distinction.

LOUDSPEAKER PERFORMANCE

(from page 23)

The first step is to cut away the spider while the periphery of the cone is still intact, to minimize the dangers of dislodging the suspension. Next, the entire gasket should be pried off with a knife, leaving the cone glued to the frame. The cone rim may now be cut away at the inner corrugation in sections, so that four parts of the cone extend to the frame and are still glued in position. These parts will hold the cone in a centered position while the four pieces of chamois are glued in position as previously described, evenly spaced in the middle of the gaps. After the glue has set, the remainder of the cone rim may be removed and the usual four large pieces of chamois cut and fitted into place. The gasket may then be replaced as before, and the job is completed.

Performance

If the work was done carefully, the speaker should now provide good reproduction, often with more "presence" than much more expensive single-unit speakers. One especially useful purpose for such speakers where cost may otherwise be excessive, is as a matched binaural speaker system. Recently the writer used two of these speakers for a binaural broadcast by the FM and AM transmitters of station KFAC of the Los Angeles Philharmonic. The sound reproduction was beautifully realistic. For ordinary monaural use these speakers give clean, quiet reproduction, although they do not have the efficiency or high power capacity of more expensive systems. While they may not stimulate the neighborhood dogs to the same extent as some of the more expensive high-frequency horns, they nevertheless supply rather satisfying music with exceedingly clean reproduction of low bass. In some of the recent high-quality recordings there are low-frequency sounds that can be felt more than heard. The true effect of these is lost in many speakers, but one of the chamois-"floated" units will supply them with clarity.

It might be pertinent to note here a limitation of these speakers. Even though the chamois is carefully fitted, considerable "breathing" occurs around the periphery of the cone. This fact precludes their use in any kind of horn enclosures.

ABOUT MUSIC

(from page 14)

composing machine will cost approximately $500,000.

The composing machine is the logical point of convergence for the hundreds of experiments in sound produced electronically, by objects other than musical instruments, or by unorthodox methods. Germany in the late Twenties produced at least two sonic explorers. Paul Hindemith anticipated John Cage in a film score composed by preparing the rolls of a mechanical piano. Ernst Toch had four speaking voices recite the names of four cities in different rhythms and later re-recorded the original at a higher speed.

Some of the more recent of a series of excursions into a new acoustical realm include those film shorts made in Canada with sound tracks produced by directly engraving patterns on the celluloid strip in the manner of a stencil. But the sounds created here are rather limited, curiously resembling a recording of someone blowing bubbles under water. In 1951, the New Music Society presented a piece by John Cage for twelve radio receivers. Twenty-four "operators" were stationed at their dials—two per dial: one for selector, the other for volume—while beer jingles, soap operas, news programs and quiz shows unwittingly played roles in Cage's new opus. At times a voice stood out above a subdued hubbub; at other moments Cage brought in the *tutti* at full volume. At one point in the proceedings all twelve sets were down to a *pppp* when Cage signaled one of his operators to ride gain. The station happened to be WQXR and for a good thirty seconds or more some "real" music floated out of the chaos. Someone in the audience (I think it was Fred Grunfeld) got up and shouted "Bravo!"

In Paris men like Pierre Schaeffer and Pierre Henry have been developing what they call "musique concrète." Schaeffer, the composer of such works as *Études* for turnstiles, railroad trains, and saucepans, says that the essential difference between "concrete" music and music as we know it lies in the fact that the latter is based on notes and the former on sounds. Last year the National French Broadcasting and Television Studios in the French capital sponsored a ten-day demonstration of the most recent creations of "musique concrète," "electronic music," and "music in spatial projection." Vladimir Ussachevsky's "Music for Tape Recorder" was auditioned; Schaeffer and Henry discussed their latest activities; and the audience listened to a lecture on the new "sound alphabet" illustrated by a drop of water, "the sound of a gong without the impact by which the sound is produced," the click of a Chinese block, etc.

A statement made by Varèse some time ago might easily apply to these new directions: "Whole symphonies of new sounds have come out of the modern industrial world and have been all our lives a part of our daily consciousness."

The above experiments, however, are as primeval as Edison's tinfoil phonograph of

1877 when compared to the potentialities of the composing machine. When the long engagement between music and electronic is finally consumated in marriage, the results, in the words of the American composer Roger Goeb (one of the leading exponents of the electronic "one-man band") "would take music (new music) out of the category of theatrical enterprise, out of the category of the museum-like strictures of Carnegie Hall, and would place it directly to the audience via recordings, radio, television, and in the neighborhood theatre. Music would be in the same position as painting, sculpture, and poetry: the artist dealing directly with his audience."

Whether the audience will take to music minus the performer remains to be seen. The theatrical aspects of Heifetz tossing off a Paganini Caprice, Rubinstein delivering a "jack-in-the-box" performance of the Rachmaninoff Concerto No. 2, Toscanini accidentally breaking his baton in two while conducting Tchaikovsky's *Manfred* and sending the free half flying across the stage like an arrow—such dramatic supplements of concert-going seem to be no less popular. More important than the nineteenth-century virtuoso hangover of contemporary concerts, however, are the obvious stimulating features of contact between artist and public.

But when the composing machine becomes a reality—and at the moment this is primarily a question of money—will the performers or the listeners run for cover?

LETTERS

(from page 8)

as possible in the first stage to which it is connected in order to avoid cumulative hum-and-noise contributions.

It is our recommendation that the total shunt capacitance be kept under 300 μμf through the use of cartridge lead lengths under 3 feet using standard shielded lead, and under 10 feet using low-capacitance lead. If it is impossible to stay within those values a preamplifier such as the General Electric Model UPX-003A should be installed close to the cartridge and the preamplifier output run to the control amplifier. This system has the advantage, not only of avoiding any possibility of resonance in the system, but also of boosting the signal level before running it any appreciable distance through ambient noise signals. If an exceptionally long run were necessary a cathode follower could be added to the UPX-003A output.

The capacitance encountered in most normal installations, that is, commercially available record changers and manual turntables, will stay within the 300 μμf and the inherent damping of the cartridge will ensure that no appreciable peaks occur. Incidentally, the value of shunt capacitance which we recommend as the optimum is 140 μμf, although values up to 250 μμf may improve response, depending upon the amount of loss in the capacitance and the type of material of which the record is made. The same results will not be obtained with all types of lead, even if the same total capacitance is retained, but these are very minor considerations which will cause little or no audible variation.

N. S. Cromwell, Supervisor
Audio Products Engineering
General Electric Co.,
Electronics Park, Syracuse, N. Y.

AUDIO engineering society

APPLICATION FOR MEMBERSHIP

P. O. Box 12, Old Chelsea Station, New York 11, N. Y.

I desire { admission into / advancement in } the Audio Engineering Society. Grade desired ....

....
Print or Type Name in Full

Born at .... *City* *State* *Country* *Date* *Age*

Residence .... *Street* *City* *State*

Mail Address .... *Street* *City* *State*

Occupation .... *Position* *Name and Address of Concern*

Present Duties .... *State in Detail (Students give school and course)*

....

Past Experience .... *Give Companies, Years, and Positions*

....

....

Member of Other Societies .... *Give Names or Abbreviations, and Grade of Membership*

....

EDUCATION

SCHOOL ATTENDED	FROM	TO	COURSE	DEGREE

ADMISSION REQUIREMENTS

A Member, according to the constitution, may be any person active in audio engineering who has an academic degree or its equivalent in scientific or professional experience in audio engineering or in a closely related field or art. Such a person shall, upon election, be entitled to all the rights and privileges of the Society.

An Associate Member may be any person interested in the objectives of the Audio Engineering Society and, upon election, shall become entitled to all the rights and privileges of the society except the right to vote or to hold office or chairmanship of standing committees.

A Student Member may be any student interested in audio engineering and enrolled in a recognized school, college or university. A student member is not eligible to vote or to serve on committees except in his own local chapter.

Three references are required with application for the member grade, two for associate membership and one for student membership. References should be familiar with your work; they need not be members. Yearly dues are $7.50 for member, $6.00 for associate and $3.00 for student, each of which is halved if the date of application is between April 1st and September 30th.

Payment must accompany application, and application must be signed to expedite handling.

REFERENCES

Name *Company and Address* *Title or Position*

1. ....

2. ....

3. ....

....
Signature of Applicant

PLEASE DO NOT WRITE IN THIS SPACE

Application Received	Amount Received	Application to Admissions Committee	Dues Payment to Treasurer	Application Approved by	Date Approved	Membership Card	Past Papers

Oddities, But Interest, in Audities

SIR:

I'm afraid Mr. Saul J. White has got himself sartorially imbrangled* in his last paragraph of "Too Much Music." The whodunit to which he alludes is "The Nine (not seven) Tailors (not Taylors)" by Dorothy Sayers (not Agatha Christie).

When I read the book I, too, raised a dubious eyebrow about the possibility of killing a feller with pure decibels—but it wasn't a bad yarn.

But he draws a perfect score for misquotation, what?

L. F. SOUTHWICK,
R.F.D. 1, Yale Avenue,
Wallingford, Conn.

* Miss Sayer's own word for "confuse, disorder, op. cit."

SIR:

"Audio Audities" by Saul J. White is a refreshing bit of tart erudition in your otherwise reserved publication.

I am reminded of my old college professor who, after a heavy mathematical session, would wave his arm at the blackboard covered with bewildering formulae and solutions, and say, "Now let's send that to the beauty parlour and have it manicured and perfumed so that you romantic gentlemen can be better seduced by it."

Then would follow ten minutes of the most fascinating popular summation which indeed threw a new light on what was up to that point a dull theoretical subject. Sugar-coating of mathematics has its place, especially after a grinding classroom session, or after a dull day on the job. It is highly relaxing to read as interesting and speculative a situation as described in "The sound that goes nowhere."

SOL G. MARCUS,
331 Bay Street,
Toronto, Ont., Canada

Frequency Runs on FM

SIR:

While Mr. Benson (July Letters) is somewhat out of range of KPFA (94.1 mc, Berkeley, Calif.), you may be interested to know that we have provided the service he requests for FM listeners in much of Northern California. We schedule an hour-long "Test Tones" program on a Saturday afternoon once a month, featuring frequency runs and sweeps for measuring response, and reference tones and silent periods for measuring distortion and signal-to-noise ratios. Actual transmitted values are announced so that it is possible to check through an entire audio system. Typically, the frequency runs are correct within 0.5 db from 30 to 15,000 cps; distortion is 0.5 per cent; and noise is 67 db below 100 per cent modulation. And many are the disillusioned hi-fi owners who thought their rigs were flat to at least 100,000 cps.

BRUCE J. HARRIS,
Chief Engineer KPFA,
2207 Shattuck Ave.,
Berkeley 4, Calif.

(*Would that many more cities had such a useful service for serious listeners.* ED.)

Early Magnetic Recorders

SIR:

I noted with interest in the May issue the article entitled "Tape Recorder Weighs A Ton" in which was described an early BBC tape recorder used in the 1930's with the appellation "one of the earliest tape recorders."

In the 1901 edition of the Proceedings of the Smithsonian Institution, there is a report on what is probably the earliest

magnetic recorder. The article deals with a device called the "Telephonograph" invented by the Danish inventor Waldemar Poulsen. There were two types of telephonograph—one using wire and the other using tape—both ancestors respectively of the modern wire and tape recorders.

The wire telephonograph had iron wire wound on a non-magnetic cylinder which was rotated like the cylinder of an Edison phonograph. The signal was applied and picked up by a coil with needle-pointed pole pieces. The input signal was produced by a telephone transmitter in series with dry cells—vacuum-tube amplifiers (and vacuum tubes) being unknown at the time, 1898. Similarly, the signal was picked up by a telephone receiver, and erased by passing d.c. through the recording-playback coil.

The band telephonograph looked superficially like a modern tape recorder except that the tape was a thin steel band much like that used in the later BBC recorder. This device was used for a time in the courts of Denmark to record testimony.

The inventor had an ingenious scheme for using the band telephonograph as a type of amplifier for use as a telephone repeater. The input signal was recorded on a continuous belt of steel tape. Immediately beyond the recording head was a pickup head connected to a recording head on an adjacent steel band. This arrangement was repeated several times so that the original signal was recorded on four or five tapes. Then the signal was picked up from all tapes simultaneously with the pickup heads wired in series or parallel depending on whether voltage or current amplification was desired. While this may appear to be getting something for nothing, it must be remembered that the added energy came from the work expended in moving the tapes against the magnetic drag of the recording heads. Immediately following the second pickup head was a permanent magnet serving as an erase head to prevent the output signal from interfering with the input.

MARTIN H. M. FRANCIS, Lt.jg, USNR,
USS Midway, CVA-41,
C/o FPO, New York, N. Y.

Employment Register

Personnel may be listed here at no charge to industry or to members of the Audio Engineering Society. For insertion in this column, brief announcements should be sent to Chairman, Employment Register Committee, P. O. Box 629, Mineola, N. Y. before the fifth of the month preceding the date of issue.

• Positions Wanted

• Technician. Over 25 years in communications, instrument maintenance, electrical and electronic musical instruments, sound, intercoms, general electrical and prototype work. For resume, address: Finley L. Berry, 94–30 113th St., Richmond Hill 19, N. Y.

• Full of enthusiasm and initiative, but short on professional experience. This year's E.E. graduate desires start in audio industry, preferably recording. Some tape and disc recording experience, mixing, editing, etc. Feels well informed in this field but requires position to prove abilities. Any location considered. Thomas W. Thorniley, 538 W. 19th St., San Pedro, Calif.

EDITOR'S REPORT

(*from page 16*)

IT'S SO SIMPLE

Ever since the introduction of LP's to the audio scene, we have been exhorted to be careful about the stylus force—that's the correct term, although common usage is stylus pressure—with which we played our valuable records. It is certain that either too little force or too much can cause accelerated wear, and for a correctly shaped stylus the optimum force is claimed to be 6 grams. If both microgroove and standard records are played, it seems that the compromise setting for the stylus force is around 8¾ grams.

To make sure that we have the force recommended, we have been using a variety of devices to measure it—spring balances, relay-spring adjusters, modified letter scales, and the like, some of which are undoubtedly ingenious. However it seems much more simple—and certainly far easier to use—to employ a "go/no-go" device much in the same fashion as we would employ a gauge to a manufacturing process.

One device just introduced (see page 51) is such a "gauge" in that it shows accurately when the stylus force is correct. It does not tell you what the force is, but shows easily and very simply when it is exactly 6 grams—or with a piggy-back weight, when it is 8¾ grams.

This device is so simple that at first look one is constrained to say "why didn't I think of that?" But someone finally did.

COMING EVENTS

Sept. 30, Oct. 1–2—1954 High-Fidelity Show, International Sight and Sound Exposition. Palmer House, Chicago, Ill.

Oct. 4–6—National Electronics Conference, Hotel Sherman, Chicago. Papers are solicited on all electronics subjects, and the program chairman would appreciate sugestions for titles and authors of suitable papers. Write George E. Anner, Elec. Engrg. Dept., University of Illinois, Urbana, Ill.

Oct. 13–17—1954 Annual Convention, Audio Engineering Society. Hotel New Yorker, New York City.

Oct. 14–17—The Audio Fair, Hotel New Yorker, New York City.

Oct. 22–24—New England Hi-Fi Festival, Hotel Touraine, Boston.

Oct. 27–30—30th Annual Convention, National Association of Educational Broadcasters. Bowman Room, Hotel Biltmore, New York.

Nov. 18–19—Sixth Annual Electronics Conference sponsored by the Kansas City Section of the I.R.E., Hotel President, Kansas City, Mo.

Feb. 10–12, 1955—Audio Fair-Los Angeles, Alexandria Hotel, Los Angeles, Calif.

VERSATILE CONTROL UNIT

(from page 21)

Modifications

The schematic of the amplifier—*Fig.* 1—shows fixed values for the frequency-determining elements, C_1 C_2, and R_2, and for the values shown, the turnover would be at approximately 375 cps, and the high-frequency response would be down approximately 6 db at 10,000 cps, which closely fits the ffrr curve. These values can be changed to suit the individual preference, or the circuit can be arranged so that various values could be switched in at will. C_2 controls the turnover frequency and R_2 controls the amount of flattening or deemphasis at the low end. The amount of rolloff is controlled by the capacitor C_1.

For equalization to fit the RIAA curve—which is becoming more and more the standard in the industry—it is advisable to decrease the value of C_2 to .0035 µf, change R_2 to 1.0 megs, and increase C_1 to 470 µµf. This should give suitable results with almost any LP record, provided some adjusting of the tone controls could be resorted to. For other equalization curves, the values shown in Table I could be substituted for those in *Fig.* 1.

TABLE I

Component Values for Different Equalization Curves

Curve	C_1	C_2	R_2
RIAA	470 µµf	.0035 µf	1.0 meg
ffrr	220	.004	4.3
Col 78	1000	.004	4.3
RCA 78	470	.003	1.8
Old AES	620	.004	1.8
Col LP	1000	.005	0.56
Compromise	470	.005	1.2

The value for R_7 is that specified by the pickup manufacturer as optimum. A 2-watt unit is recommended to ensure low-noise operation.

PARTS LIST

C_1, C_2	See Table I
C_3	2400 µµf, mica, 5%
C_4	1200 µµf, mica, 5%
C_5	560 µµf, mica, 5%
C_6	270 µµf, mica, 5%
C_7, C_9, C_{13}, C_{17}	0.25 µf, 600 v, paper
C_8, C_{16}	50 µf, 25 v, electrolytic
C_{10}, C_{11}, C_{20}	0.1 µf, 600 v, paper
C_{12}	1.0 µf, 600 v, paper
C_{18}, C_{14}	4700 µµf, 400 v, paper
C_{15}	100 µµf, mica
C_{19}	0.15 µf, 600 v, paper
C_{21}	2 µf, 200 v, paper
L_1	0.8 Hy
R_1	0.11 meg, 2 watts
R_2	See Table I
R_3	15,000 ohms, 1 watt, 5%
R_4	22,000 ohms, 1 watt, 5%
R_5	36,000 ohms, 1 watt, 5%
R_6	62,000 ohms, 1 watt, 5%
R_7	See text
R_8	1500 ohms, deposited carbon, 1%
R_9	0.22 meg, 2 watts
R_{10}	1.0 meg, 1 watt
R_{11}	0.15 meg, 1 watt
R_{12}	2400 ohms, 1 watt
R_{13}, R_{14}	10.0 megs, 1 watt
R_{15}, R_{35}	1.0 meg, 1 watt
R_{16}, R_{31}	1600 ohms, 1 watt
R_{17}, R_{32}	15,000 ohms, 2 watts
$R_{18a, b}$	Dual 25,000-ohm potentiometer, linear taper
R_{19}, R_{20}, R_{29}	0.1 meg, 1 watt
R_{21}, R_{25}	1.0-meg potentiometer, linear taper
R_{24}	0.47 meg, 1 watt
R_{22}, R_{23}	47,000 ohms, 1 watt
R_{26}	68,000 ohms, 2 watts
R_{27}	560 ohms, 1 watt
R_{28}	0.22 meg, 2 watts
R_{30}, R_{33}	33,000 ohms, 2 watts
R_{34}	18,000 ohms, 2 watts
V_1, V_2	Two halves of 12AX7
V_3, V_5	Two halves of 12AT7
V_4	12AU6

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.
AUDIO EXCHANGE EXCHANGES AUDIO

30% DISCOUNT Factory-fresh guaraneed LP records. Send 10 cents in coin for complete catalogue
SOUTHWEST RECORD SALES, Dept. A, 4710 Caroline, Houston 4, Texas

FM ANTENNAS. Broad band Yagis and standard types. Wholesale Supply Co., Lunenburg, Mass.

MUSIC FROM A BOX—is this your Hi-Fi? Thirteen years experience in engineering, constructing, and rebuilding home music systems. May I help you? Sherwood Sax, 3638 Regal Pl., Los Angeles 28, Calif. HOllywood 9-4043

Sell complete file AUDIO ENGINEERING and AUDIO from second issue, June 1947, to date. No reasonable offer refused or will donate to organization. Henry Shaw, 1811 Roberta, Willow Grove, Pa.

WHARFEDALE 5/CS/AL treble speaker, month old, $18.50. A. M. Vash, Stony Brook, N. Y.

SELLING OUT: Complete Brociner audio control center consisting of A100 preamplifier equalizer and CA-2 control amplifier, $60. Kelton Diplomat speaker system, $30. All in perfect condition. Tony Hofmann, 90-A Kirkland Street, Cambridge, Mass.

SELL two Rek-O-Kut Console model turntables; original value $700 each; 6 years old. Make offer. Also 5 R-J baffles, almost new. Audio Electronics, Inc., 2516 Highland, Cincinnati 19, Ohio.

CONCERTONE NETWORK RECORDER, mechanism and amplifier, never unpacked. New price $795. Must sacrifice $495. B. Kamnitzer, 89–21 153rd St., Jamaica, N. Y.

SELL—Partridge output transformer WWFB and mounted resistor board for Williamson amplifier, used but perfect, $15. Wm. Tannenbaum, 160 Bennett Ave., New York 40, N. Y. TO 7-1698.

HEATHKIT Ultra-Linear Williamson, perfect, $50; Craftsmen RC2 amplifier, $20; University 6201, $30; Permoflux ST-8-1, $7.50. Each in excellent condition. Norman Tetenman, 2350 E. 27th St., Brooklyn, N. Y.

MICROPHONES: SELL two Shure #300 multi-impedance (with 3-way switch for 30/50, 150/250, and 100,000 plus ohms) bidirectional broadcast microphones complete with 20 ft. 3-conductor shielded cable; in original boxes. Used only 22 hours; we replaced with directional mikes. $50 each. BURTON BIGELOW ORGANIZATION, 274 Madison Ave., New York 16, N. Y.

Hi-Fidelity plastic-base recording tape, 1200 ft. on 7½" plastic reel, $2.19 ea., 6 for $12. Hi Fi Shop, 2 N. Howard St., Baltimore 1, Md.

Visit AUDIO at the International SIGHT and SOUND EXPOSITION Palmer House, Chicago Sept. 30, Oct. 1 and 2
Room 735

Industry People . . .

Bill Bachman, who developed the GE magnetic pickup while with General Electric, has started a new trend in audio with design of a new electrostatic speaker for the Phonograph Division of Columbia Records, Inc.—it will be used first in the revised model of the Columbia "360" table phonograph . . . **Dr. William Shockley,** best known for his contributions to the development of the transistor, has taken leave of absence from his position as Director of the Transistor Physics Department of Bell Telephone Laboratories to become Director of Research for the Weapons Systems Evaluation Group, a division of the Department of Defense.

One of the season's most lavish trade showings was conducted by The Magnavox Company to introduce its new high-fidelity component line as well as assembled radio-phono-TV receivers. Held at New York's Park Lane Hotel, the meeting was co-hosted by Magnavox president **Frank Freimann** and **Lester J. Sholty,** account executive for Maxon, Inc., Magnavox advertising agency . . . Equally impressive was the buffet luncheon given at the Belmont Plaza by **Charles Ollstein,** president of Manhattan's Sanford Electronics Corporation, **Les Hirtenstein** and **Ray Bellinson,** sales execs., to announce that the firm has taken over distribution of Jensen speakers and Regency amplifiers, in addition to the Webcor line of phonos, record changers, and tape recorders which it has handled for some time.

Stanley Kligfeld, writer on high fidelity for The Wall Street Journal, has resigned to hang out his shingle as a practising attorney . . . **Lyman E. G. Suiter,** formerly with the Radio Division of Westinghouse, has been appointed Assistant to the Vice-President of Fairchild Recording Equipment Company . . . **Henry T. Roberts** has been named vice-president in charge of the Commercial Music Division of Magnecord, Inc.—he will continue to act as general manager to which position he was appointed last May . . . **Linwood G. (Lin) Lessig,** formerly with J. Walter Thompson Company, has joined the New York office of Al Paul Lefton Company, Inc., as Director of Technical Advertising—background includes 14 years in various departments of RCA Tube Division.

Bryce Haynes, vice-president of Audio Devices, Inc., expressing enthusiasm over an Air Force contract for the company to supply 15 million feet of three-inch-wide magnetic recording tape—enough to reach from New York to San Francisco. Cost of tape will be about $220,000 . . . **Max Baume,** formerly general manager of Brook Electronics, Inc., has opened shop as a factory representative in New York under the firm name Baume Electronic Sales Company.

Frederick I. Kantor has retired from the rep field to become sales manager for Encore magnetic tape—most of Kantor's accounts have been taken over by **Leonard Zlowe** of the Leonard Zlowe Company . . . Death of **Harold Sherman,** prominent member of the Audio Engineering Society and pioneer in binaural recording, a matter of sincere grief throughout the audio industry. **Gerhard G. Schneider,** who joined the company in 1934 as a tool maker, has been elected vice-president in charge of production of National Union Electric Corporation . . . **William R. Saylor,** formerly in the Cambridge office of General Radio Company, has been appointed manager of the firm's new engineering and sales office in Silver Spring, Md.

Herbert Borchardt, president of Sonocraft, Inc., forecasts greatly expanded use of tape recorders in schools and colleges—expects Fall sales in the educational field to set new records . . . **William H. Clithero, Jr.,** previously with David Bogen Company, has been appointed manager of branch store operations by Gates Radio Company . . . **Bert Berlant,** president of Berlant Associates, in an effort to protect dealers and jobbers against price-cutting, announces that effective immediately all Concertone products will be fair-traded, and that strict franchise policy instigated by the company last January will be strengthened.

Jimmy Carroll, sales exec in Harvey Radio Company's Sound Department, has recovered from major operation performed during his August vacation. Vacation? . . . **Bill Mooza,** prominent New York factory representative, is showing one of the cutest gimmicks yet to come along in the form of a radio concealed in the replica of an old-fashioned wall-type telephone—not exactly high fidelity, but it's plenty easy on the eyes; manufactured by the same outfit that produces those fancy little "spice boxes" . . . Don't forget, Audio Fair Time is almost here—October 14 through 17 at the Hotel New Yorker—and if the buzz-saw tempo of Fair Manager **Harry Reizes'** activities is any indication, we're in for the time of our lives.

ADVERTISING INDEX

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BRAND
GREEN BAND
Professional

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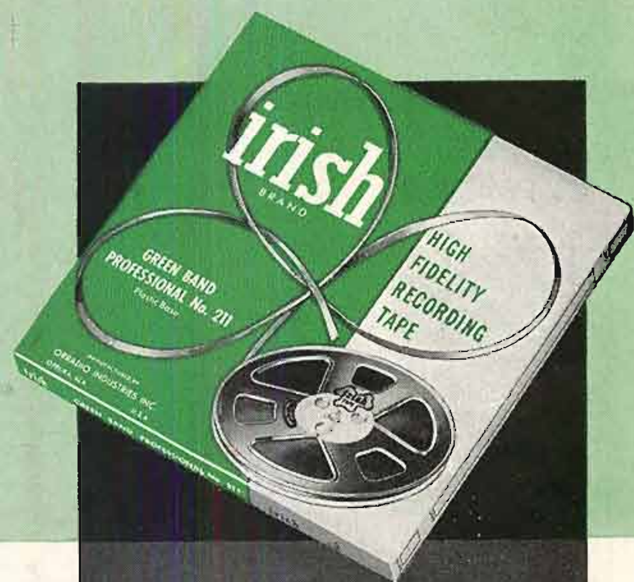
FINEST TAPE

Your Recorder

Can Use....



600 feet on plastic reel	net $2.10
1200 feet on plastic reel	net 3.30
2400 feet on metal reel	net 7.71

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Available Wherever Quality Audio Reproducing Equipment is Sold

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EXPORT DIVISION: Morhan Exporting Corp., New York, N. Y.
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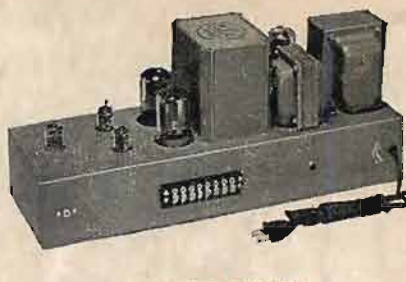
NEW HEIGHT OF FIDELITY
20 WATTS
KIT FORM

LINEAR STANDARD MLF AMPLIFIER



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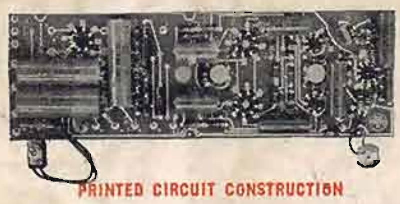

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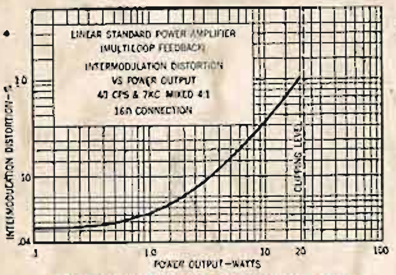
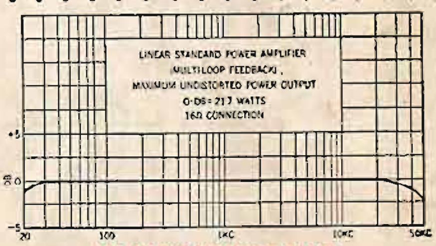
SUITED TO 7" RACK PANEL MOUNTING



INTERMODULATION DISTORTION CURVE



FREQUENCY RESPONSE CURVE

The Linear Standard amplifier climaxes a project assigned to our audio engineering group a year ago. The problem was, why does a Williamson circuit amplifier which tests beautifully in the laboratory seem to have considerable distortion in actual use? It took a year to fully determine the nature and cause of these distortions and the positive corrective measures. This new amplifier not only provides for full frequency response over the audio range but, in addition, sets a new standard for minimum transient distortion.

An inherent weakness of the Williamson circuit lies in the fact that its negative feedback becomes positive at subsonic and ultrasonic frequencies. The resultant instability in use lends to parasitic oscillation at the high end and large subaudio cone excursions both of which produce substantial distortions. The Linear Standard Amplifier uses Multiple Loop Feedback and network stabilization to completely eliminate these instabilities. The oscillograms below show comparative performance. The flat frequency response and extremely low intermodulation distortion provided by 36 db feedback, are self evident from the curves shown.

In addition to providing an ideal amplifier electrically, considerable thought was given to its physical form. A number of points were considered extremely important: (1) Size should be minimum (power and audio on one chassis). (2) Each kit must have identical characteristics to lab model. (3) Rugged, reliable, structure is essential.

This resulted in a rather unique construction employing a printed circuit panel as large as the chassis with virtually all components pre-assembled and wired. The result is that each kit, which comes complete, including tubes and cover, can be fully pretested before shipment. Additional wiring involves only the connection of 17 leads to screw terminals for completion.

LINEAR STANDARD TYPE MLF AMPLIFIER SPECIFICATIONS . . .

Rated Power Output:	20 Watts
Intermodulation Distortion:	.07%-1W, 1%-20W
Frequency Response (controlled):	1 db 20 to 20,000 cycles
Hum & Noise Level:	80 db below rated output
Feedback:	36 db
Output Impedances (not critical):	4, 8, 16 also 2, 5, 10, 20, 30 ohms
Tubes:	1-12AX7. 2-6AU6, 2-5881, 1-5V4G
Dimensions & Weight:	5¼" x 8" x 17⅛", 24 lbs.
Net Price:	$108.00

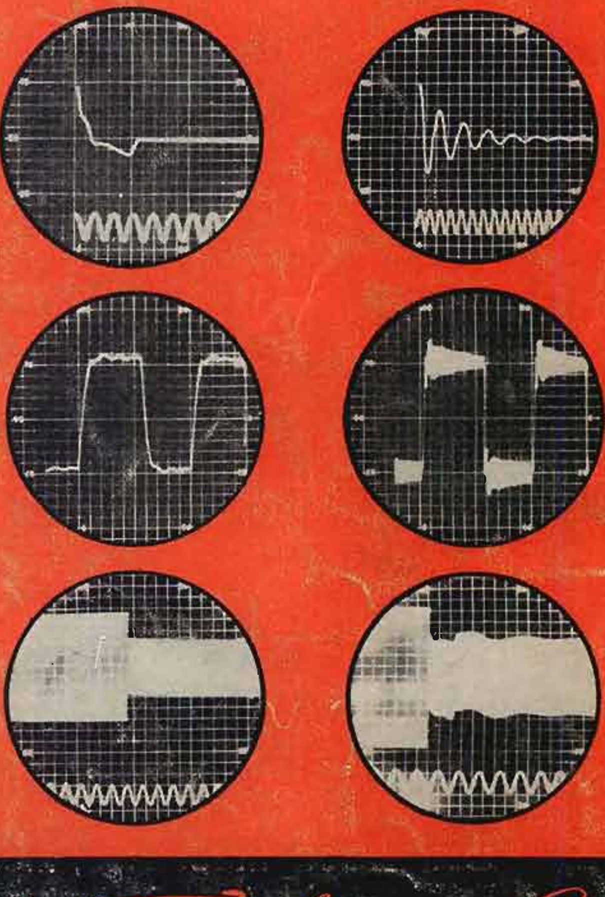
COMPARATIVE PERFORMANCE

LINEAR STANDARD — WILLIAMSON TYPE

Step function (low frequency) transient stability.

High frequency oscillation stability. Average speaker wiring capacity.

Overload recovery transients.



United Transformer Co.

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