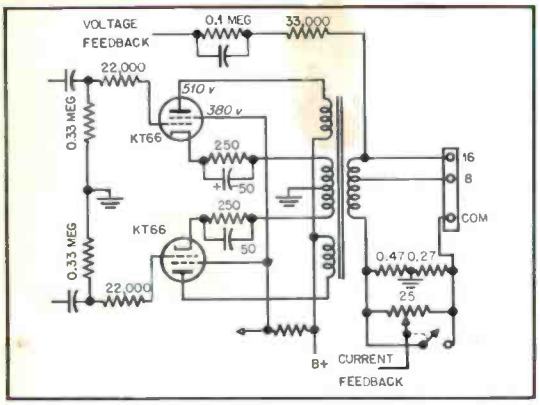
AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

JANUARY, 1955

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This circuit represents the output stage of one of the modern power amplifiers described—along with "front ends"—in the 40-page Amplifier and Preamplifier section. See page 21.



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AMPLIFIERS AND PREAMPLIFIERS — a 40-page section

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AUDIO

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AUDIO PATENTS

RICHARD H. DORF*

IT IS UNFORTUNATE that broadcast stations, both FM and AM, are forced to have limiting amplifiers somewhere in the system, usually at the transmitter. The reason, of course, is that overmodulation must be prevented despite vagaries of performers and incidental noises which, but for the limiter, would drive the modulator into distortion and FCC unhappiness. The reason for the adjective "unfortunate" is that in some cases limiting tends to reduce the sound quality of the result, particularly on FM. We have in the past in this space decried the tendency of some operators to crank studio gain up with the idea of keeping a high modulation level and letting the limiter skim off the top, and we will again offer to shoot on sound the boys at the knobs who make a *pp* indistinguishable from a *ff*.

Aside from music, however, some dramatic sound effects, such as pistol shots, are reduced in effectiveness by normal limiter action. A pistol shot is a high-intensity but very short-duration sound. If the height of the pulse it creates is levelled off by a fast-acting limiter to the normal peak of most program material, the shot sound loses its effect, since the sound power created by a narrow pulse is small and it must have abnormally high peak amplitude to sound loud.

To cure this defect in usual limiters, Jarrett L. Hathaway and Raymond E. Lafferty have invented and assigned to RCA an improvement which acts as a limiter should except when a high-intensity, short-duration pulse hits it. Such pulses are allowed to go through. The patent is numbered 2,692,306, and the schematic diagram the patent gives (with a few additional notations) is shown in the *Fig* 1.

The audio signal goes first through a standard voltage-amplifier stage, which is shown as a box since it is conventional. From there it goes to a 6J5 V_1 connected as what the inventors call a phase inverter and this column vowed long ago to call a phase splitter. R_3 and R_4 are the equal-value plate and cathode resistors.

The two phase-opposed signals go next through blocking capacitors C_1 and C_2 to the control grids of two 6SA7's, the plates of which are connected to the ends of the output transformer in the standard push-pull arrangement. This is not a power stage; the transformer secondary normally drives a push-pull power-output stage.

The control grids of the 6SA7's are biased by a negative voltage source, C–, through grid leaks R_2 and R_1. The screens are supplied with positive voltage through potentiometer R_5, the arm of which can be adjusted for tube balancing. The cathodes and suppressor grids are grounded.

The 6SA7 is a pentagrid tube normally used as a converter or first detector in radio receivers but also often used as a gain-control stage in compressors and expanders. It is so convenient for this purpose because the third grid, which is used for level control, is effectively shielded by grids 2 and 4 from the control grid and from the plate. By ap-

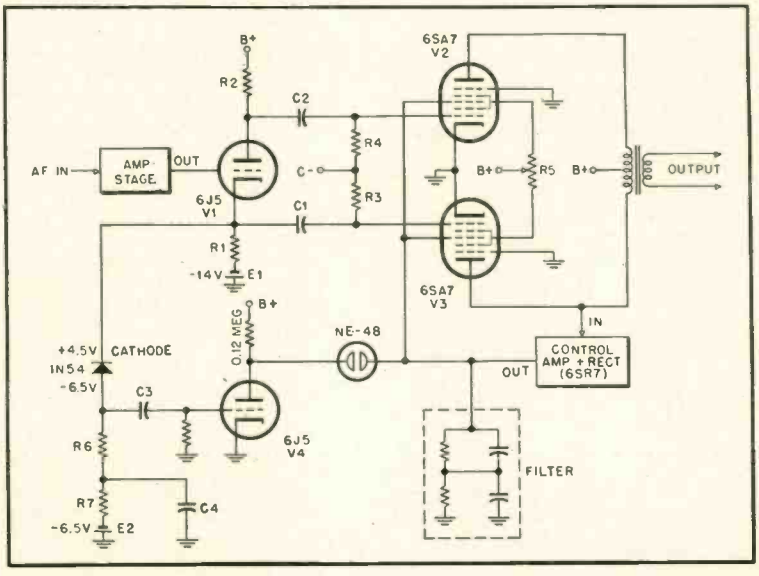


Fig. 1.

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

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plying a d.c. signal to grid 3, the electron flow from cathode to plate can be varied, resulting in a control over the gain of the stage.

The d.c. for this purpose is derived from a control amplifier and rectifier which is conventional and is shown in block form. This stage may use a 6SR7, which is a duo-diode-triode, the triode amplifying and the diodes rectifying the amplified signal. This control stage derives signal from the plate of V_3 or V_4 (V_3 in the drawing), so that the d.c. emerging from the stage is proportional to the r.m.s. level of the audio signal developed at the output of the push-pull V_3–V_4 stage. The control rectifier is wired so that the d.c. provided is negative. This is applied to the third grids of both 6SA7's. As a result, an increase of signal level out of the 6SA7's causes an increase in negative d.c. out of the 6SR7. Applied to the third 6SA7 grids, the d.c. causes a reduction in 6SA7 gain, reducing the output level. The control can never, of course, reduce 6SA7 output to zero, since then there would be no voltage to excite the 6SR7 control stage.

In practice this is a special kind of feedback loop which tends to keep the output of the amplifier from varying too greatly. If some sort of a delay is incorporated in the 6SR7 stage to prevent it from working until the output level exceeds a certain threshold, the circuit may be designed with a high control-stage gain for use as a limiter. If there is no delay and control-stage gain is moderate, it is simply a volume compressor.

The filter across the control-stage output tends to remove a.c. ripple from the rectified signal so that it does not act as simple audio feedback, as well as to give a short delay so that the gain of the amplifier is not cut instantly giving an unpleasant sound. In this invention the delay is very short, about 1 millisecond.

As described up to this point, the circuit may be that of a standard limiter, and it will, of course, limit the amplitude of such sounds as a pistol shot, with the loss in dramatic effect which we mentioned earlier. However, additional circuitry is provided.

Signal is obtained from the cathode of V_3 and fed through a crystal diode and capacitor C_8 to the grid of V_4. The diode is present to act as a delay. Its anode is biased 6.5 volts negative by voltage source E_2. Because of the combined action of the V_3 bias source E_1 and the tube cathode current, the cathode of V_3—and the cathode of the 1N54—is 4.5 volts positive. Thus there is normally no conduction through the diode. However, when an audio peak comes along which is 24 db or more above an established "threshold" value, the cathode of the 1N54 goes sufficiently negative to allow the peak to pass through it and develop a pulse across diode load resistor R_6. R_6 is bypassed to ground through C_4 and R_7 is a bias isolation resistor.

The pulse across R_6 is coupled through C_5 to the V_4 grid. Only rather narrow pulses can pass through C_5 since it has a small value and will not pass slower voltage changes; the grid of V_4 is therefore not responsive to large peaks unless they contain a high-frequency component as a pulse does.



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The negative grid pulse on V_4 produces a positive pulse at the plate. This is rather large, since the plate resistor has a high value and the plate voltage is normally low. The positive pulse is large enough to ignite the NE-48 neon lamp, transforming it from an open circuit to a rather low resistance, and passes to the No. 3 grids of the 6SA7's, right along with the large negative pulse from the 6SR7 stage which has also resulted from the high-amplitude sound. The positive and negative pulses tend to cancel. Therefore, the 6SA7 gain is not reduced, and the pistol shot or other high-amplitude pulsed sound goes through without reduction in level.

What the inventors have done, therefore, is to use a standard method of limiting, but to incorporate an auxiliary circuit to cancel the limiting action when a short, high pulse comes through. The additional circuitry required for this special purpose is minimal and would not be important in a broadcast limiting amplifier, but it appears to do the job. Of course there are occasions when other sounds of a pulse nature might come through unwanted, and a switch can easily be installed to cut off the auxiliary circuit at will, perhaps by simply removing plate voltage from V_4.

There isn't much more detail in the patent, but you may examine it yourself by sending 25 cents, along with the patent number, to The Commissioner of Patents, Washington 25, D.C.

COMING EVENTS

Jan. 20–21—Symposium on Printed Circuits, sponsored by R.E.T.M.A. Univ. of Penn. Auditorium, Philadelphia, Pa.

Feb. 10–12—Southwestern region of the I.R.E. seventh annual conference and electronics show, Baker Hotel, Dallas.

Feb. 10–13—Audio Fair—Los Angeles, Alexandria Hotel, Los Angeles, Calif.

Feb. 17–18—National Conference on Transistor circuits, Irvine Auditorium, Univ. of Pennsylvania, Philadelphia, Pa. Registration, W. J. Popowski, Minneapolis-Honeywell Regulator Co., 176 W. Loudon St., Philadelphia 20, Pa.

Mar. 21–24—Radio Engineering Show and I.R.E. National Convention, Kingsbridge Armory, N.Y.C.

May 26–27—Electronic Components Conference, Los Angeles, Calif.

May 16–19—Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

Sept. 30–Oct. 1–2—The 1955 High Fidelity Show, Palmer House, Chicago.

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NEW LITERATURE

• **Allied Radio Corporation,** 100 N. Western Ave., Chicago 80, Ill., recently announced publication of a completely revised edition of "A Dictionary of Electronic Terms" which contains more than 3500 terms used in television, radio and industrial electronics. Edited by Gordon R. Partridge, Ph.d., associate professor of electrical engineering, University of Purdue, the publication answers the need for an accurate, up-to-date reference source of words used in all branches of electronics. Definitions range from many words no longer in use, retained for historic reasons, to the new language of color television and the electronics of nuclear physics. Containing more than 150 illustrations and many diagrams, this book will be helpful to everyone interested in electronics. Requests for copy should specify stock number 37-K-756 and must include a remittance of twenty-five cents.

• **Sound Equipment Division,** Stromberg-Carlson Company, Rochester 21, N. Y., recently issued two publications of specific interest to users and distributors of audio equipment. One is a colorful pocket-size folder which illustrates and describes the complete line of the company's Custom 400 hi-fi components and cabinets. The other is a 6-page catalog-type folder featuring the division's full line of amplifiers, microphones, speakers, housings, re-entrant horns, drivers, and accessories for public-address use.

• **Harvey Radio Company, Inc.,** 103 W. 43rd St., New York 36, N. Y., devotes five pages of its new audio equipment catalog to an explanation of high fidelity which is intended to assist the reader in selecting components for his home hi-fi system. The catalog consists of 34 pages highly-illustrated and filled with descriptive material and price information on equipment of most leading manufacturers. Copy will be mailed free on request.

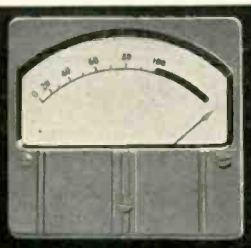
• **Amperex Electronic Corporation,** 230 Duffy Ave., Hicksville, N. Y., in a colorful 6-page folder, announces a special group of premium-quality tubes with a guaranteed minimum life of 10,000 hours. Designed for use in equipment where unsupervised, uninterrupted operation is essential, the new tubes have been field-tested in such applications as telephone equipment, coaxial cable telephony, beam transmitters, and radar.

• **Altec Lansing Corporation,** 161 Sixth Ave., New York 13, N. Y., provides detailed information on high-fidelity equipment it manufactures in a new catalog which will be mailed on request. The booklet covers AM-FM tuners, preamplifiers, amplifiers, speakers, enclosures, and various accessories. Also the catalog contains a great deal of information which will prove helpful in selecting the various components for a complete high-fidelity music system.

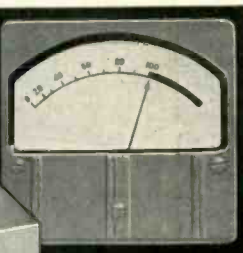
• **The Turner Company,** 929 17th St., N. E., Cedar Rapids, Iowa, covers microphones, pickup cartridges, microphone interiors, and microphone accessories in a new general catalog which is now ready for distribution. In a unique departure from usual catalog make-up, names and addresses of all Turner representatives are listed on the front cover. Illustrated and described are 40 microphone models of various types and impedances, with stock numbers assigned for ease of ordering. Requests for copy should specify Catalog No. 961-A.

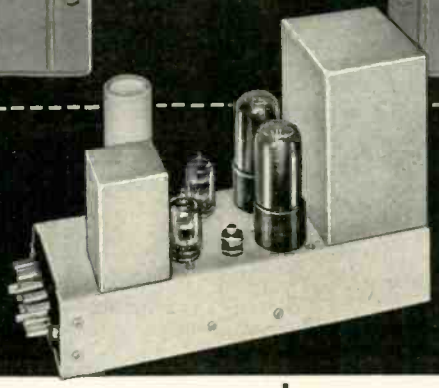
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LETTERS

Balancing Tubes

SIR:

I should like to call attention to a method of balancing the sections of dual triodes as reported by R. E. Aitchison (*Nature*, 174, 704. 1954). He claimed that 50 per cent of the dual triodes (12AU7, 12AX7, etc, with center-tapped heaters) could be balanced by a heater-voltage adjustment of 5 per cent. The method consists of changing cathode emission in the tubes by connecting a potentiometer of a few ohms resistance across the heaters and adjusting the slider to obtain balance. One leg of the supply voltage is connected to the slider and the other to the heater tap.

A similar expedient could be used to balance separate tubes in an output stage, for example.

FREDERICK KAVANAGH,
1826 N. Pennsylvania St.,
Indianapolis 2, Ind.

Improving (?) Loudspeaker Performance

SIR:

The notion put forward by Weems in the September, 1954 issue under the above title (less the "?") is as old as the history of dynamic speakers, and it doesn't work. At least, while it may reduce the bass resonance of the speaker, it introduces other forms of distortion that make the speaker so treated not in any way high-fidelity.

The completely flexible outer surround was a British idea; the first flexible surround on an American speaker was on the 1926 Rice-Kellogg, but it wasn't all that flexible. Among early British dynamics with cloth surrounds were the 1927 G.E.C. (which had wire spoke rear suspension!) a 1927 Baker, and the 1927 Hartley-Turner. At a later date other speakers appeared and many articles appeared in the British technical press of those days, for making dynamic speakers at home was a well-established hobby, it being generally considered that the professional designers didn't know how to do it. The flexible cloth surround was "It," but the home designers didn't know how to test the "It" speaker. There is a fatal snag in unlimbering the cone in a conventional magnet design.

If the cone is free to move, the voice coil will pass into a weaker magnetic field on the first half-cycle of a sinusoidal signal; it will not return to the norm on the second half-cycle because it is in a weaker field. What happens is called electro-mechanical rectification. If the rear suspension is stiff enough to pull the coil back into the gap, the application of a two-component signal will cause modulation of the higher frequency by the lower—simple intermodulation distortion. If, now, the suspension is stiff enough to haul the coil back to the norm, but free enough to give a low bass resonance, application of a sinusoidal signal will still cause electro-mechanical rectification because the magnetic field in the usual design of magnet is much more intense behind the front magnet plate than before it. The total result of loosening the suspension is, therefore, to introduce two forms of distortion—electro-mechanical rectification, which desensitises the speaker on every loud signal, and intermodulation distortion whenever a low-frequency signal accompanies a high-frequency signal.

This can be proved by actual test and demonstration, but it is a simple matter to check up at home. Subject a speaker, treated in the way described by Weems (and others) to a nice big output from an organ record which gives highs while it is also giving well-recorded pedal organ, and the result is audibly distressing—best described as "burbling." The only way of avoiding this is to design the magnet so that some loss of sensitivity must be put up with, since only so much flux can be gotten out of a limited diameter of center pole.

H. A. HARTLEY,
62, Latymer Court,
London W.6, England.

Literary Trash!

Sir:

Clownish articles such as "Hi-Fi-Manship at the Fair" by Charles Sinclair are literary trash, should occupy no space in AUDIO, and are not worth reading.

William Paul Thompson,
Audio Technician,
Union Theological Seminary,
New York 27, N. Y.

(*Opinion or fact?* ED.)

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ABOUT MUSIC

HAROLD LAWRENCE*

Living with Bach

LIKE SHAKESPEARE and Einstein, Johann Sebastian Bach is universally recognized as a "great." Then he is put on a shelf—or, rather, a pedestal—and promptly forgotten for all practical purposes. In the mind of the layman, Bach is conjured up in an unfortunate set of impressions: here was an austere and unapproachable master who wrote ponderous fugues, involved counterpoint, and pietic cantatas. With few exceptions, the name commands respect but not reverence. In a sullen hush, the average music lover will sit through performances of a keyboard suite, cello sonata, or some other less familiar composition. When asked during intermission what he thought of this or that piece, he may lack the courage to admit that he found it a crashing bore. Although a number of soloists and groups make Bach come alive in interpretations that reveal a love and comprehension of the composer and his period, too many performers (and, as a result, the bulk of the listening public) are still in the Romantic age in their attitude toward the Eisenach master.

The inventory of Bachian misinterpretations, ranging from pecadillos to lollapaluzas, is almost long enough to fill the pages of The Red Book. Here are a few examples. The British tradition of choral singing is a fine thing except when it gets out of hand numerically, in which case it can transform a work like the *Saint Matthew Passion* into something more suitable for a sports arena than for a church or concert hall. Pitted against a vocal army, the instrumental forces are virtually drowned out except in solo movements. In the opening of the *B Minor Mass,* the flutes and oboes carrying the flowing contrapuntal line would, similarly, be reduced to an ineffectual murmur. And, to compound the felony, a nineteenth-century organ will muddy up the continuo part; the concertmaster (probably of the Auer school) will make of the violin part in the *Gloria* a miniature Wieniawski concerto, tremolo and capricious phrasing included; and last but not least, let's not forget the "massacre of the ornaments"—that abysmal ignorance of the expressive meaning of Baroque embellishments such as the turn, trill, mordent, etc.

Then there's the pianist to whom nothing counts but the "theme." This he will bang out for all it's worth in such works as the Liszt transcription of the *Organ Prelude* and *Fugue in A Minor*. Many other musical events may be taking place throughout: counter themes, fascinating modulations, dynamic ebb and flow. But all these are just flotsam and jetsam when the "subject" comes along. The effect is as subtle as inserting a trumpet part (without mute) into the third movement of the Debussy String Quartet. An audible "twist of the dial" and the volume drops; the stage is set, and we're in for yet another repetition of the theme.

Prominent among the Bach killers are the "hyphenaters"—those composers and conductors who want to help the cause along by popularizing certain keyboard works and chorale preludes. To them, the Baroque organ is a "bubble-and-squeak type of instrument"; the harpsichord sounds like the "ticking of a sewing machine"; and the trio sonata is a form of eighteenth-century potted palm music. Calling upon a battery of percussion instruments, enough brass to scare up a rousing performance of John Philip Sousa's *Semper Fidelis,* and a full complement of strings that would have satisfied the orchestral palette of Gustav Mahler, the transcribing maestro brings his audience a version of a *Fantasia and Fugue* that should send Bach spinning in his grave.

On the other extreme is the devoted Baroque performer with a built-in metronome and a flair for turning the most inspired composition into the dullest finger etude straight out of Czerny. He is generally far more scrupulous than the hyphenater about obeying the composer's instructions (whenever they are plainly indicated) and he will take pains in tracking down the Urtext, or original manuscript. But the result is a dryasdust rendition that thoroughly alienates the music lover who has not yet gotten into early eighteenth-century music.

Even when Bach's cantatas are performed with a healthy respect for proper balance, size of choral and instrumental forces, we have to contend with the "glee club" flavor which is so deeply ingrained in American culture. The precision and discipline that are its main characteristics are fine, but one is too conscious of the football field, college reunion, and campus songfest.

Confronted with these musical crimes in the name of Bach, it is no small wonder that the discophile often loses interest in all but a handful of Bach's works—and these usually in "free" arrangements. All of which makes his initial plunge into the vast ocean that is Bach's list of works more and more a dubious venture. Where to start? Tackling the Schwann catalogue's Bach section in alphabetical order is defi-

(*Continued on page 67*)

* *26 West 9th St., New York 11, N.Y.*

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We have heard from some of you that certain records do not always drop on the "Magic Wand" spindle furnished with the first units we delivered. The difficulty was caused, in the main, by imperfectly centered record labels projecting over the center hole and interfering with the precision action of the "Magic Wand".

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Milton D. Thalberg

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EDITOR'S REPORT

DEFINITION OF "HIGH FIDELITY"—II

WE ARE INDEBTED to Charles V. Kettering—a former New Yorker who has deserted the metropolis for a life as manufacturers' representative in the Rocky Mountain area—specifically in Aspen, Colorado—for a little envelop stuffer to, in his words, "try to offset the misconceptions and downright ignorance on the subject, and restore some of the lost confidence of the buying public in purveyors of hi-fi merchandise—the real thing." His leaflet says:

"What is this thing called High Fidelity (hi-fi for short) of which we hear so much? What does it mean in simple language?

"Take one word at a time—

"'High'—define it as 'a high degree of.'

"'Fidelity'—use one word, 'faithfulness.'

"But 'faithfulness' to what? There is only one answer —'faithfulness to the original sound.'

"So the phrase 'High Fidelity' becomes *'a high degree of faithfulness to the original sound.'* Simple, isn't it? It can be made even simpler by using only one word, 'Naturalness.'

"The term 'High Fidelity' is applied, of course, to reproduced sound such as from a phonograph record, tape recording, radio, TV, or a public address system.

"Make your own test—it's easy.

"Does the symphony orchestra, dance band, chorus, single instrument, or voice coming from a recording, radio, or TV sound 'natural,' much as it does when you hear it 'live' in the concert hall or studio? Can you pick out the various instruments of the orchestra or band as you hear them playing together in the record and trace any given instrument (violin, flute, oboe, clarinet, trumpet, string bass, brass bass, etc.) throughout the composition, by its distinctive quality? If you can do that, your reproducing system must be a pretty good one.

"If on the other hand you hear only a 'mass' of high sounds, some more in the middle range without definite character, and a lot of low 'boom boom' in the bass range, and if, as is usually the case, the tone control is turned down to make the music sound more pleasant, the reproducing set or system can stand considerable improvement.

"There are many degrees or levels of performance in seeking perfection. *Absolute* perfection has never been attained and likely never will be. However, fairly close approaches have been made in laboratories at tremendous cost in effort and equipment. Fortunately for the average person, this research and development of various components has resulted in quantity manufacture at modest prices. By choosing wisely, with the help of an expert, very fine sound reproducing systems can now be assembled from the best products of the various manufacturers for only a few hundred dollars. One of the many important reasons for the assembling of fine 'components' into a sound reproducing 'system,' aside from the finer quality, is the ease with which improved components (preamplifier-equalizer, power amplifier, turntable, pickup, speaker) can be substituted as they become available, and thus keep up to date at a minimum cost. This is next to impossible with manufactured 'sets' commonly available, bearing a hi-fi label.

"The manufacture of fine quality high-fidelity equipment has become highly specialized in a very short time. Some specialize in the design and building of receivers for radio and TV; others in preamplifier-equalizers and power amplifiers; others in turntables, tape recorders, loudspeakers, pickup arms and cartridges, as dictated by the technical background and experience of the particular manufacturer.

"From the products of these manufacturers, the buyer is offered the finest selection of components in a fairly wide price range. Many individuals buy and assemble their own home systems to suit their particular needs or preferences—usually with more or less advice and assistance from technically trained radio and service men.

"A sound reproducing system can be only as good as the weakest unit or 'link' in the chain of components. For example, if the *pickup* does not correctly trace the minute undulations of the record groove, the result is distorted *un*natural sound; and the other units of the system, no matter how fine, are powerless to improve what the pickup feeds to them and make it sound 'natural.' Likewise, a poor preamplifier-equalizer, power amplifier, turntable, or speaker will limit the finest pickup in the world and reduce its output to the quality level of the weakest unit.

"Pickups and loudspeakers, the *beginning* and the *end* of the reproducing cycle (for records) are most often at fault, even in very expensive systems, and great care must be used in selecting them. The other components present special problems, and each could be discussed at length. The purpose here is to point the way to better evaluation of the claims for 'hi-fi'—namely, to *judge by the sound* that comes from any given reproducing system (or combination of components) the degree to which it 'faithfully reproduces the original sound.' And—it is important to listen as often as possible to 'live' music in order to provide a *correct basis for judging. . . .*"

Thank you, Mr. Kettering. Please join our growing circle of AUDIO Lifers, with our compliments.

AUDIO FAIR MANAGER LEAVES AUDIO

Harry N. Reizes, manager of The Audio Fair and formerly advertising manager for AUDIO, has resigned from AUDIO in order to devote more of his time to the years' biggest audio show. He is also associated with the Audio Fair—Los Angeles, and last year served as consultant to the first New England High-Fidelity Music Show. Mr. Reizes has been advertising manager since the first issue of AUDIO ENGINEERING 'way back in 1947.

Management of as large an enterprise as The Audio Fair is an arduous task, and really demands full-time attention. Our best wishes go with Harry—and we'll expect still bigger and better Fairs in the future.

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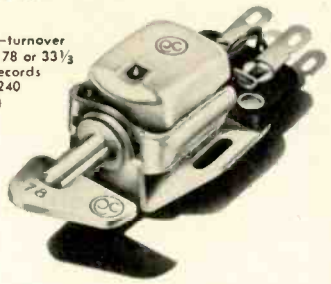
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MODEL 260—turnover cartridge for 78 or 33⅓ and 45 rpm records (the 220 and 240 back-to-back)

The 220 and 240 are engineered to maximize performance. By comparison they are without equal . . .

The **220** *and* **240** *are*

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Smaller—⅝ by ¾ by ⅜ inches

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Highest Output—30 millivolts/10cm/sec.

More Compliance with Less Tracking Force

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Less Moving Mass

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These characteristics have real meaning to those who understand that maximum performance depends upon components which meet professional standards. If you want the best that high fidelity can offer, ask your dealer to demonstrate the 220, 240 and 260 Pickering cartridges . . .

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Radio Relay station on route between Chicago, Ill., and Des Moines, Iowa. Every fifth or sixth relaying tower is a control station, where high-speed switching equipment enables a TV picture to skip out of a troubled channel and into a stand-by protection channel faster than the eye can wink.

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This is an important addition to the automatic alarm and maintenance system that guards Bell's Long Distance network for television and telephone calls. It marks a new advance in Bell Laboratories' microwave art, developed to make your Long Distance telephone service, and your TV pictures, better each year.

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Three-Channel Preamplifier-Mixer

HAROLD REED*

When the equipment required to do a certain job does not exist, or where the requirements are sufficiently unusual that no standard manufactured equipment could be purchased as a ready-made item, there is only one solution—design and build it yourself. The versatility of this small unit makes it adaptable for testing, experimenting, recording, and many other applications.

THERE ARE OCCASIONS when it is desirable in sound reproducing systems, not only to employ several microphones of similar type, but to use several microphones of different types simultaneously. For example, carbon-button-type microphones may be wanted for certain applications while other requirements may call for the use of crystal microphones. Still other sound reproducing activities may dictate the use of low-impedance moving coil microphones.

The three-channel preamplifier-mixer described in this article provides for the use of three of any one of these different types, or any combination of the three, thus satisfying most any need in pick-up requirements.

This equipment consists of a three-line, three-channel mixer-preamplifier with 500-ohm output suitable for feeding a low-impedance line or low-impedance tape recorder input. The 500-ohm line output may also be terminated with a 500-ohm resistor and bridged with a high-impedance input monitor amplifier and loudspeaker. Also, the terminated 500-ohm output may be used to feed the high-impedance bridging input of a recorder. Of course, if the line is already terminated by equipment of 500-ohm input, the 500-ohm terminating resistor is not required when bridging with a high-impedance.

A description of the circuit configuration follows, referring to the schematic in *Fig.* 1.

There are three line inputs wired to the dual selector switches Sw_1, Sw_2 and Sw_3. When a selector switch of any particular channel is set to position 1, the line input of that switch goes directly to the grid of the first stage of the preamplifier through the two sections of the switch. The line input is, therefore, suitable for use with high-impedance microphones, such as the crystal type. In position 2 of a selector switch of any channel, the line is terminated in the low-impedance input winding of the A-11 input transformer, with the high-impedance secondary winding going to the grid of the first stage through the second half of the selector switch. This is the setting for use with low-impedance microphones. Number 3 position of any input selector switch is for use with carbon microphones. For

(*Continued on page 66*)

* *3917 Madison St., Hyattsville, Md.*

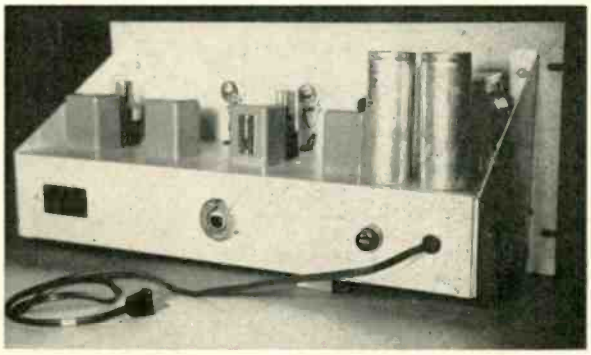


Fig. 2. Rear view of the preamplifier-mixer chassis.

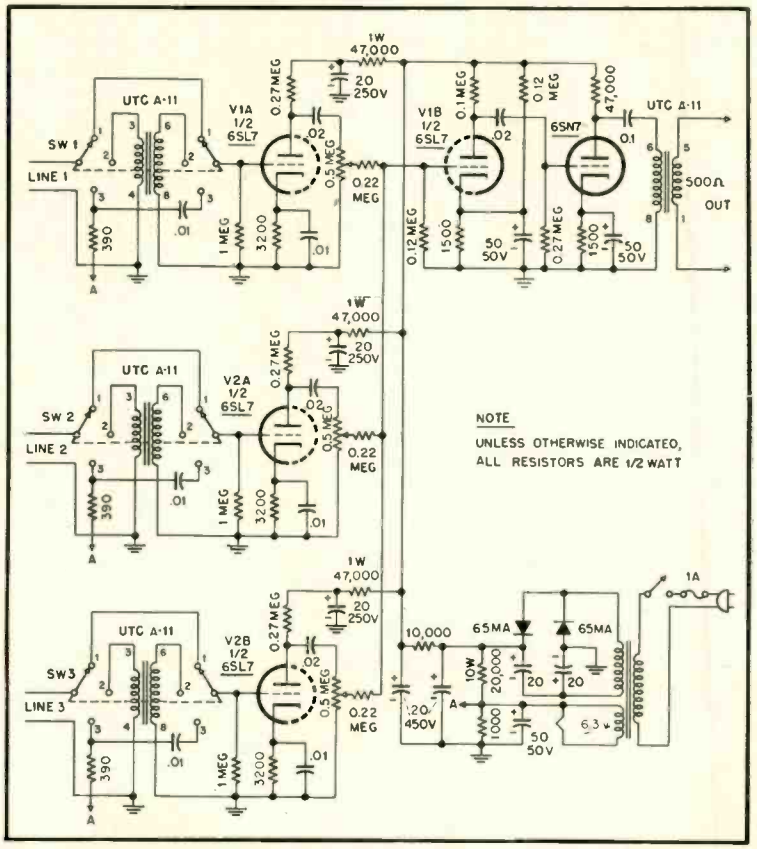


Fig. 1. Schematic of the three-channel preamplifier-mixer. Unique feature of this device is its adaptability to practically any common type of microphone.

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The MIT Audio Network

DAVID L. KLEPPER*

Wired-audio system permits everyone to enjoy a wider variety of records than each could possibly have in his own collection—and provides operating experience.

IT HAS OFTEN BEEN NOTED by visitors that MIT is, for a school that is not a conservatory, a most musical place. The concert band, choral society, glee club, and symphony orchestra are very active, and their concerts are well attended. Couple this interest with one for the technical aspects of sound reproduction and you have a very high enthusiasm for high fidelity, an enthusiasm that has led to the development of the audio line network.

It was four years ago that two undergraduates, Dave Kessle and Philip Benkard, decided to share their record collections by running wires between their rooms. Soon other students in their dormitory wanted to be able to listen to the music played in either room; and wires mixed with the ivy throughout the East Campus Dormitories. The lines were operated on a single wire, ground return basis, and all sending and receiving amplifiers had to be securely grounded to the plumbing system to avoid hum. The line was usually connected to the speaker output of the sender's amplifier, although some people went to the trouble of building line amplifiers, and sent into a high-impedance, high-level input of the listener's amplifier. A number of a.c.-d.c. radios were also converted to allow them to receive the audio line signal.

As the number of listeners grew so did the service given them. After the two originators of the line left, with their large record collections, the programming of Boston's FM stations was regularly scheduled on the line—WXHR, Boston's all-classical-music station, for almost all their air time; WGBH, the Lowell Institute educational station for all broadcasts of the Boston Symphony and certain chamber-music concerts; the Metropolitan Opera (when it was available on FM) and the New York Philharmonic on weekends. WBUR, the Boston University station, provided some classical music programming during afternoons. East Campus became blanketed with the main audio line, know as the Runkle line from the dormitory of its two originators, as well as other audio lines connecting people not always happy with the Runkle-line programming. One of these, the "Pops line" earned quite a few listeners, and one East Campus dormitory now boasts a 12-wire cable, each wire having a different signal. The low-impedance output of the sending audio amplifiers keeps down crosstalk.



The elaborate system owned by Robert Schwartz, '57, of Burton House, includes a Fisher FM tuner, Master Audio Control, and 50-watt amplifier, and a Heathkit preamp and a 6-watt Williamson amplifier— the latter being used only for cueing. Bob's interest is mainly in popular music, but when he feeds the lines, the quality is professional.

The technical knowledge necessary to operate an audio line connecting rooms located nearby each other with a single wire is not very great. It has already been mentioned that a good ground for all equipment is essential; also necessary are switching systems to allow an individual to either listen to or feed a signal on the line, with precautions against feedback; L-pads to control the speaker volume, allowing the sender to keep the line volume constant; and reasonably high-quality equipment. The amplifier of the sender can be a normal feedback audio amplifier. The effective (not the nominal 4-, 8-, or 16-ohm) output impedance should be low enough to prevent signal distortion because of changes in the speaker impedance, a condition met by all quality home amplifiers today. To prevent shorts and transient switching noises from appearing on the line a high (10,000- to 100,000-ohm) resistor should be in series with the line to each listener's input; to protect the sender's equipment the line from his output should be fused (a ⅛-amp fuse will do the job). A typical single-wire audio line can be seen in *Fig.* 1.

Although the low-impedance output of the audio amplifiers used kept down hum for a considerable distance along the Runkle line, in crossing the street from the Runkle unit to the other East Campus dormitories a considerable quantity of power-line buzz and r.f. was picked up, affecting the transmission fidelity. Placing the main Runkle line in a conduit under the street helped this

* *Box 523B, MIT Graduate House, Cambridge 39, Mass.*

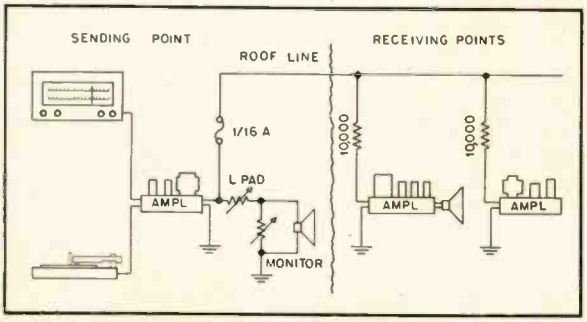


Fig. 1. A single-line transmission system using ground as the return.

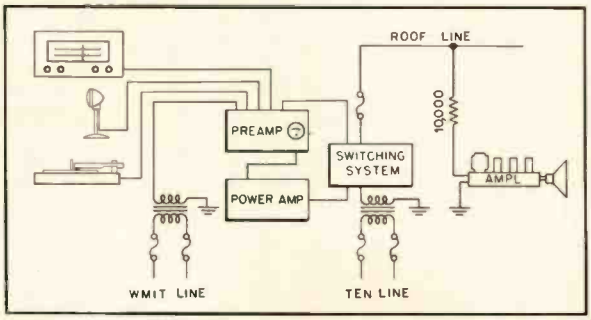


Fig. 3. Block diagram shows installation in one living unit.

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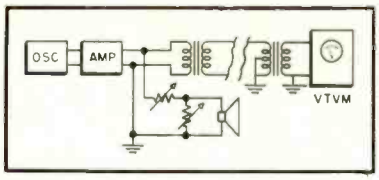


Fig. 2. This circuit, with a balanced transmission line, was used between East Campus and Graduate House for frequency-response testing.

problem considerably, but even then it was recognized that eventually balanced two-wire-line operation would provide the solution for distant transmission of music, and the underground line was laid as a pair.[1]

Extending The System

Other living groups around campus began operating their own much smaller audio systems, and the question of tying them all together often arose, but the first attempt to extend the audio lines outside of East Campus came last summer, when another student and the writer moved across the Charles River to Boston. Several listeners on the Runkle line had thought of the possibility of renting a telephone pair to our apartment, an idea we welcomed. MIT's student engineering magazine, *Tech-Engineering News,* now became interested in the project; it had for some time used a high-fidelity system in its East Campus office, and the staff members had always appreciated the music coming to them over the magazine's connection with the Runkle line.

Now they rented the Bell System pair and collected each person's share from us and the East Campus residents on the audio line. Two 1:1 line-matching transformers were built for this line by Mystic Transformers, Winchester, Mass.; these not only had to have a flat frequency response with negligible distortion at normal peak signal levels, but also had to be unaffected by shorts and handling by inexperienced personnel. The line was operated somewhat differently from a normal program line, a point to be discussed later.

The fall brought efforts toward an expansion of the audio system throughout the MIT campus. The Institute was installing additional phone service using 29-pair cables; student labor removed installation expenses, and the magazine received the use of one pair linking the East Campus dormitories with the Graduate House. Further expansion West to Burton and Baker houses, the newer undergraduate living units, has taken place through the use of a rented Bell System pair; this is to be replaced with Institute-owned cable in the near future. The interest of a number of fraternities has been aroused, and several are considering renting pairs to the magazine office at East Campus. All these lines are operated as balanced lines and are terminated with transformers.

The first question often asked us by electrical engineers who learn of the operation of the audio line is "but what about the impedance?" By this they imply that something must be radically wrong if the impedances are not matched; the source and load impedances should be matched to the characteristic impedance of the line. This is sometimes false. Efficiency considerations are entirely unimportant to us because a sending amplifier that is feeding ½ watt average power into its 4-, 8-, or 16-ohm speaker and L-pad load is already available. Bell System lines usually require the signal not to exceed +4 db or 2.5 milliwatts into a 600-ohm line, a voltage level approximately equal to that from a normal home amplifier feeding a conventional speaker during an average passage—about 1.23 volts r.m.s.

It is, therefore, perfectly simple to feed a balanced line bridge across the output of such an amplifier through a 1:1 transformer; the power fed to the line will be negligible as far as the conventional hi-fi amplifier is concerned. Loading the line at the receiving end with its characteristic impedance may or may not improve the line's frequency response, depending on the length of line involved. The line across the river was loaded with 600 ohms at whichever end was receiving; no accurate measurements were made, but the line sounded best operated this way. The present MIT pair between East Campus and the Graduate House sounds best with the receiving end unloaded. The method of testing is shown in *Fig.* 2 and the response in *Fig.* 3. It is obviously easy to equalize this characteristic, even with conventional tone controls.

Programming on the audio network has been improved by lines from the Charles Hayden Memorial Library where music is played in the main room from 9 a.m. to 9 p.m., and taps from WMIT's transmitter lines in each of the four living units. (WMIT is our AM student-operated radio station with transmitters in each living unit.) It is after 1 a.m., when classical music from FM and WMIT has ceased, that the ties between the different living units really prove their value; one student studying late will share his collection with any of the other approximately 400 owners of amplifiers tied to the audio line—24-hour service is not unusual.

The informal, comprehensive service offered by the audio lines has resulted in numerous purchases of amplifiers and amplifier kits and speakers by students unable to afford a complete high-fidelity installation. The freshman can enjoy the music coming from his 6-watt Heathkit and inexpensive speaker now, and plan on purchasing or building a record player and tuner in the future. His musical horizons will be broadened because he has the opportunity to listen to almost every composer included in the LP catalogue. Perhaps our example may suggest similar systems for other groups of music lovers living in close proximity.

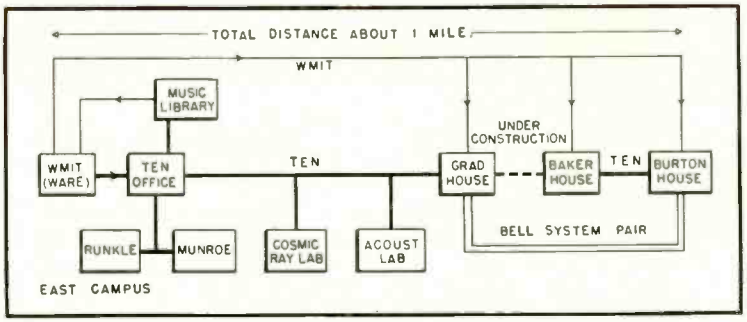


Fig. 4. The complete MIT network using balanced transmission lines.



Author's rack contains a Browning RV-108 tuner, modified McIntosh C-104 preamp, Williamson amplifier, Sessions timer, VU meter, patch panel, and controls for noise suppressor. Line jacks are closed circuit, with contacts normalled to feed regular "network."

[1] A balanced line consists of two wires terminated with a transformer at each end. The only voltage appearing across the transformer at the receiving end is the signal voltage; the line is isolated from differences in ground potential. Because the only connections to ground are from a centertap on the line side of either or both transformers, the signals on each wire are opposite in phase, but equal in magnitude; therefore, the line is known as a "balanced" line.

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Success Found in "Sound" Principles

BERT ENNIS*

Proving that sound business practices work in the sound business as well as elsewhere, Nate Reiss has achieved a sucess measured not only in terms of financial reward but more importantly in the satisfaction of a well done job.

28 YEARS AGO, a young man in the American municipality famed as the automotive capital of the world awoke to a momentous, long pondered decision. It was a decision that had been made many times before by millions of young men like him—eager, enthusiastic, energetic young Americans seeking a particular place of their own in the sun. He decided to go into business for himself. Long on ambition, short on capital, a native Detroiter, oddly enough the thriving automotive industry was not the object of his business aspirations. He chose instead a business, young and undeveloped as it was, for which he had demonstrated a natural affinity and talent, a business which he was convinced possessed tremendous potentialities and untapped avenues of exploitation. With a certain amount of experience in this particular field as his principal asset, he elected to enter that area of commercial sound then more or less loosely described as "public address." 28 years ago not too many had the vision to apprehend the tremendously vital and profitable role the use of public address equipment was to play in practically every known facet of industry, commerce, and entertainment.

Copy-book mottoes today are as trite and as true as they were when the "work-and-win" axioms appearing in McGuffey's First Reader stirred the initiative and fired the ambitions of those whose learning flowed from the pioneering scholastic trail blazed by the zealous circuit-rider-preacher-turned-school-master. We don't know whether our particular young man ever heard of McGuffey. But we do know that before he embarked upon the most important step in his life he laid down certain rules of conduct for himself, based on fundamentals as sound and as true as any of those which enriched the pages of McGuffey's Reader. Necessary as they are to the lasting success of most undertakings, the rules with which he charted his course are sometimes more honored in the breach than in the observance.

Before he sought his first contract, this young Detroiter mentally framed the following resolutions: He would handle only the finest equipment available from the standpoint of quality; he would accord every job, large or small, his most diligent efforts; he would seek out and perform successfully "headache" assignments others had failed to achieve, assignments competitors in his field had turned down as too tough to handle; he would keep faith with himself and his customers.

* *Altec Lansing Corp., 161 Sixth Ave., New York 13, N.Y.*



Nathan Reiss, founder and head of Reiss Public Address Systems, Detroit.

Who was this young man who 28 years ago set these precepts of character and conduct for himself as he embarked upon his own business enterprise? He answers now, as then, to the name of Nathan D. Reiss, one of the outstanding figures in the field of commercial sound not only in his native city of Detroit, but wherever communications are used in industry and commerce, sport and entertainment throughout the United States. The story of "Nate" Reiss is truly a copy-book epic, the story of a success founded on sound principles of integrity, ability, and character. It is the story that in the opinion of many will sooner or later merit consideration of a special award by one of the groups which annually single out an individual for his remarkable achievements in his own particular field of endeavor.

The First Job

It was back in 1926 that Nate Reiss undertook his first job, a job to which he applied his cardinal rule of using only the finest sound equipment available. In the opinion of Reiss, Altec Lansing public-address components meet the quality standards he established. Thus, since 1946 he has employed that company's equipment on many projects large and small; only recently he completed his 712th installation. During these 28 years of service and success, Reiss Public Address Systems has supplied the equipment and technical installation services which have marked many of the largest and most complex communications systems in auditoriums, stadiums, arenas, factories, places of worship, schools, and colleges all over the United States.

Throughout these 28 exciting and achievement-filled years Reiss has handled the products of but two outstanding manufacturers. His 712th installation, with Altec Lansing equipment, performed at a contract price of $12,500 was in behalf of General Motors Prevue of Progress.

But what about the very first job that came the way of the young, ambitious Detroit installation engineer? It was an order for an installation in a church. The year was 1926. The place was Detroit, and the church was St. Paul's Cathedral. The equipment involved was the old Western Electric 373W double-button carbon microphone, 549 "loud-speaking telephone" receivers on 6-A trumpet horns, and a 13C amplifier which drew its filament supply from a 12-volt battery, its plate supply from eight 485 EverReady batteries. The check called for the payment of $1,325. The intervening years brought payment for jobs in many structures throughout the country. The 700th installation he made was also in a church, this time St. Boniface, also in Detroit, a public address system which included 633A microphones, 1510 and 1520A combination amplifier, H803 multicell horn and 290B unit. The price? $1,384, almost identical with the revenue from his first job.

The young man who set forth 28

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years ago to prove that nothing succeeds like success still possesses the same unlimited enthusiasm, energy and vision which were his principal assets then. These, and little more, were the mainstays that saw Reiss through his first job. His place of business was a modest store at an inconspicuous location in Detroit. His staff? He smiles when you ask him about that. With the aid of a few engineers at odd intervals, from radio station WJR, in Detroit, he handled his first assignment himself. Grown to full stature now in a highly competitive field, his establishment today, while well-ordered, highly organized, and adequate to handle the impressive contracts which regularly come his way, is neither ornate nor imposing in size.

His engineering staff is noted in sound circles more for ability than size, selected by the Reiss yardstick of experience, initiative, and integrity. Thus, the surface manifestations of his success lie, not in an impressive business facade, overdone decor, and a huge staff. He is content to let success express itself in results, in the belief that results speak a language understood by all who seek performance and quality.

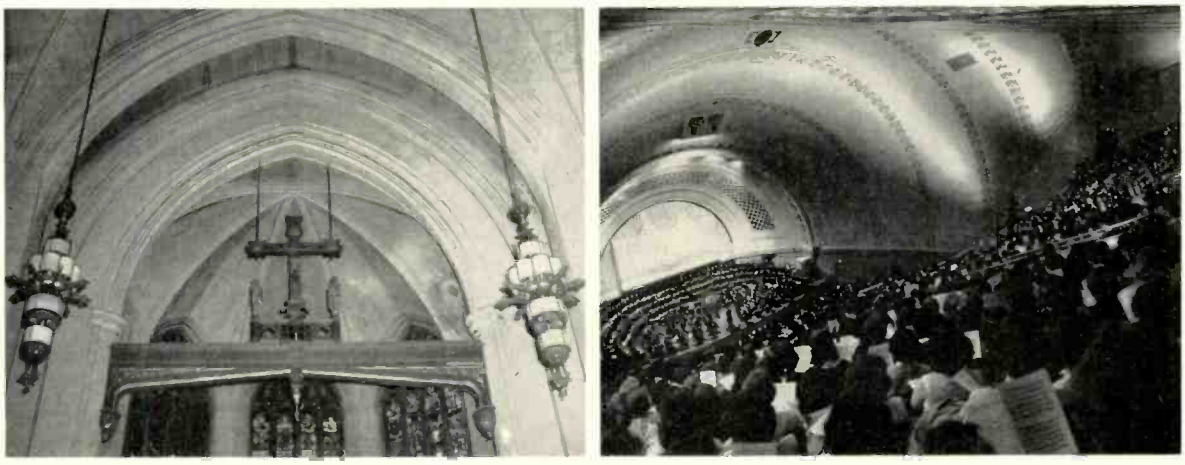
Sound Serves at Hydramatic Fire

These years have naturally embraced a great variety of tasks, some of which have taxed his ingenuity, experience, and determination to the utmost. But each one has been a challenge to the man who deliberately set himself years ago to the accomplishment of assignments when others had faltered and failed. His recounting of the gigantic task which fell to him and his organization late last year when the hydramatic manufacturing plant of General Motors was destroyed by fire is typical of his "lets-get-it-done" attitude. Before the embers had cooled, he was called upon to install, with the least possible delay, a super dispatching system at GM's emergency headquarters set up at Livonia, Michigan. Time was important—he and his crew worked four times around the clock. Herein lies a measure of the man, a perfect exposition of the principles in which his business was founded. Following 96 sleepless hours, the dispatching system was completed, and in operation. During this period there had been installed a single 632A microphone at a central control board, which, through two 1410A and fifteen 1430A amplifiers, drove twenty-six 730A units on re-entrant horns, and five 730A drivers on 31A horns, thus delivering blanket sound over an area of many acres. An assist was given in this monumental task by Altec Lansing, who rushed much of the vitally needed equipment to Livonia by air express from the company's plants in California. Despite an instinctive reticence, Reiss recently was induced to talk about this round-the-clock installation. He said: "On the Saturday morning after the fire we were asked to install a rush PA system in the garage proper, which would be used as an operating point for all personnel involved in the salvage operation. It was vitally necessary that this phase of Cadillac manufacture be restored to operation as quickly as possible. The principal purpose of our work was to enable the numerous salvage crews working over this great area to direct efficiently the movement of the various vehicles used for pickup and delivery. There were two telephones on a desk at the main entrance to the garage that was to be used for the "focal point." All transmission of orders and requirements of personnel would be called to or directed from that point. The following day, Sunday, we were called upon to install additional speakers and amplifiers on the roof of the main building, to cover the truck entrance and the areas where a great amount of traffic was involved. Thus those in charge of salvage operations could page vehicle drivers and personnel and facilitate their movements to necessary locations. By means of this system a fleet of almost 200 trucks, bull-dozers, tractors, cranes, fire fighting equipment and first-aid mobile units was kept constantly moving over the huge area, thereby hastening in no small degree the time necessary in salvaging operations. On Monday, the third day, we were asked to install additional speakers along the portion of the roof remaining intact on the west side of the plant, to cover additional traffic in that area. So it went, meeting requests for additional speakers and amplifiers as the scope of the salvage operations grew. Operations at the central "focal point" I spoke of were conducted like those of a railroad dispatcher. Two score boards were erected on which were indicated in precise detail the movement in and out of men, trucks, and machines, enabling an accurate check to be kept on progress being made, and showing what tasks of salvage still had to be performed. Eventually we were compelled to lease telephone lines and install telephones, coils, and bridging amplifiers at remote locations to cover the vast area devastated by the fire."

Thus, in matter-of-fact language, Reiss describes what proved to be a remarkable job of "disaster" installation equipment for the nation's greatest manufacturer of automobiles. The equipment which he installed served General Motors so well during the emergency that it was kept in operation for a period of six weeks, when the tremendous job of salvage had been completed.

From Cadillac to Soap Box Derby

In contrast to the overtones of disaster which marked his efforts at Livonia, Reiss can look back on certain engineering accomplishments concerned with happier occasions. One of these is the famed Soap Box Derby, the annual event held at Derby Downs, Akron, and which attracts an audience from all over the country estimated at 65,000 excited humans. For several years now he has been called upon to provide the equipment and installation which carries, via sound waves, the announcements, shouts and general happy commotion which marks the careening vehicles piloted by young



Almost obscure on the main beam across the arch of the Blessed Sacrament Church, Detroit, (left), is an Altec multicell speaker. A total of 13 amplifiers are used in this installation. An equally unique placement of speakers serves Hill Auditorium of the University of Michigan, (right).

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Soap Box Derby entrants. Also in this same exciting realm there falls to him and his organization the job of seeing to it that the sounds which mark the course of the annual Detroit River Boat Races are heard by the spectators who witness this event.

It was said at the beginning that Nate Reiss thrives on accomplishing the impossible in the field of communications, on solving those problems which arise from climatic vagaries, acoustical difficulties, architectural hazards. Thus, the problems posed in providing efficient equipment and operation for the Detroit Boat Race are welcomed by him. With all the aplomb that would normally accompany the stringing of a hundred feet of cable, this specialist in "difficult" jobs installed a staggering total of 26 miles of wire along the Detroit River bank, together with the exact type of equipment necessary to broadcast this exciting event properly.

The paths of Reiss and General Motors have crossed more than once—and will continue to cross again, if all outward indications serve—to their mutual satisfaction. In past years, Reiss has been called upon to handle the intricate engineering detail involved in the General Motors broadcast "Conference," in which a speech of about ten minutes duration has been carried to thousands of the company's executives and employees throughout the United States. As the prime contractor for this gigantic communications task, Reiss and his organization handled the establishment and installation of the equipment necessary to carry the GM message, via telephone lines, to 80 cities in the United States.

The variety of endeavors which have marked these exciting, challenging years have been truly remarkable. Over the 712 Altec installations he has made have come the voices of famed sports announcers and the roar of the crowd in arena and stadium, the word of God by priest, rabbi, and minister from numerous church pulpits, the call for workers in times of disaster, the speeches of industry tycoons, the history-making statements of governmental representatives in connection with the harnessing of the atom for industry and peace-time use.

One of the high-water marks in his eventful and successful career was his efforts in connection with the gigantic "Phoenix Project," wherein the United States government released information concerning certain atomic developments for industrial use. In this instance, and under the auspices of the University of Michigan, Reiss handled the sound pickup from a central point in Ann Arbor for transmission by telephone line to hotel auditoriums and meeting rooms in 87 cities throughout the nation. Included in this tremendous task was the pickup of individual programs from five cities throughout the country, their relay back into the Ann Arbor central control point, and then out again to the 87 city networks. Because of the usual careful preparation and precise engineering planning Reiss accorded this gigantic task, the entire program was conducted without delay or breakdown. Six weeks of study and survey made possible a country-wide audio network possibly without parallel in his particular field of engineering. The complete coverage accorded this project included all engineering details, together with supplying, setting up and operating the central control of this network, and the arranging for the terminal equipment in each of the 87 cities involved. Six weeks of work to assure the success of a project with an actual life of 49 minutes.

The name Reiss has become almost synonomous in connection with the public address requirements and facilities of the University of Michigan. At various times he has installed in this famous institution of learning sound systems totaling almost $100,000. Whether it be the football stadium, field house, Hill Auditorium, Natural Science Building, Rackham Memorial Building, West Engineering Building, Angel Building, there you will see equipment indicative of the engineering magic of this unusual man.

Manifestations of success are sometimes seen in imposing business facades and large establishments, but "Nate" Reiss has been content to let his achievements spell out the externals of success. His efforts and reputation have brought the material things of life most men seek. But over and above his two Cadillacs, his home in a Detroit suburb, or the profits which all of us welcome, one senses a more significant symbol of his success. It is a comprehension of the continuing faith he has in the "sound" principles he laid down when he started in business 28 years ago, and his satisfaction in knowing that he has not deviated from them. There are the things he treasures, the things reflected by the esteem of those who know him.

We cannot forego a concluding word of our own. The story of Nate Reiss offers conclusive proof that the area of sound communication in its application to public address has indeed come of age in industry and commerce. The rapid development of this efficient means of communication should convince those engaged in this field, as well as those who contemplate entry into it, that it is an accepted, successful specialized industry offering reward and security.

(Continued on page 78)





Our Lady Queen of Apostles church, (left), at Hamtramck, Michigan, features a speaker installation in the dome over the altar, shown above, providing unusually good sound distribution throughout.

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AMPLIFIERS and PREAMPLIFIERS

A SECTION OF

AUDIO

JANUARY, 1955



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*Harold J. Leak, Esq. explains...

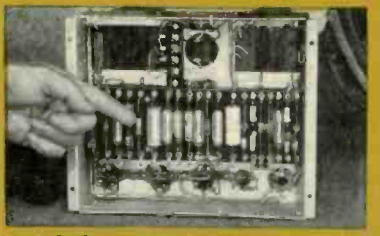
How the LEAK "Point One" high-fidelity amplifier actually duplicates the original music

... and how it simplifies radio-record playing and tape recording

LC: Mr. Leak, please tell our readers what the "Point One" amplifier combination does in a high fidelity music system.

HJL: As you know, Mr. Carduner, the amplifier is actually the "heart" of the system. Your record player, radio tuner, or tape recorder feeds electrical impulses into the pre-amplifier and amplifier. These, in turn, strengthen the signals and feed them into a speaker.

It is difficult to strengthen a signal without distortion. "Point One" means that the Leak reproduces voice and instruments with insignificant harmonic distortion of 0.1% at 8 watts! This gives the illusion of the actual "presence" of the performer.



LC: In demonstrating the "Point One" amplifier at Audio Fairs, the most impressive thing we do is to turn the amplifier on its side, show people the terminal board "custom" construction used in American scientific instruments, almost never in radios.

HJL: We had a practical reason for this ... because every terminal connection is easily accessible. It keeps servicing costs down ...



LC: Yes, and many have praised the control panel of the "Point One" pre-amplifier, because it offers every sensible adjustment to match the new hi-fi records ... and full 25 db bass and treble range.

HJL: In fact, the "Point One" has more adjustments than the Leak amplifiers supplied to the BBC, but no superfluous settings to add unnecessary cost.



LC: Well, you have one very important exclusive feature. Plug-in jacks on the Leak *front* panel make it easy to give *any* tape recorder the full benefit of the Leak circuit, in recording and playback! People with portable tape recorders, who put them away when not in use, can connect them instantly. Practical features like this make the "Point One" most enjoyable to use.

A quality-endorsed product of the British Industries Group, which includes Garrard Record Players, Leak Amplifiers, Wharfedale Loudspeakers, and R-J Enclosures.



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Amplifiers and Preamplifiers

C. G. McPROUD

A practical discussion covering the operation, design, construction, and testing of all types of amplifiers used in home music systems, and a presentation of the interesting features of commercially available products.

TO SAY that a fully comprehensive study of vacuum-tube amplifiers could be incorporated in some twenty pages of printed matter would be utter folly. In fact, about six hundred pages of *Radio Designer's Handbook*[1] are devoted to vacuum tubes, audio amplifiers, and power supplies, and much of that material consists of references. For a further study of the subject, the reader is respectfully referred to that volume, since it is very complete and as up to date as practicable for a book. It is hoped, however, that the reader may be able to gain a general understanding of modern amplifiers from this short treatise, for like yesterday's news, last year's amplifier is almost obsolete. Not quite, of course, for some very fine home music system amplifiers have been working steadily for five to ten years—they lack only some of the more recent features which make for convenient operation. They are still serviceable, giving pleasure to their owners and—best of all—a minimum of trouble. One of the advantages of a typical high-quality amplifier is that it rarely suffers a breakdown, largely because the hi-fi amplifier is usually built along professional lines, with better components and larger factors of safety.

[1] Available in North and South America from Tube Department, Radio Corporation of America, Harrison, N. J., or from most radio distributors; in U. K. and Europe from Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1, England; in Australia and vicinity, from Amalgamated Wireless Valve Company Pty., Ltd., 47 York Street, Sydney, Australia.

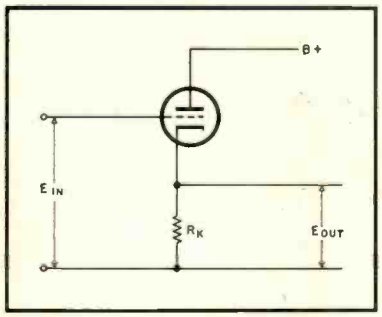


Fig. 2. Simplified schematic of a cathode follower.



Fig. 1. The only commercially available output-transformerless amplifier—the Stephens "Citadel."

Types of Amplifiers

There are two basic types of amplifiers —voltage and power. Both increase the signal voltage, but the voltage amplifier is usually considered to work into a high impedance, while the power amplifier usually works into a low impedance. Thus the selection of load impedance and and operating conditions determines whether an amplifier provides only an increase in voltage or an increase in voltage and power. In home-music-system amplifiers there are usually four or more voltage-amplifier stages, and only one power stage, which is the last stage and the one which drives the loudspeaker.

The most common output stage consists of two tubes in push pull, although for higher power outputs four, six, eight, or more tubes may be used in push-pull parallel. While the push-pull amplifier stage does provide nearly complete cancellation of even harmonics, it has certain other faults which become apparent at high power outputs, and designers have resorted to variations of the push-pull amplifier to correct these conditions.

Some designers have worked on the idea of eliminating the output transformer from the circuit altogether, and a few have succeeded. The output transformer is a very important element of the typical amplifier, and its characteristics affect frequency response, power output, and distortion to a large extent. The transformer is usually the most costly single item in an amplifier, for if it is to be good, it requires a large core of expensive material, and it requires a complicated coil construction that is expensive to build. Thus if the output transformer could be eliminated entirely, the over-all cost would be reduced appreciably. Several experimental circuits have been described in the technical press —one as recently as last June[2]—but the only commercial model on the market for home use is the Stephens Citadel, which is designed for speakers with 500-ohm voice coils. This unit is shown in *Fig.* 1.

Another type of amplifier is the cathode follower, which is a circuit arrangement designed to convert a signal at a high impedance to a signal at a low impedance. The output votlage from a cathode follower is usually between 0.5 and 0.9 times the signal applied to the grid, but the lower impedance allows the stage to feed a signal through a relatively long shielded cable from the preamplifier-control unit to the power amplifier without attenuation of the high frequencies. The circuit configuration of the cathode follower is shown in *Fig.* 2—the signal being fed in at the grid and the output signal appearing at the cathode. The output impedance of this circuit configuration for usual values is approximately $R_k/(1+g_mR_k)$. Thus with a typical triode having a g_m of 2200, and using a value of 10,000 ohms for R_k, the output impedance would be 435 ohms. A wide

[2] D. P. Dickie, Jr. and A. Macovski, "A transformerless 25-watt amplifier for conventional loudspeakers," AUDIO, June 1954.

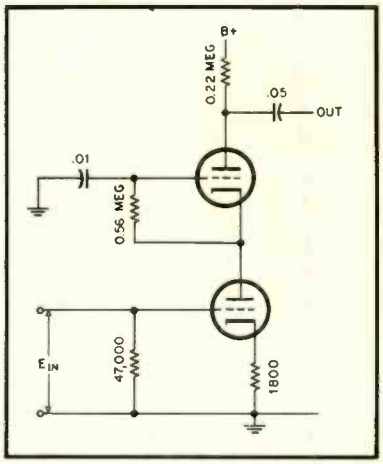


Fig. 3. Simplified circuit for the amplifier called "cascode." This differs from the original concept of the cascode, but is used in this form as a low-noise input stage in some preamplifiers.

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variety of circuit arrangements is used to provide for different bias voltages, higher input impedances, and greater power output, but the operation of the cathode follower is similar in each case.

Another amplifier circuit which has made its appearance is called the cascode, although it should more properly be described as a grounded-cathode stage feeding a grounded-grid stage. This circuit has the advantage of an extremely high input impedance and a minimum of input capacitance, and is advantageous in the first stage of preamplifiers operating from low-impedance, low-output pickups where a transformer might otherwise be required to provide a signal voltage sufficiently high to override the residual noise of the standard type of amplifier circuit. A typical arrangement of the cascode is shown in *Fig.* 3, which is that of the Fairchild 240 Preamplifier-Equalizer.

The typical music system amplifier consists of two sections, electrically, although they may be combined into one physical entity to save space, or to keep costs to a minimum. The performance of the separate unit type of amplifier is not necessarily any better than when the entire amplifier is constructed on one chassis—that is all a matter of design. But for many installations it is more convenient to locate the control unit separate from the power amplifier, with connections between the two for signal and power, with possible connections for additional power outlets for operation of tuner, tape recorder, phonograph turntable, or other auxiliary equipment.

Regardless of the physical arrangement of the amplifier, the same functions are required. To begin with, the average magnetic pickup provides an output signal well under 1/10 of a volt whereas a one-watt signal across a 16-ohm loudspeaker represents 4 volts. This does not appear to be a great difference in signal voltage, but there is a great difference in power, since the output of the pickup is considerably less than 1 millionth of a watt, whereas the power in the loudspeaker is one watt.

Typical Amplifier Arrangement

The first section of the usual home-music-system amplifier provides sufficient voltage gain to boost the output of the pickup so that it approximates the output of a tuner or other signal sources. This section, known as the preamplifier, provides the equalization necessary to match the recording characteristics in addition to sufficient gain so the phono signal may be fed to the remainder of the amplifier at approximately the same level as that from other sources.

The preamplifier is usually followed by the selector switch, and two or three stages of amplification with tone and volume controls, and, in some instances, low-pass filters to reduce needle scratch or unwanted high frequencies, and high-pass filters to reduce rumble. One or more voltage-amplifier stages follow, raising the signal strength still further. Some form of phase splitter provides two equal and opposite signals to the grids of the driver stage or of the output stage, depending on the design, and the output stage is transformer coupled to the loudspeaker.

The user is not generally concerned with the actual circuitry, but is primarily interested in what facilities are provided in the way of equalization, tone control, output impedances, and power output.

Power Output

For home use, an output of *at least* 10 watts should be available in order to provide sufficient power to handle the peaks of music reproduction. Some engineers are of the opinion that considerably more power is required than this minimum, but it is felt that a reasonably good system can be provided with a maximum of 10 watts provided one does not expect to drive several speakers throughout the house with the one amplifier. Actually, the power required for so-called "average" or "program" level is nearer 1/10 of a watt, but engineers are agreed that a safety factor of 16 to 20 db is required above the average level to take care of peaks. Thus with an average of 1/10 watt and a 20-db factor of safety, it is seen that 10 watts is the minimum if peaks are to be reproduced without distortion. The "hi-fi nut" type of listener who uses his system to show how it will play, and who likes his music reproduction several db above concert-hall volume would do well to provide a minimum of 25 watts, and would be still safer with 50 or more. However, the great majority of music lovers have a more practical outlook on music reproduction in the home, and would be well served with a maximum of 10 watts.

The output stage of most modern amplifiers consists of two tubes in push pull, although some use four tubes in push-pull-parallel arrangement. The argument has waxed long without resolving the facts as to whether pentodes, triodes, or tetrodes are better. Let it be stated categorically that it is possible to make excellent amplifiers with any of these types of tubes, assuming that equivalent engineering skill is applied to the design problem. It is perhaps easier to build a triode output stage than one using tetrodes or pentodes, since the circuit requirements are somewhat more simple for the triodes. Undoubtedly one of the reasons for the success of kit amplifiers using the Williamson circuit with 807's, KT-66's, or 6L6's *as triodes* was that the builder without access to test equipment could usually follow the instructions and end up with a good amplifier. With the evolution of this type of amplifier into the Ultra-Linear circuit, Some builders have encountered trouble unless they could observe the results of their work with a scope, and had an audio oscillator capable of reaching 100 kc, together with a.f. voltmeters which could measure up in this range. With factory produced amplifiers, however, there is little to choose between triode and beam-tube operation, since it is assumed that each manufacturer will build the best equipment he is able to within the limitations of cost to the user.

The Output Stage

The power output stage is the controlling factor in the power *vs.* distortion characteristics of the amplifier. Some form of feedback is almost universally used, but the matter in which it is applied differs in various amplifiers. Within the last year, several manufacturers have adopted a form of feedback originally described in these pages[3] which permits the user to adjust the damping of the amplifier to suit the characteristics of the loudspeaker. Thus where the speaker impedance rises—both at the low-frequency end where the resonant peaks of the speaker end of most enclosures occur, and at the high-frequency end where the inductive reactance of the voice coil rises—the output impedance of the amplifier can be adjusted to match more nearly the impedance of the speaker. Some engineers maintain that a loudspeaker should be driven by a constant voltage source, which provides high damping and which means that the source impedance is very low, whereas others believe that the source impedance of the amplifier should be more closely matched to the speaker. There is no doubt that some types of speaker enclosures will work better with a matched impedance, whereas other types seem to sound better with a low-impedance source. Since this is largely a matter of "cut and try" with a particular speaker-amplifier combination, it is impossible to state a fixed rule that would apply to every case. It is true that some difference in listening quality is observed, and the choice should be made by the individual listener. However, since the output impedance in this type of amplifier is under the control of the user, he can adjust it so as to give him the type of quality he wishes, and since tastes differ this would be a satisfactory solution. All of the amplifiers on the market so far with some damping factor control—regardless of what the individual manufacturer may choose to call the circuit arrangement—are adjustable, and the user may find that the ability to vary this control is of some importance. It is not believed by this observer, however, that such a control should be used as an operating tone control, but that it should be set for any given installation and then left in the position which the listener believes sounds best.

Preamplifier Controls

The practice in modern amplifier is to provide considerable flexibility in equalization so that the user can match any possible recording characteristic. With the fairly complete standardization finally arrived at by record industry, it seems probable that most music lovers who are just beginning a record collection would be satisfactorily served with only one characteristic—the RIAA—and further corrections in quality can be made with the tone controls, assuming

[3] Werner Clements, "New approach to loudspeaker damping," AUDIO ENGINEERING, August, 1951.

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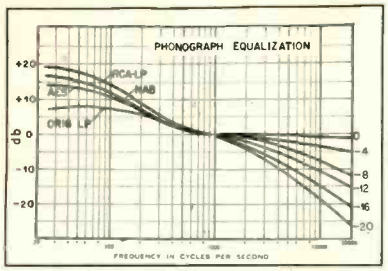


Fig. 4. Typical phono equalization curves.

that they have suitable curves. However, many listeners have a large collections of records dating back to the pre-LP days, and even many of the earlier LP's and especially the foreign recordings are not within the limits specified by the AES, NARTB, or the RIAA. For these, different equalization curves will be found necessary, and it is not uncommon to find six or eight curves being available. The greatest flexibility is obtained when the low-frequency characteristic is selected by one control and the rolloff by another, so that the user can have any turnover combined with any rolloff. This is not considered as simple for the user, and one of the criticisms of hi-fi amplifiers has been that the members of the family other than the enthusiast himself find it difficult to achieve satisfactory record reproduction because of the complication of controls. However, since tastes and demands differ, and since both types of amplifiers are available, everyone should find it possible to select equipment that suits his particular desires. We have always felt that while it is admittedly desirable to be able to match a recording curve accurately, a greater difference in the actual recording characteristic can result from moving a microphone a foot or so than the relatively small difference resulting from changing the rolloff from 16 db to 12 db at 10,000 cps, for example. Thus it has been recommended often in these pages that the user should select an amplifier that has sufficient flexibility of control to cover practically any situation, and then adjust the controls for best sound quality, regardless of what the label on the panel indicated. The same method would suffice for the amplifier with only one knob—provided the original selection of curves was satisfactory—since the user could adjust the control for optimum quality, regardless of what the record indicated to be the curve with which it was recorded. The extremely critical listener will undoubtedly be happier with an amplifier which provides him with a wider variety of controls than might suffice for the less critical. *Figure* 4 shows a group of curves typical of modern amplifiers.

Tone Controls

Practically all modern amplifiers employ separate treble and bass controls, since this is the only way to give the user adequate flexibility. Most of these work on the principle of a "losser"—that is, if a boost is required at the treble end of the spectrum, the entire band is amplified by the same amount and the low end is attenuated by suitable resistance-capacitance networks. Controls working on this principle have the characteristic of raising and lowering both lows and highs around a mid-frequency "hinge" which usually occurs between 700 and 1000 cps as shown in *Fig.* 5. Proper selection of circuit parameters controls the shaping of the curves and gives good listening quality. Note that when we refer to "boosting" the highs, for example, we are not actually increasing the amplification of the high frequencies, but we are attenuating the lows, and leaving the highs unattenuated. This gives the same result, of course, and is somewhat easier to do without resorting to resonant circuits which have not been used in tone controls in high-quality equipment for several years.

Another type of control that is encountered in a number of amplifiers is known as the "Baxendall," after its original designer. This control uses a feedback network to boost or cut both

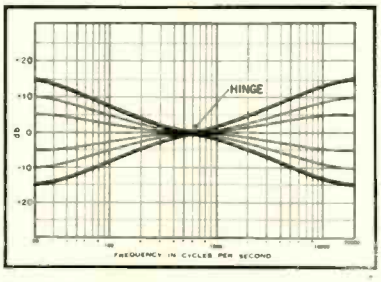


Fig. 5. Tone control curves using the conventional circuits. Regardless of the settings of the controls, the response curves "hinge" about a midpoint.

ends of the spectrum, and instead of resulting in curves which hinge around some center frequency, the maximum boost or cut curves move horizontally along the spectrum, so to speak, with a typical series of curves being similar to those of *Fig.* 6. Thus this circuit results in changing the inflection point continually as the control is turned. This type of control is preferred by some because it provides compensation at the extremes of frequency without affecting the mid-range frequencies until the amount of correction comes close to the maximum.

Still another type of control provides for feeding separately equalized circuits to the ends of the control and to a tap at the center. This arrangement, while somewhat more expensive to build, permits the designer to incorporate entirely different characteristics to the boost and cut positions of the control, and the effect can be tailored to a closer degree than the two other types.

Regardless of the type of controls used, they are necessary to compensate for different recording studio characteristics, for different acoustic conditions in the listening room, and for the individual preferences of the listener. Controls may be used to make up for deficiencies in loudspeaker or enclosure, with a fixed amount of bass or treble boost being introduced when the speaker is not adequate in those ranges, or for reducing shrillness from an improperly balanced tweeter.

Volume vs. Loudness Controls

Some means of controlling the volume level of the reproduction is an absolute necessity in any sound reproducing system. Different sound levels occur from record to record, or between recordings and broadcast programs; the time of day and the current activity of the listener call for different sound levels; some people want their music reproduced softly while others prefer it at full concert volume. Therfore, some method of controlling the volume is required.

The human ear has different characteristics of hearing at different levels of sound, and when the reproduction takes place at a level which is different than that of the original sound, the balance between highs and lows is different to the ear. This has been investigated by scientists, and is called the Fletcher-Munson effect, after those who did the original work on the subject. The ear is most sensitive at the midfrequencies, with sensitivity falling off rapidly as the frequency lowers. Therefore, if we reproduce music at the same volume at which it was performed, it will apparently have the same balance between lows and highs. As we lower the volume, there is an apparent loss of low frequencies. Some writers maintain that this effect also occurs at the high-frequency end of the spectrum, but an inspection of the Fletcher-Munson curves or sensitivity of the ear will show that there is very little difference between the sensitivity at 1000 cps and 10,000 cps at any volume below 90 db. There is an upward twist to the curve, as shown in *Fig.* 7, but the curves are almost identical above 1000 cps.

At the low end, however, there is a considerable difference in the shape of the curves. If the level of a 1000-cps signal is reduced from 100 db to 60 db, for example, equal loudness at 30 cps requires a level of 85 db—which means that a boost of 25 db (85 – 60) is required to make the reproduced signal sound like the original. The average sound level in an auditorium with a symphony orchestra will usually be somewhat in the vicinity of 85 db, whereas that in the home is more likely

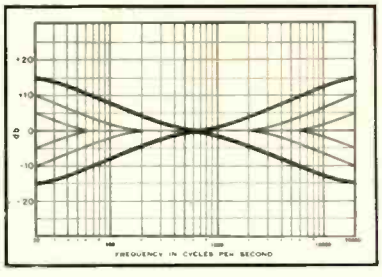


Fig. 6. Response curves for the Baxendall type of tone control. At intermediate settings, the controls affect progressively smaller and smaller sections of the frequency extremes.

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to be around 65 db. Environment often requires that the music lover reproduce his programs at still lower levels than 65 db, which increases the apparent lack of bass. The loudness control, first described in these pages[5], is a device which compensates for this variation in sensitivity of the ear as volume is lowered. In its original form it provided steps of about 5 db each which permitted the user to correct the frequency characteristic to match the ear more closely as he reduced the volume. However, the 5-db steps were too great to permit this control to serve as the volume control of the system, and other controls made their appearance with steps of around 2 db, which is about the minimum change in level the average ear can perceive on program material. The control was somewhat expensive to build, and other types were engineered which could be made more cheaply. The basic principle has been retained, however, and the combination of volume and equalization controls is still used in many amplifiers. Not everyone likes this type of control, so various methods have been employed to give the user greater flexibility. In some there is a switch that changes the control from a volume control to an equalized loudness control simply by cutting the reactive elements out of the circuit. Others provide one control that is set for the average level at which the sound is to be reproduced, with the usual uncompensated volume control being used to adjust the level. Whatever the method, however, it is felt that the loudness control has made it possible for the listener to have high-quality sound reproduction without the need for ear-splitting volume —which was the principal reason for considerable criticism of early hi-fi installations.

Most loudness controls now incorporated in current amplifiers correct both low and high ends of the spectrum, although the sensitivity of the ear, as mentioned previously, does not change appreciably above 1000 cps. Thus from a purely scientific standpoint, no compensation should be required in the treble range, but this is not borne out psychoacoustically. Most designers are of the opinion that the best listening quality is obtained with some compensation added for the treble range in addition to that for the bass range, and this type of control is the one usually employed.

There is still some controversy about whether this type of compensation is desirable or not. In any case, most modern amplifiers have a loudness control, together with some means for cutting it out at will.

Filters

Some amplifiers are equipped with low-pass filters which serve to limit the frequency range of the reproduction to some predetermined cutoff point—usually selectable at will from a number of

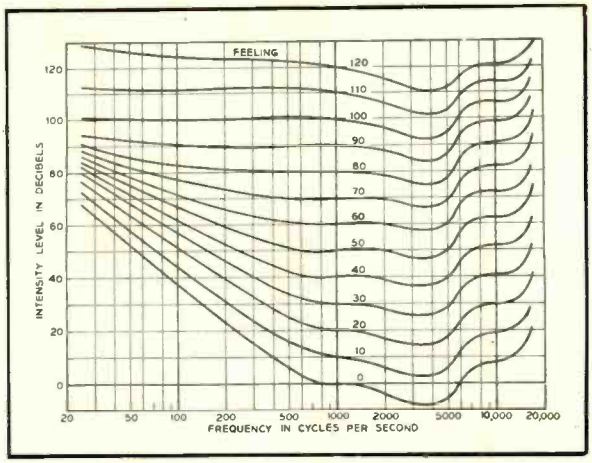


Fig. 7. The Fletcher-Munson curves of equal loudness for the human ear.

frequencies, such as 10,000, 7000, and 5000 cps. The need for low-pass filters has abated somewhat since shellac records have faded from popularity, but there is some justification in their use in broadcast reception, particularly in those areas where the only program service is AM radio. Wide-range receivers capable of passing frequencies above 10,000 cps are often troublesome because of the reproduction of "monkey chatter," the name given to interferenee between the carriers of two adjacent-channel stations. The low-pass filter will effectively remove this type of disturbance, although most high-quality AM radio receivers have some provision for reducing the pass band so as to limit the high-frequency response. Another use for the low-pass filter is to reduce the apparent distortion in a poor signal source by eliminating frequencies in the higher ranges.

Similar filter arrangements are often provided with high-pass configurations to cut off the transmission band just above the rumble frequency from turntables which are not sufficiently rumble-free for true wide-range reproduction. The cure in this case lies in replacing a poor turntable with one which is suitable for a hi-fi system, but the filter is sometimes desirable even with high-quality equipment in cases where the source material is not perfect. Many records will be found with rumble content.

Low-pass filters—to have a sufficiently sharp cutoff—are usually constructed with inductances and capacitances, and unless carefully designed may be susceptible to hum pickup from adjacent equipment. Most commercially available amplifiers using L-C filters are arranged so that the external pickup from the inductors is reduced to a minimum or eliminated altogether, but the trouble is often encountered in home-built equipment. Some amplifiers have filters with controllable slope beyond cutoff, which permits using the filter only to the extent necessary, thus producing a minimum of deleterious effect on the musical reproduction. High-pass filters are almost universally of the R-C type, since a sharp cutoff of low frequencies usually generates some undesirable effects above the cutoff frequency and thus in the transmitted band. Such undesirable products resulting from low-pass filters would be outside the pass band, and thus not be heard, so a sharper low-pass filter can be used.

A low-pass filter effect can be obtained with any magnetic pickup by shunting it with a capacitor and resistor. The inductance of the pickup resonates with the capacitor and causes a 12-db-per-octave rolloff above the resonant point. The resistor serves to eliminate the peak just before rolloff, and provides a smoother over-all response. The peak ahead of rolloff is unpleasant to the ear, and should be eliminated by proper choice of the shunting resistor.

Auxiliary Services

To provide sufficient flexibility for the average user, the amplifier must be able to accomodate several inputs—phono, radio tuner, TV, tape, and possibly crystal or ceramic pickup and microphone. With the exception of the microphone, these other sources have an output in the vicinity of 1 volt, which makes it possible to switch between them at the input of the control section, with the preamplifier output being of approximately the same level. When provision is made to feed a signal source to a tape recorder, it is preferably from a point in the circuit ahead of the volume and tone controls so that the quality of reproduction during the recording process can be controlled to suit the listener without affecting the signal fed to the recorder. With such an arrangement it is possible to adjust the tape recorder volume control to a suitable level and make the recording without necessarily reproducing the incoming signal at the same time. Some units have provision for monitoring from the tape recorder while the recording is being made, but this requires that the recorder be equipped with three heads—erase, record, and playback,—rather than only two, which is most common practice with medium and low-priced recorders. However, when used with a three-head machine, this arrangement is desirable

[5] David C. Bomberger, "Loudness control for reproducing systems." AUDIO ENGINEERING, May 1948.

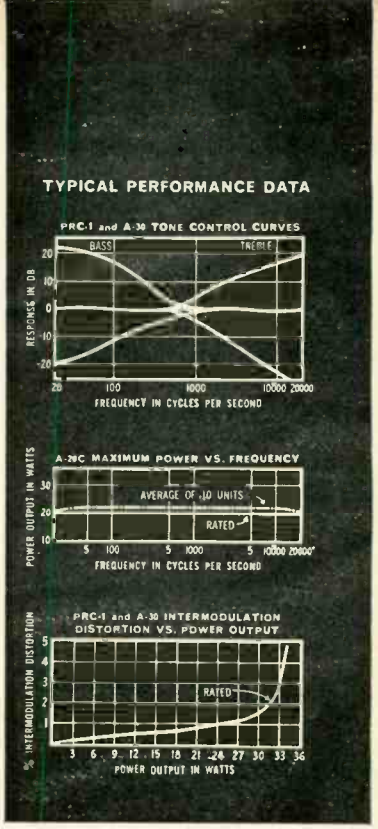
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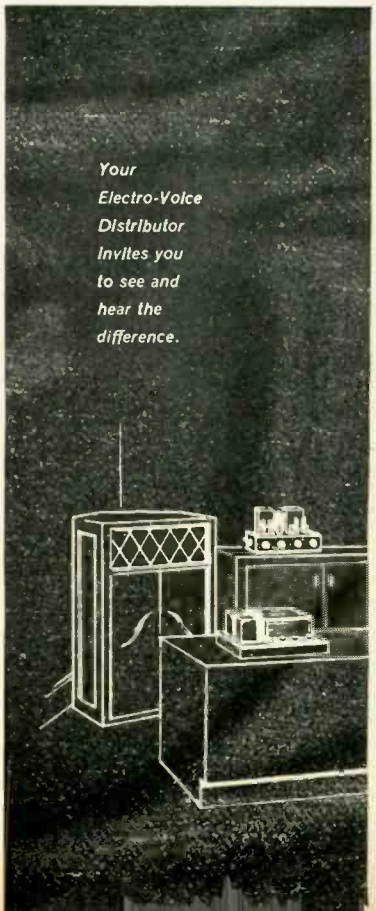
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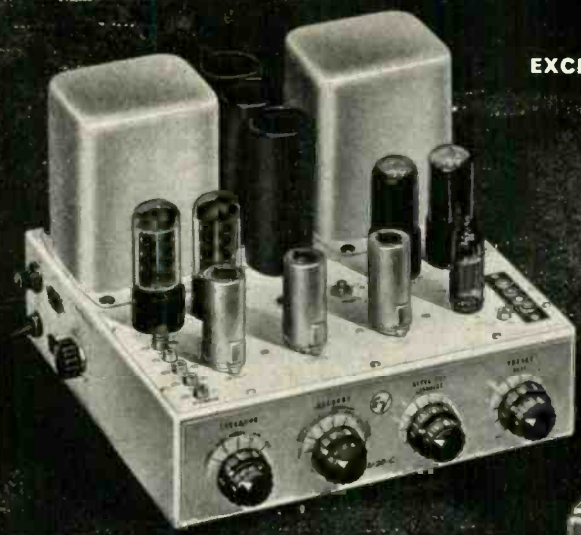
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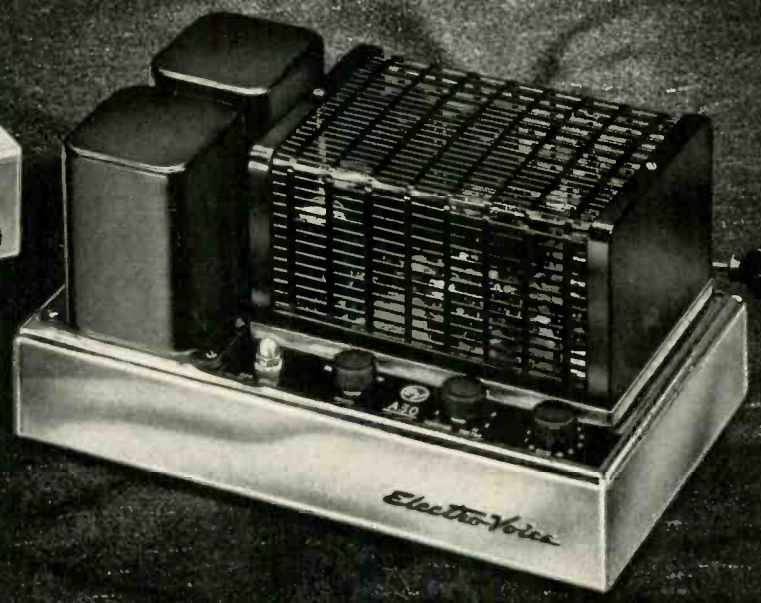
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and permits the user to check the recording quality as it is being made. Some tape recorders are equipped to permit this type of monitoring within their own amplifier equipment, but if not, the facility for doing so is useful in many instances.

The tape input on the average amplifier is designed to take a high-impedance output from the playback amplifier and reproduce it through the complete system, with usually better quality than from the speaker and amplifier in the recorder itself.

The TV input is designed to take a signal from a TV set—usually from a cathode-follower circuit—and reproduce it through the amplifier and speaker of the better-quality system. This requires that the TV receiver be equipped for this type of output, as the TV tuners are. It is a fairly simple modification to a conventional TV set to provide this output, but with the widespread use of transformerless TV circuits, it is usually a practice which will give plenty of trouble to avoid hum, and the possibility of grounding the a.c. line in the TV set through the amplifier.

Microphone inputs require considerably more gain than is usually available in the average amplifier following the point of circuit selection. However, since the gain of the phono preamplifier is adequate for any type of microphone—provided the low-frequency equalization is made inoperative—some amplifiers have this provision. It is a desirable adjunct when the main amplifier system is used to feed a tape recorder, for it permits the use of high-quality, low-level microphones, with resultant improvement in the recordings. However, most users would not find this feature of sufficient value to warrant insisting upon it.

Selecting an Amplifier

The choice of a good amplifier is one which is difficult to make, for from the specifications published by the manufacturers it is obvious that any of the amplifiers made by the reputable manufacturers in the high-fidelity field will give satisfactory results. Furthermore, the ability of the amplifier to continue to give good service is usually dependent upon the integrity of the manufacturer, and if the user selects any of the amplifiers from the well known components manufacturers, he is sure to get good value for his money, and he may expect long and reliable service. Since there is some difference in the sound from the various amplifiers, it would be desirable if the prospective purchaser could arrange with his supplier to permit a short period of home trial before making a final selection. To the inexperienced ear, any good hi-fi system sounds pleasant for a short period—witness the sounds at an Audio Fair—but some components may not be as "easy to live with" as others, and this can be determined only by living with them for a time. In any case, our recommendation is that the prospective purchaser make his selection from any of the products of the reputable components manufacturers on the basis of what *sounds* best to him. It is desirable that he make his selection of an amplifier, for example, using the same type of phono pickup and the same type of loudspeaker—as well as the same type of loudspeaker enclosure—as that with which he will use the amplifier.

Given a choice as to what single element of a music system should be of the highest possible quality if it should be necessary for budget reasons to economize somewhere, it has always been the writer's belief that the amplifier is the most important. An excellent loudspeaker will show up the deficiencies of a poor amplifier quicker than a poor speaker will; if there is very little or no distortion in the amplifier, it will not be reproduced in whatever speaker is being used, and even a mediocre speaker will sound fairly well with a high-quality amplifier driving it.

This should not be construed to indicate that it is possible to have the finest in sound reproduction with low-quality components anywhere in the system. The old adage about the chain being no stronger than its weakest link applies to audio equipment as well as its original subject. By all means, buy the best equipment your budget will permit, connect it together properly, and then relax and enjoy the music.

Amplifier Performance

The performance of an audio amplifier can not be measured readily by the individual who goes into his dealer's to make a purchase, but the information is generally made available in the specification sheets on the equipment. It is important to the user to know just what to look for when he goes to make a purchase, and to have a general idea of how to interpret the specifications. In practically every instance, the manufacturer of high-fidelity audio components may be considered to be thoroughly honest in stating his specifications, for he knows full well that occasionally a potential buyer may insist that the performance data be checked to his own satisfaction. Various types of equipment reports—in this magazine and others as well as by the two consumer organizations—serve to stamp a mark of approval on the published specifications of a piece of equipment, and may be relied upon as unbiased and correctly measured data.

In discussing the performance of an amplifier, for example, the points that are most important are:

Intermodulation distortion
Harmonic distortion
Power output (at rated distortion)
Frequency response
Hum and noise level
Tone-control range
Phono equalization

Each of these will be discussed separately in the succeeding paragraphs, along with accepted standards of measurement and the methods of making the measurements.

Intermodulation distortion. In this writer's opinion, this is the most important of the performance data of an amplifier, since it is believed to come closer to the effect upon the human ear than harmonic distortion. The reason for this is that all music, for example, is composed of fundamental tones and overtones, and all of the overtones of any musical note are harmonically related to the fundamental. While not all harmonics are not *pleasantly* related to the fundamental—the fifth and seventh often being considered objectionable—most of them are, and serve only to change the timbre of the note somewhat. However, the products of intermodulation distortion are not harmonically related to the original tone, and are in most instances unpleasant to the ear. AUDIO stands on the belief that amplifiers should be rated at the power output for which the intermodulation distortion measures 2 per cent, using a low frequency such as 60 cps and a high frequency or approximately 7000 cps, and a ratio of 4:1. There is no accepted standard for the measurement of IM distortion, but most manufacturers use test frequencies of approximately these values, and AUDIO considers this as its own standard—with EQUIPMENT REPORT measurements made on this basis.

The IM distortion measurement is made by introducing into the input of an amplifier a composite signal which is composed of two frequencies. The output is connected to an IM analyzer which eliminates the low frequency and measures the modulation of the high frequency by the low frequency as a percentage of the high-frequency signal. This modulation is caused by nonlinearity in the amplifier. Any good amplifier will measure well under 1 per cent IM distortion at outputs less than 1 watt, where the average program level will usually be set for home listening. It is only on peaks that the IM distortion reaches the higher values. Most listeners are familiar with the roughness that often accompanies the loudest passages in a musical selection, and many say they instinctively cringe as the volume rises to a peak, knowing that it will be harsh and unpleasant. This will not be the case where IM distortion remains low even on peak outputs, and cleanness of reproduction *can* be had with the best amplifiers.

Some manufacturers use an IM signal in which the two frequencies are at the same level—with a ratio of 1:1. This gives a lower numerical value to the distortion, but should not be compared directly with a figure obtained with the 4:1 input signal. The power output at which the distortion is measured should be measured, in AUDIO's opinion, as the Equivalent Sine Wave Power, rather than as the output which is shown by the usual instruments. Equivalent Sine Wave Power represents the power in a signal which would be present if the peak value of a sine wave equalled the peak value of the composite IM signal, which is 25 per cent higher than the average power in the signal. Thus, when an amplifier is rated at Measured Power Output and compared directly with an amplifier rated at Equivalent Sine Wave Power Output, it suffers numerically, although

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the meaning is clear enough if one knows the difference. The Equivalent Sine Wave Power figure may be obtained by multiplying the Measured Power Output by 1.48, approximately.

No standards have yet been set for the measurement of an equalized amplifier—such as a phono preamp. It is believed, however, that a fair comparison would be to introduce a composite signal into the amplifier with the ratio adjusted so that the ratio at the output of the amplifier is 4 : 1. It makes little difference what method is used so long as all measurements are made by the same method and that figures have the same basis on which to compare them.

Harmonic Distortion. This form of distortion is measured by introducing a pure sine-wave signal to the input of an amplifier and analyzing the output signal, using either a wave analyzer or the simpler harmonic distortion meter. All amplifiers have some distortion, but the figure for harmonic distortion should be less than 1 per cent at rated output for best quality of reproduction, and this should be made up principally of second, third, and fourth. Much fifth-harmonic distortion is particularly objectionable, and some authorities recommend the rating of an amplifier at a certain (small) percentage of fifth harmonic. This requires the use of a wave analyzer, and not all laboratories are so equipped. The more common distortion measuring equipment consists of eliminating the fundamental from the output signal and measuring the total remaining signal, which is composed of all the distortion products. This gives a slightly lower numerical value than the sum of the distortion figures for each of the orders —second, third, fourth, and so on—but so long as everyone uses the same method the results can be compared.

Power Output. The power output of an amplifier can be measured by several different means, and *all* should be employed for a thorough analysis. One of the easiest is by the use of an oscilloscope, observing the point at which the sine wave signal begins to change its shape—this point being known as the "clipping" point. Every amplifier should be tested by this method so as to make sure that the clipping point is symmetrical on both halves of the sine wave, for if there is a tendency for one side to clip before the other, the result is unpleasant to the ear. The power output at the clipping point is likely to correspond to that at a measured harmonic distortion of 5 per cent, since the change in shape of a sine-wave signal on the 'scope screen is barely detectable until the distortion is around this value.

Amplifiers are most commonly rated at a given percentage of IM or harmonic distortion. The test signal—a sine wave for harmonic measurement and the composite signal for IM testing—is fed to the input and the output measured by suitable equipment. At the distortion figure for which the amplifier is to be rated, the actual output power is measured, and this is given as the rated power output for the amplifier. In most instances the amplifier is terminated with a resistance

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load equivalent to the nominal output impedance. However, further tests should be made with loudspeaker loads, using a 'scope to observe the output signal, and as a further check on stability the amplifier should be tested with no load and with a short-circuit across the output—in the latter instance the 'scope input should be connected to one of the output tube grids. As a further check for stability, amplifiers should be tested with capacitance loads up to about 1 μf, and with inductive loads up to about 100 mh. In no instance should any spurious frequencies be generated as the input signal is swept through the entire audio frequency range and over a wide range of power output.

Frequency Response. In this day of high-quality output transformers and the almost universal use of feedback, there is no problem in obtaining a flat frequency response over the entire audio-frequency range. However, that is not enough for good transient response, which is the ability of an amplifier to reproduce faithfully the starting and stopping of a tone—such as that of a piano or other percussion instrument. In order to reproduce the start of a 1000-cps tone accurately, it is necessary that the amplifier pass a frequency range *at least* ten times the fundamental, or 10,000 cps. With music ranging in fundamental frequencies up to, say, 4000 cps, it is obvious that the frequency response of a satisfactory amplifier must extend to 40,000 cps, even though the human ear does not hear up in that range. This can be proved, however, by reproducing a selection through a high-quality amplifier with a pass band extending to 100,000, for example, and then listening to the same selection with a 10,000-cps low-pass filter in the circuit. It will be seen that there is a noticeable difference. The frequency response of an amplifier should be stated as "flat within ±2 db from 10 to 65,000 cps," using the applicable figures. The "±2 db" should be interpreted to mean that the amplifier response does not deviate more than ±2 db from its output at 1000 cps (or some other mean frequency), although in an endeavor to show a better figure, some literature has been observed in which a different interpretation was intended. Suppose, for example, that a certain piece of equipment were rated as having a frequency range from 50 to 9000 cps, ±5 db. If two lines are placed on the graph sheet, one 5 db above the reference and one 5 db below, the curve can then be placed on the sheet so that the highest point touches the top line and the frequency range is noted where the curve crosses the lower line at both ends of the spectrum. Since the middle range of frequencies is usually relatively flat, this means that the lowest and highest frequencies, according to that rating, are *10 db down* from the midrange frequencies. The rating is strictly true, but it is certainly misleading. It would be far better if audio equipment were rated as having a frequency range of "30 to 15,000 cps, with not more than ±2 db variation from the 1000-cps level," or some substantially similar form.

Hum and Noise Level. With high-quality equipment, the hum and noise present in an amplifier—or any other audio equipment—becomes important because any good loudspeaker system should be capable of reproducing the 60- and 120-cps hum frequencies, as well as the noise frequencies which are likely to be well above 5000 cps. Amplifiers are generally rated as having a hum level *n* db below rated output, but AUDIO does not consider this a valid indication, for with a 50-watt amplifier, for example, this will result in a rating 7 db better than with a 10-watt amplifier having exactly the same hum and noise output. This is a trifle misleading, for the average listener will not necessarily use a 7-db higher program level with a 50-watt amplifier than he will with a 10-watt amplifier. It is considered more accurate to indicate hum and noise as *n* db below 1-watt, for example, or to some other reference level. In the case of preamplifiers, the rating should be stated as *n* db below 1-volt output, for example. This would permit a direct comparison between amplifiers, without any possibility of misinterpretation.

With a high-quality speaker system, a satisfactory hum level is obtained when the hum is lower than 70 db below 1 watt, although a figure of 60 db below 1 watt is not too objectionable.

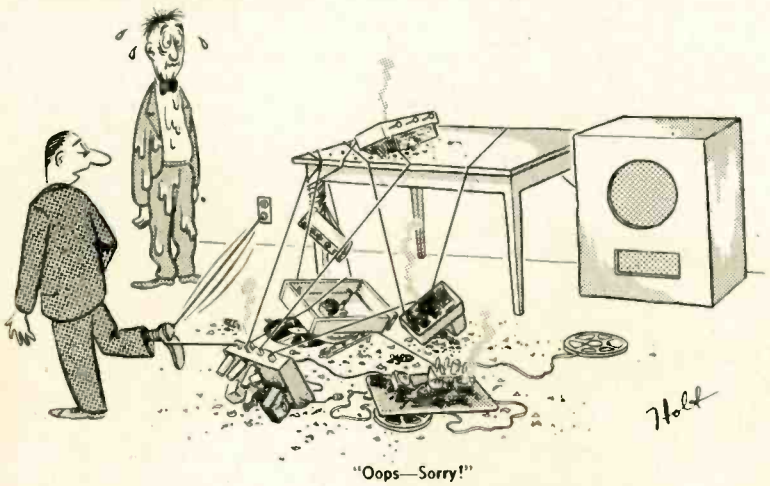
Tone Control Range. Modern amplifiers are all equipped with separate bass and treble tone controls, and they are usually arranged to provide both boost and cut so the user can adjust the sound output to compensate for recording studio characteristics, loudspeaker deficiencies, and acoustics in the listening room. For specification purposes it is usual to measure frequency response with both tone controls in the maximum boost position and again with both in the maximum cut position. This method gives the limits that can be obtained by manipulation of the controls, but is not absolutely accurate, since some types of controls affect the response at the 1000-cps reference point. However, for most purposes this method is adequate, since it does show the character of the tone-control curves, and will show up any resonances in the frequency-shaping circuits.

For average use, it is sufficient that the tone controls provide a boost of 12 to 15 db at 50 cps and 10,000 cps, and a cut of about the same magnitude at the low frequency and of 20 to 25 db at the high end. However, if the phono circuits are properly equalized, somewhat less than these figures can be considered sufficient, particularly if a loudness control is provided.

Phono Equalization. Equalization for magnetic pickups is measured in the same way as frequency response, using each of the separate positions individually. If independent controls are provided for turnover and rolloff, it is sufficient to measure each end separately, using a fixed position for the other. Naturally, the tone controls should be in the "flat" position.

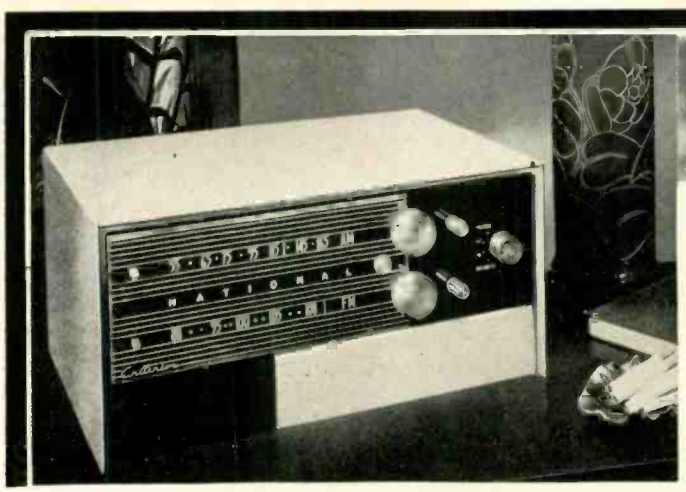
While a large variety of equalization curves is provided, not all of them seem to be necessary, particularly for the newcomer to record collecting, since he is likely to restrict his buying to LP's and 45's, all of which have a recording characteristic which is, within limits, acceptably played on an RIAA curve. This is largely a matter of taste, and the most critical listeners may want more flexibility than the basic three or four curves that are most necessary.

Measurement of phonograph equalization is usually made by simply connecting the audio signal generator to the phono input jack and noting the output as the frequency is varied. This does not take into account the impedance of the pickup cartridge, and some input circuits depend upon this impedance to achieve the desired rolloff or cutoff characteristics. The proper method of making measurements on preamplifiers is to place a pickup in series with a low resistance—say, one to five ohms—and connect this combination to the input. The output from the generator is then fed across the low resistance, suitably matched for impedance. This serves two purposes simultaneously—it gives a low voltage without unduly large attenuation in the generator, and presents the proper impedance to the input circuit of the preamplifier, thus giving true response curves.



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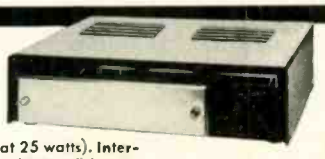
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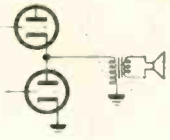


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(At 20 watts rated output)
Harmonic distortion: less than .3% (.6% at 25 watts). **Intermodulation distortion:** less than 1%. **Sensitivity:** 1.6 volts. **Hum & Noise:** 80 db below 20 watts. **Frequency response:** 20 cps-20 kc, ±.1 db; 10 cps-100 kc, ±1 db. **Power response:** 20 cps-20 kc, ±.15 db; 10 cps-60 kc, ±1 db.

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Harmonic distortion: .5%; **Intermodulation:** 1%. **Frequency response:** 20 cps-20 kc, ± 1 db. **Power response:** 20 cps-20 kc, ± 2 db. **Hum & Noise:** 70 db below full output on high level inputs (low level inputs — 50 db below.) Preamp Control has 2 high level inputs for tape and tuner. Record compensation positions for R.I.A.A., A.E.S. and Foreign. Treble boost: 11 db and 10 db treble cut at 10 kc. Bass boost: 15 db at 30 cps. Built-in loudness compensation.

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COMMERCIAL AMPLIFIERS

Up to this point the discussion has been general, and has not been confined to these products of any particular manufacturer. The remainder of the section will be devoted to descriptions of the amplifiers that are currently on the market, with an attempt being made to point out the characteristics that are of special interest in the individual units. The writer is indebted to the various manufacturers for their cooperation in furnishing photographs, schematics, and operating instructions on all of this equipment, without which this section would have never been possible.

Acro Products Company, 369 Shurs Lane, Philadelphia 28, Pa.

While not actually the manufacturer of an amplifier, this company does provide output transformers to many amplifier manufacturers for use in the circuit known as the Ultra-Linear, which provides a form of feedback from the plate to the screen of the output stage. A typical circuit is that of *Fig.* 8. The in-

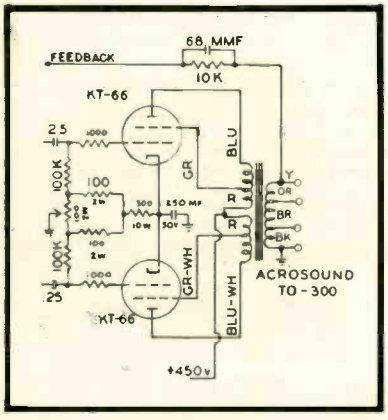


Fig. 8. Typical Ultra-Linear output stage.

clusion of a portion of the primary winding of the output transformer in the screen circuit is said to produce lower distortion for a given output than either triode or tetrode connection of the same tube. In any case, the Ultra-Linear connection has been incorporated in many commercial amplifiers which employ the Acrosound transformers in many instances. The earliest description of the Ultra-Linear circuit[6] appeared in these pages some time ago, and the circuit may be said to have achieved excellent acceptance since that time.

Whether or not this circuit lives up to the claims of its inventors may be controversial, but reliable measurements indicate that while some 15 watts may be obtained from a conventional "Williamson" amplifier using 807's as triodes, the same tubes in the same amplifier with the exception of the output transformer which is changed to the Ultra-Linear will give an output of 24 watts with the same amount of distortion.

Altec Lansing Corporation, 161 Sixth Ave., New York 13, N. Y. and 9356 Santa Monica Blvd., Beverly Hills, California.

Three units constitute the line of this company—a 10-watt single chassis amplifier, model A-339A; a deluxe preamplifier-control unit, model A-440A; and a 35-watt power amplifier, model A-340A.

The A-339A, *Fig.* 9, employs a 12AY7 as a preamplifier tube, with feedback around the first section to provide the

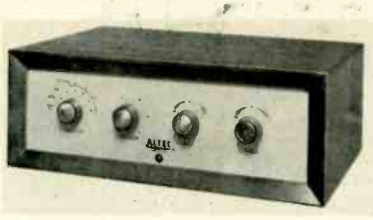


Fig. 9. The Altec Lansing A-339A Melodist amplifier and record control unit.

high-frequency rolloff and with feedback around the second section to provide the low-frequency boost required for the magnetic pickup input. It has four phono equalization positions and a microphone input, in addition to two inputs for high-level sources such as inner, TV, or tape recorder, each of these inputs having separate level-adjusting controls. Two sections of a 12AX7 with the tone controls and a loudness control between them serve as voltage amplifiers, fol-

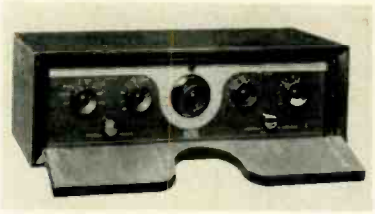


Fig. 10. New Altec A-440A preamplifier-control unit.

lowed by a direct coupled amplifier and phase splitter and the output stage consisting of two 6CM6's in push pull, pentode connected. Output impedances of 4, 8, and 16 ohms are provided, and 25 db of feedback hold harmonic distortion to 2 per cent at 10 watts.

The A-440A, shown in *Fig.* 10, is of unusual construction, being provided with a hinged panel on the front which covers all the controls except that for volume when the "door" is closed. Thus the critical listener may open the door and adjust controls to suit his fancy, while the less critical listener can have a one-control amplifier simply by closing the door. This unit provides for two phono inputs and three high-level inputs each with level adjusting potentiometers. The phono equalization requires two controls, one for the low end and one for the high; there are five low-frequency positions ranging from flat to a 600-cps turnover, and five rolloff positions ranging from 0 to 16 db at 10,000 cps. The tape recorder feed is taken from the output of the selector switch, just ahead of the volume and loudness controls, choice of which may be selected

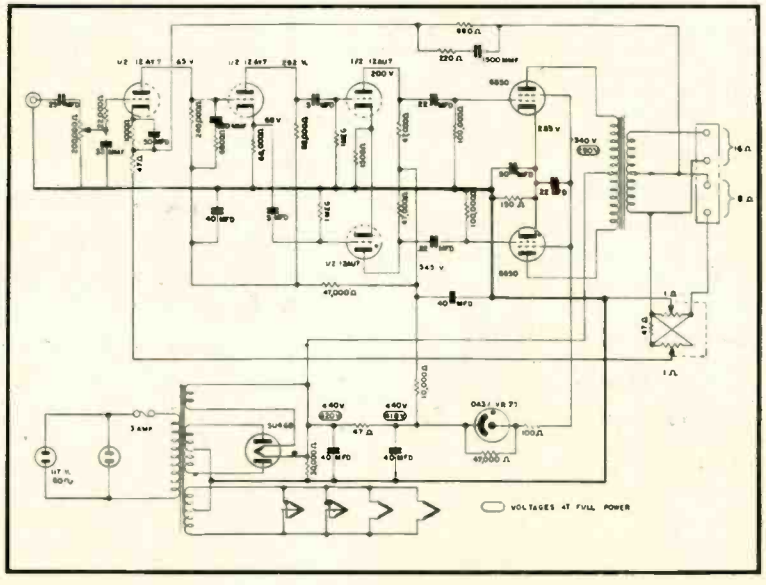
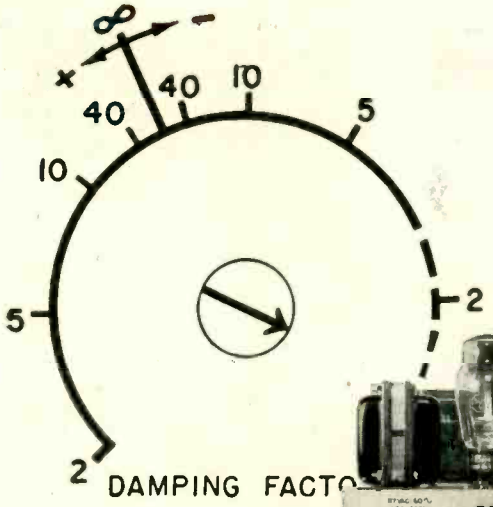


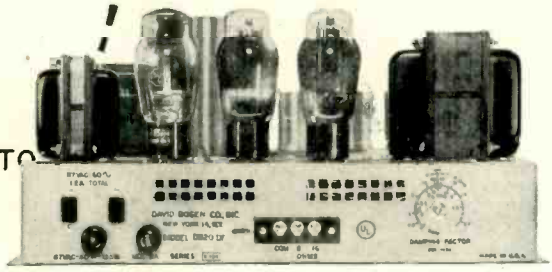
Fig. 10a. Schematic of the Altec power amplifier using the new Tung-Sol 6550's.

[6] David Hafler and Herbert I. Keroes, "An Ultra-Linear amplifier," AUDIO ENGINEERING, Nov. 1951.

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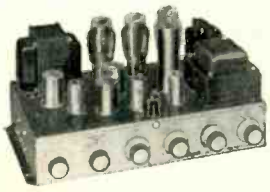
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by a switch which also permits monitoring the output from a tape recorder while feeding it a signal from any of the other inputs. The recorder output, taken off ahead of the volume control, goes through a cathode follower to provide a low-impedance source. A second cathode follower feeds the normal output to the power amplifiers. The entire unit is self powered, using selenium rectifiers for both plate and heater supply—all heaters being fed with d.c. to keep hum to a minimum.

The 35-watt power amplifier, model A-340A, is the first unit to appear on the market using the new Tung-Sol 6550 in the output stage. The amplifier consists of four stages—a 12AY7 as an amplifier and direct coupled phase splitter, a 12AU7 as a push-pull driver stage and the 6550's in the output, connected as beam tetrodes. A voltage regulator tube serves to maintain the screens at a fixed voltage below the plates. A control in the output circuit permits adjusting the impedance of the amplifier on the 8-ohm tap over a range from −4 ohms through 0 to +4.5 ohms so as to accommodate practically any type of speaker and enclosure. The networks $R_{11}-C_{11}$ in the feedback circuit and R_8-C_7 in the grid circuit of the second triode section control the input-output phase relationship at high frequencies so that stability is obtained with any type of load. Since this is the first 6550 amplifier circuit to be made public, the schematic of the amplifier is shown in its entirely in *Fig.* 10a.

Ampex Corporation, 634 Charter St., Redwood City, California.

While this manufacturer is primarily known for its tape recorders, it also has a line of high-power amplifiers intended for theater use. It does, however, have one unit that might find its way into a home system—the model 620 amplifier-speaker. The amplifier itself consists of three stages—a 5879 direct coupled to a "long-tailed pair" type of phase splitter using a 12AU7, and a pair of 6V6's in the output stage. It is combined with an efficient 8-inch loudspeaker in a portable carrying case, and together the amplifier and speaker provides a fairly flat acoustic output from 65 to 10,000 cps. This is accomplished by a frequency-selective network in the feedback circuit when the built-in speaker is being used—when an external speaker is used, the network is out of circuit and the amplifier is within 1 db

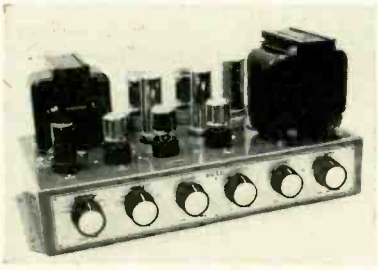


Fig. 12. Bell Model 2200C amplifier.



Fig. 11. The Ampex Model 620 Amplifier-Speaker combination.

of flat throughout the audio spectrum. *Figure* 11 shows the external appearance of the unit with the cover of the case removed.

Bell Sound Systems, 555 Marion Road, Columbus, 7, Ohio.

One of the most interesting examples of the Bell line of equipment is the new Model 2200C, shown in *Fig.* 12, particularly because of its engineering features. This unit was designed especially for those who are interested in serious home music systems or who are inclined to experiment with audio reproduction. It has a rated output of 20 watts with less than 0.3 per cent harmonic distortion and 2 per cent IM distortion (actual power output, not equivalent sine-wave power as most measurements are made). For comparison purposes, this value would be approximately 29 watts. This amplifier uses a 6SC7 as a preamplifier, with feedback equalization over the second half, and with a built-in rumble filter. The input circuits were designed to accommodate high- and low-level magnetic pickups, crystal pickups, microphone, and three high-level sources. The selector switch is followed by a loudness control and the first section of an uncompensated volume control. The second section of the volume control precedes the basic amplifier and serves to keep hum output to a minimum when reproducing sound at very low levels. The tone controls both employ dual pots to permit optimum shaping of the response curves and to ensure flat response at the center positions of the controls. The basic amplifier is fairly conventional as to tube lineup—with a 6SN7 as amplifier and cathodyne phase splitter, 6SL7 as driver, and two 5881's as the output stage, which differs in that it is both plate and cathode loaded—the latter by means of a tertiary winding on the output transformer. A chassis mounted switch permits selection of microphone or phonograph application of the preamplifier, and a d.c. balance control is provided for the output stage. A hum-balancing control adjusts the tap on the positively biased heater circuit for minimum hum. One additional control permits adjustment of radio tuner signal to match that of the phono preamp output.

This unit appears to have been designed with practical requirements in mind, and provides in a single chassis considerable flexibility.

Following the modern trend for compactness, the 12-watt Model 2256 amplifier, *Fig.* 13, provides many of the same features as the 2200C, but in a smaller package and with less power output. This unit employs two 6V6's in the output stage, and requires fewer stages, but it has both volume and loudness controls, bass and treble tone controls, and five equalization positions for phono, with input accommodations for high- and low-level magnetic pickups as well as for crystal, ceramic, and capacitance pickups. The housing is the same size as the Model 2255 AM-FM tuner.

Another unusual amplifier in the Bell line is Model 3-D, the binaural amplifier. This unit incorporates two separate 10-watt 6V6 amplifiers on the same chassis, with selector switch, function switch (which permits binaural, monaural, and binaural-reverse operation) a control for balancing the two channels, and gain and tone controls which operate simultaneously on both sections.

The most elaborate unit in the line is Model 2145-A, which comes with a remote control unit which requires only one cable between the main chassis and the control box, all inputs and outputs being connected directly to the main chassis. This amplifier—a 30-watt unit—will fit in with many users' requirements where the control unit must be separated from the main chassis. The line also includes several smaller amplifiers for modest applications.

David Bogen Co., Inc., 29 Ninth Ave., New York 14, N. Y.

The Bogen line is one of the largest in the hi-fi field, commencing with the 30-watt DO30, with variable damping factor; and following with 20-watt DB20 and DB20DF the latter also incorporating the variable damping factor; the 15-watt DB15; the 10-watt DB110; and the old standby, the 10-watt DO10. In addition, a new preamplifier-equalizer has just been announced, the PR100, which incorporates some unusual features.

The variable damping factor feature is of some interest, and has been intro-



Fig. 13. Bell Model 2256 compact amplifier.

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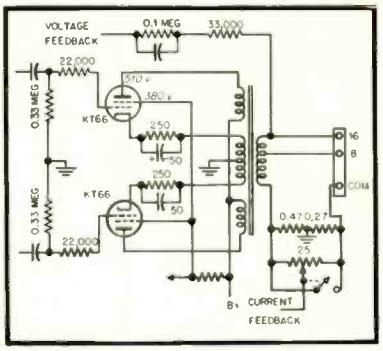


Fig. 14. Output stage arrangement of the Bogen DO30A amplifier. The QUAD II is similar, but uses a common cathode resistor between the center tap of the tertiary winding and ground.

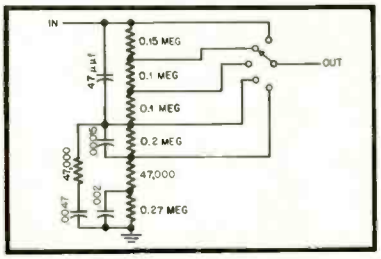


Fig. 15. The Bogen "Loudness Contour Selector" circuit.

duced by several manufacturers during the past year under various names. As used in Bogen amplifiers, the damping factor control permits the loudspeaker damping to be adjusted from a low positive value through infinity to a low negative value. This control is effective only in the frequency range below 300 cps, and permits loudspeaker damping to be adjusted for optimum low-frequency response. For further information on this circuit, the reader is referred to an earlier article[7] on the subject, in addition to that of reference 3. The DO30 utilizes some cathode loading of the output tubes, which are KT-66's operated as tetrodes. *Figure* 14 shows the output stage with the variable damping factor connection to the cathode of the first amplifier stage indicated. The DO30A is only a power amplifier, having no controls, and requiring the use of a preamplifier-control unit or a tuner with suitable controls for complete system operation.

The DB20 series incorporates two additional tubes to provide a preamplifier and tone controls, and is thus a complete unit in itself. The output stage employs 6L6G's in a similar circuit to the DO30, and the variable damping factor control is available as the DB20DF. The tone control circuit is basically that of the Baxendall design, and while the volume control is uncompensated, the amplifier incorporates a "Loudness Contour Selector," as do many other Bogen amplifiers. This device is, in effect, a volume control with 10-db steps and with suitable compensation so the listener sets the control at a point corresponding to the level at which he wishes to reproduce the music. The calibration on the selector is in the number of db below normal performance level that the reproduction is to be heard, and is readily mastered by the user in a short time. *Figure* 15 shows the configuration of the loudness contour selector which is connected between the source selector switch and the first section of the volume control.

The DB15 is slightly smaller than the DO20, but is similar in circuit design, employing the Baxendall tone control and the loudness contour selector. It is normally used in a housing shown in *Fig.* 16 which eliminates the need for cabinetry in such installations where the user might wish to place the amplifier on a bookshelf, for example.

The 10-watt DB110 is a relatively new addition to the line, but it is quite complete in its features and serves well for smaller installations where price becomes a factor. It incorporates a preamplifier-equalizer, and the Baxendall-type tone control is used.

The DO10 has long been a popular amplifier in the low price class. It has no controls except a semi-fixed volume adjustment, but provides 10 watts to 4-, 8-, or 15-ohm loudspeakers.

The PH10 is another 10-watt model, but provided with a 3-position input selector switch, a volume control, and a tone control with four fixed positions It is equipped to feed 3.2- and 8-ohm loudspeakers.

The Challenger HF8—also built by Bogen—is an 8-watt model which provides continuously variable bass boost and treble rolloff controls, and has a fader-type volume control with tuner input to the left and phono input to the right of the center position. An equalized preamp is included, with a chassis mounted switch to select magnetic or crystal and ceramic pickup inputs. It is designed to feed 4-, 8-, and 16-ohm loudspeakers.

The new PR100 Deluxe Preamplifier, shown in *Fig.* 17, uses four dual con-



Fig. 18. Front and rear views of the Brociner Mark 12.



Fig. 16. Bogen DB15G amplifier.



Fig. 17. The forthcoming Bogen PR100 preamplifier-control unit.

centric controls and six pushbuttons to provide its many characteristics. Low and high ends are separately controllable in the phono preamplifier; separate bass and treble boost and cut controls are provided; low- and high-pass filters are selected by a third pair of knobs; and the volume control and the loudness contour selector are incorporated into the remaining dual unit. Input sources are selected by the pushbuttons. The phono input stage is a cascode, and sufficient gain is provided for the low-level moving-coil pickups. In addition, recorder output and tape monitor facilities are built in, d.c. is used on the heaters of the first four stages, and a.c. convenience receptacles are provided. This model seems to offer all the features that anyone could think of, with the possible exception of a presence control.[8]

Brociner Electronics Laboratory, 344 E. 32nd St., New York 16, N. Y.

In addition to the UL-1 power amplifier, the A100 preamplifier-equalizer, and the CA-2 control amplifier described in the EQUIPMENT REPORT in the November, 1954, issue, the Brociner line incorporates two new models—the Mark 12, which is a compact single-unit 12-watt amplifier, and the Mark 30 series, which consists of a 30-watt power amplifier and a separate control center.

The Mark 12, shown in *Fig.* 18, provides an input for magnetic pickups, another for crystal, ceramic, and capacitance pickups, and three high-level inputs, as well as a recorder feed which is not affected by the loudness control—although it does follow the tone controls. It uses two 6AQ5's as tetrodes, fed by one half of a 12AX7 as a cathodyne phase splitter, which is direct coupled to the first half of the 12AX7 as a voltage

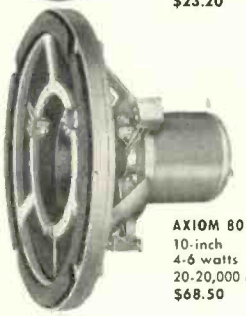
[7] Charles A. Wilkins, "Variable damping factor control," AUDIO, Sept. 1954.

[8] C. G. McProud, "Preamp with presence," AUDIO ENGINEERING, Jan. 1954.

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amplifier. The loudness control may be removed from the circuit by inserting a pin plug into a phono jack on the rear of the chassis. The input selector is combined with the low-frequency turnover control, with four phono positions, AES, NARTB, 800, and LP. The rolloff control is separate, and provides droops of 0, 5, 10.5, 12, 13.7, and 16 db at 10,000 cps.

The entire unit is enclosed in a perforated metal case which provides good ventilation. Outputs of 4, 8, and 16 ohms are available, and all connections are made on the rear of the case. Printed-circuit wiring is used in this model, which accounts for the small size—the panel area being only 4¼ × 10⅞ in.

Figure 19 shows the Mark 30A power amplifier, which is also compact because of printed wiring. It has no controls, but is designed to work with the 30C control center, which resembles the Mark 12 in panel appearance. The amplifier has an output of 30 watts with 1 per cent IM distortion, and is 3½ in. deep, 12 in. long, and 9 in. high. The control center provides essentially the same functions as the Mark 12, but uses a panel-mounted switch to cut in or out the loudness compensation, and in addition has a switch to select one of two pickups. Equalization curves on both the Mark 12 and Mark 30C are tailored to exceptionally close agreement with the prescribed recording characteristics.

Cook Laboratories, 101 Second St., Stamford, Conn.

Many enthusiasts have a highly developed interest in stereophonic reproduction, and in order to control the sound sources, some special type of amplifier is required unless the user is willing to put up with the inconvenience of handling two separate units. Cook Laboratories manufactures a dual control unit, the BN/mn preamplifier shown in *Fig.* 20. It is designed to accommodate either two tuners or two phono pickups, and is fitted with a selector switch to choose between radio binaural, phono binaural, or phono monaural, using only the "left" phono pickup. Dual bass and treble tone controls as well as a dual volume control permit adjusting both circuits simultaneously, while a "focus" control effectively adjusts the balance between the two halves of the unit. A reversing switch switches the outputs so as to accommodate various placements



Fig. 20. Cook BN/mn binaural-monaural preamplifier.

of the two channel microphones to best suit the listener's requirements. The unit uses two cathode followers for the output circuits, and requires an external power source of 400 to 450 volts at 20 ma and 6.3 volts at 1.2 amps.

The Radio Craftsmen, Inc., 4401 N. Ravenswood Ave., Chicago 40, Ill.

The Craftsmen line consists of the C350 equalizer-preamplifier, the Solitaire—a 20-watt self-contained unit—the 30-watt C550 power amplifier, and the 10-watt model 400.

The C350, described in the December, 1954, EQUIPMENT REPORT, is a self-powered input unit which provides for magnetic pickup input as well as three high-level sources, and provides an output for a tape recorder which is unaffected by volume or tone controls. The preamplifier accommodates seven recording characteristics, matching the curves quite well. A dual volume control, which may be connected by a panel switch so that one section operates as a loudness control, reduces hum to a minimum for low-level reproduction; the tone controls are fed from separate stages, thus isolating them from each other to prevent interaction. Construction is sufficiently open to permit easy servicing, and noise is kept to a minimum by the use of deposited-carbon resistors in the low-level stages, with the British Z729 in the first stage further reducing noise in the phono circuits. This unit is shown in *Fig.* 21 with a filter control section which provides cutoff of both low and high frequencies independently to reduce rumble and undesired high-frequency disturbances.

The Solitaire, *Fig.* 22, incorporates the same basic functions as the C350 together with a 20-watt power amplifier in the same unit. It has four equalization positions, and provides for three high-level inputs. It uses the Baxendall tone control circuit and a dual concentric volume control—one section being uncompensated while the other is a loudness control, It also provides a recorder output which is unaffected by the loudness control, but is controlled by the level-setting volume control and the tone controls. Three-position filter switches are built in, permitting cutoff at 40 and 150 cps on the low end, and at 6500 and 3000 cps on the high end, in addition to the flat positions.

The C550 power amplifier is a fixed package of gain employing two KT66's in an Ultra-Linear output stage. This model is equipped with a thermostatic time-delay switch which does not apply plate voltage to the amplifier until the tubes have warmed up. This is a desirable feature for high-power equipment, since voltages are likely to be high, and tubes may be damaged without this protection. The amplifier circuit is similar to the Williamson, using two 6SN7's ahead of the output stage.

The 400 is somewhat smaller, using 6V6's in the output stage, driven directly by the phase splitter which is in turn driven by two voltage amplifiers. It provides for 4-, 8-, and 16-ohm output taps, and furnishes its rated output from a 0.7-volt input signal.

Electro-Voice, Inc., Cecil and Carroll Sts., Buchanan, Mich.

One of the major advances in audio amplifier design has been introduced by this company with its entry into the amplifier field during the past year. This involves the elimination of one of the common sources of distortion in power amplifiers when working close to maximum output.

Under these conditions, the plate current in the output transformer flows alternately to the two output plates, since one of the tubes is practically cut off during the half cycle when the other is drawing maximum current. During the next half cycle, the position is reversed. This results in what is termed a "switching transient," since the plate current in each tube is "switched off" for a portion of each cycle, and because of the leakage inductance in the transformer, this abrupt change in current creates a momentary transient voltage twice during each cycle.

In an effort to avoid this particular form of distortion, the E-V amplifiers employ a bridge-circuit configuration which eliminates plate current from the primary winding of the output transformer, with the simplified circuit shown in *Fig.* 23. With this arrangement, one half of the load is in the plate circuit of each tube and the other half is in the cathode circuit. However, the same winding serves both tubes, so the portion that is in the plate circuit of one



Fig. 19. Brociner Mark 30A power amplifier.

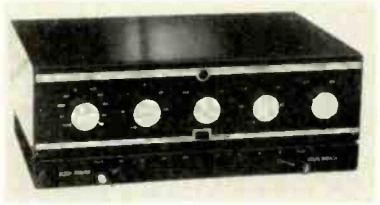


Fig. 21. Craftsmen C350 preamplifier and control unit with the C375 filter mounted below it.



Fig. 22. The new Craftsmen Solitaire.

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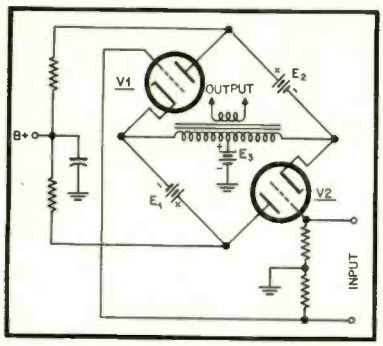


Fig. 23. Schematic of bridge output circuit of E-V amplifiers to show plate supply for preliminary stages.

tube is in the cathode circuit of the other. Thus there is a close coupling between the tubes, and by proper arrangement of the power supplies, no d.c. appears in the windings. This does require that two separate power supplies be used, but since the requirements are thus halved, the additional complication does not increase the cost appreciably. In addition, the plate supply to the driver stage is derived from the output stage in a fashion which adds the signal voltage to the supply voltage, and the resulting voltage to the driver stage is "bootstrapped" when it is driving the output tubes the hardest. The over-all result is a reduction in distortion, and these units have excellent operating characteristics.

Another feature of these amplifiers is the employment of a dual control in the variable-damping circuit which maintains the *total* feedback constant, although the voltage feedback and the current feedback are both being varied together. The arrangement that provides this feature is shown in *Fig.* 24.

These features are incorporated in both of the E-V amplifiers—the 30-watt A-30 power amplifier, and the 20-watt unit which is complete with preamplifier and control section. The A-30, *Fig.* 25, uses two 6BG6's in the output stage, with a 12BH7 driver and a 12AX7 as a voltage amplifier and phase splitter. The damping factor is adjustable from 0.1 to 15, and the rated output is obtained with an input of 1.25 volts.

The A-20C amplifier, *Fig.* 26, proves the advantage of the circuit by reaching a power output of 20 watts from a pair of 6V6's, which are usually employed in 10-watt amplifiers. Aside from its lower power rating, the A-20C has the same type of output circuit and the same damping factor control as the A-30, and in addition has preamplifier and tone control stages, both loudness and volume controls, and inputs for ceramic and magnetic phono pickups, radio, tuner, and tape, and it provides an output for feeding a tape recorder—the latter being controlled by both tone and level-setting controls. One feature of the E-V output circuit is that it provides a 600-ohm output without requiring a complicated output transformer—most transformer engineers believing that it is practically impossible to design a conventional transformer which will give good response on both speaker and line windings over the wide frequency range required for modern high-feedback amplifiers. The 600-ohm output comes from taps on the primary of the output transformer, the center tap of which is grounded.

Two input sets are available for use with the A-30 amplifier—the PRC-1 which will accomodate both ceramic and magnetic pickups, and the PRC-2 which does not have the preamp required for the magnetic pickups. Both of these input sets consist of two separate units—one being the preamplifier unit which has a master on-off switch and a function selector on the panel, and four individual level controls on the rear apron. The remote control unit accommodates the record compensation switch with nine positions, a level control, and bass and treble tone controls, a volume-loudness switch, a presence switch which introduces an 8-db rise at 5000 cps, and a rumble-filter switch which reduces the response 30 db at 30 cps and only 3 db at 70 cps. These units take their power from the A-30 line amplifier.

Espey Manufacturing Company, Inc., 528 E. 72nd St., New York 21, N. Y.

For use primarly with their models 710 and 700 AM-FM tuners, this company provides the Model 501 amplifier, shown in *Fig.* 27. It has no controls, being designed to work with a tuner which provides all the control facilities. The output stage consists of four 6V6's, preceded by two 6SN7's in a conventional Williamson circuit. Rated at 24 watts, this amplifier is relatively small, being 12 in. long, 5 in. high, and 8 in. deep. It provides outputs for 4-, 8-, and 15-ohm speakers.

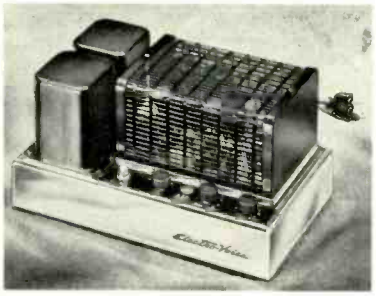


Fig. 25. Electro-Voice A-30 power amplifier.

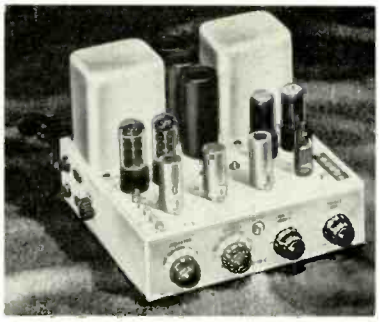


Fig. 26. Electro-Voice A-20-C amplifier—combining both power and control sections.

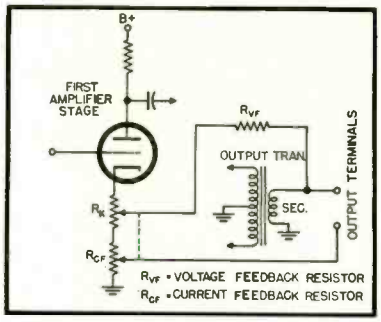


Fig. 24. Schematic showing variable voltage and current feedback used to change internal impedance of the amplifier.

Fairchild Recording Equipment Co., 154th St. and 7th Ave., Whitestone 57, N. Y.

This company has recently announced two units—the Model 240 preamplifier-equalizer, and the Model 260 50-watt power amplifier. The former, shown in *Fig.* 28, provides inputs for magnetic pickups and for three high-level sources. It uses a 12AT7 as a cascode input stage, followed by two 12AX7's as three voltage amplifiers and a cathode follower. The unit is self powered, using selenium rectifiers for both plate and heater supply—all heaters being fed with well filtered d.c.

This amplifier has an interesting design in that the knobs on the bass and treble tone controls are, in effect, the extremes of the audio spectrum curve, the center range being represented by a straight lucite bar. Thus the response curve may be said to be flat when the controls are in line with the center section, and as the response curve is changed by turning either control, the appearance of the "curve" as indicated on the panel is changed also. Another interesting feature is the use of a switch labelled LO, NORMAL, and HI for adjusting loudness compensation for different listening levels, at the same time dropping the level by some 15 db for each position down from HI.

The Model 260 power amplifier employs two 1614's in an Ultra-Linear output stage, driven by one section of a 12AU7 as a cathodyne phase splitter, preceded by the other section as a direct-coupled voltage amplifier, and by a 6AB4 in the input stage. Both bias and dynamic balance are adjustable. To adjust the latter, one inserts a phone plug into a jack on the chassis. This places a high a.c. signal on both output grids in phase.

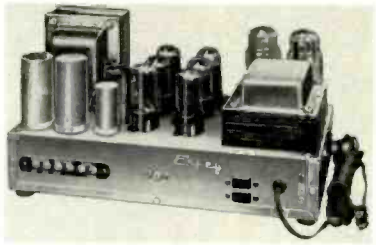


Fig. 27. Espey Model 501 Williamson-type amplifier.

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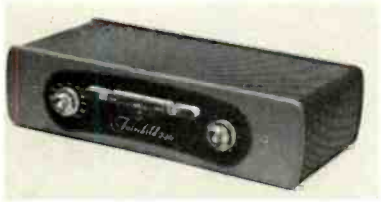


Fig. 28. The Fairchild model 240 preamplifier, with "Balanced Bar" tone-control arrangement.

Adjustment of the balance control to give minimum hum in the speaker balances the stage dynamically. A meter plugged into the same jack permits adjustment of the bias control—fixed bias being used on the output stage. The output transformer is tapped to accommodate 4-, 8-, and 16-ohm speaker loads.

Fisher Radio Corporation, 21-21 44th Drive, Long Island City 1, N. Y.

Offering a complete line of equipment, from a simple fixed-equalization preamplifier to a 50-watt power amplifier, the Fisher line is well reputed for its reliability and quality. The basic preamplifier, model PR-5, is designed to provide sufficient amplification, together with equalization for a 500-cps turnover, to permit changing to a magnetic pickup while still using an amplifier designed for a higher-level type. It is self powered, and employs a single 6SC7, with feedback equalization between the plates of the two sections of the tube.

Model 50-PR is similar in circuit, but provides variable equalization, with separate controls for low and high frequencies. The turnover control selects between AES, RIAA (NARTB, ORTHO), 800 cps, and the old LP curve, while the rolloff control provides droops of 0, 8, 12, and 16 db at 10,000 cps. The unit is housed in a small molded case, similar to the 50-F Hi-Lo Filter System, shown in *Fig. 29*. This latter unit permits the user to introduce a sharp cutoff at either end of the audio spectrum to eliminate rumble and hum in the low end, and needle scratch, distortion, and other objectionable disturbances at the high end. The Hi-Lo Filter is also self powered, and employs R-C networks for the high-pass filter action, and L-C networks for the low-pass filter action where sharper cutoffs are desirable. A single 12AX7 is used, with the filter networks between the two halves; the second section serves as a cathode follower to provide a low-

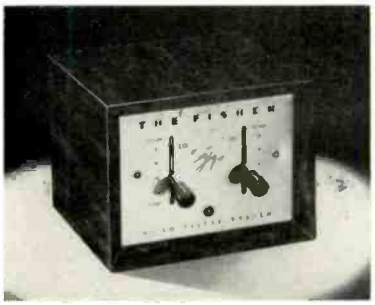


Fig. 29. Fisher Hi-Lo filter system, model 50-F.

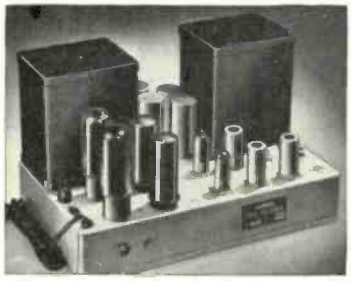
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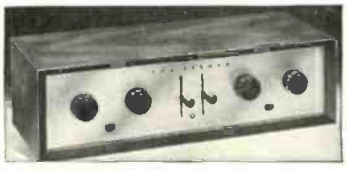
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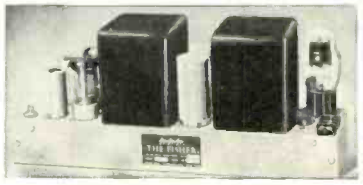
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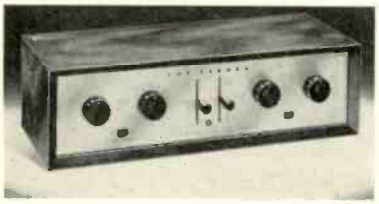


Fig. 30. Fisher Master Audio Control, series 30-C.

impedance output. Model 50-PR-C is identical to the 50-PR except for the addition of a volume control.

The Master Audio Control, 50-C-4, is shown in *Fig.* 30. This unit, which may be had in either blond or dark mahogany cabinets or in chassis form for installation in a larger equipment cabinet, provides essentially same facilities as the 50-PR for phono equalization, and has, in addition, a volume control, selector switch, separate bass and treble tone controls, and a loudness balance switch. This unit is also self powered, and furnishes filtered d.c. to the heaters of the three tubes—a 12AX7 preamplifier, a 12AU7 with one half serving as a cathode follower to provide a low-impedance feed to a recorder and to drive the volume control while the other half serves as the output cathode follower. The other 12AX7 serves as a voltage amplifier to provide sufficient gain for the tone controls. The loudness switch cuts in or out of circuit an R-C network connected to the volume control.

The amplifier line is completed with two power amplifiers, the 25-watt Model 70-AZ and the 50-watt Model 50-AZ, shown in *Fig.* 31. Both employ the new "Z-Matic" control, which constantly and automatically adjusts the output impedance of the amplifier to match the impedance of the loudspeaker. A variable control permits the user to make this adjustment himself to obtain optimum performance and sound quality. The 50-watt model is noteworthy in that it employs only two 1614's as output tubes, working with fixed bias and fed by two cathode-follower drivers which are transformer-coupled to the output grids. This amplifier provides full 50-watt output with an input signal of 1.5 volts, and shows an IM distortion of only 2 per cent at 45 watts.

Freed Electronics & Controls Corp., 200 Hudson St., New York 13, N. Y.

This line consists of two amplifiers, the 10-watt model 910 and the 20-watt model 920. *Figure* 32 shows the former, which employs two 6V6's preceded by a 12AU7 driver and a 12AT7 voltage amplifier and phase splitter.



Fig. 33. Model A1-200 General Electric preamplifier and control unit.



Fig. 31. Fisher laboratory Standard Amplifier, Model 50-AZ.

The 20-watt amplifier uses two 5881's in the output stage, with one 12AU7 as voltage amplifier and phase splitter and another 12AU7 as driver. An additional 12AU7, preceded by a 12AT7 preamplifier provides complete facilities—except for controls—to work with a radio tuner which does have controls but no preamp.

General Electric Company, Radio & Television Department, Electronics Park, Syracuse, N. Y.

With the preamplifier and control unit as a "front end" and a 10-watt power amplifier to drive the loudspeaker, this line is small, but offers adequate flexibility for home use. The A1-200 control unit a 6SC7 as a phono preamp, followed by a cathode follower to drive the tone controls, two voltage amplifiers, and an output stage which—while not a cathode follower—offers an output impedance of 4000 ohms. The volume control can be connected, by means of a switch on the rear of the chassis, to work as a loudness control. This unit is designed to work with a GE pickup, and if other pickups are to be used a few changes of resistors and capacitors must be made in order to maintain the same characteristics, because the rolloff and cutoff controls function with the inductance of the pickup to give the required results. The unit is self powered, using a selenium rectifier for plate supply, and is shown in *Fig.* 33.

The 10-watt power amplifier, Model A1-300, is a compact unit using a 12AX7 as two voltage amplifier stages, followed by a 6C4 cathodyne phase splitter and a pair of 6V6's in the output stage. It has relatively low IM distortion for a 6V6 amplifier, and provides rated output at 2 volts normally, with a minor change making it possible to obtain full output with an input of 0.3 volts. This unit is shown in *Fig.* 34.



Fig. 34. General Electric Model A1-300 power amplifier.

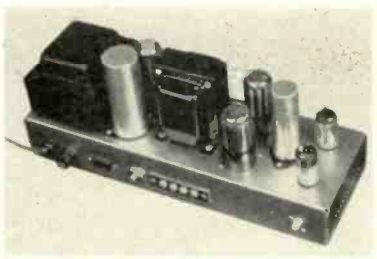


Fig. 32. Freed model 910 10-watt amplifier.

Harman-Kardon, Inc., 520 Main St., Westbury, L. I., N. Y.

In addition to Model D-1000, the Festival—a deluxe AM-FM tuner with tone controls and phono preamp combined with a 20-watt Ultra-Linear power amplifier, this company offers the Melody, Model C-100, which is a self-contained unit having a power output of 10 watts, and equipped with tone controls, a phono preamp with three degrees of equalization, and a loudness contour selector offering six positions of compensation.

The amplifier, shown in *Fig.* 35, employs a 12AX7 as the preamplifier, with feedback for equalization, and with inputs from high-level sources being fed to the grid of the second section to provide more usable gain. Full output is obtained with 0.3 volts from the high-level jacks, and with 8 mv from the phono input. LP, RIAA, and EUR equalizations are offered on the three positions of the selector switch, with tuner and two auxiliary inputs occupying the other three positions. Bass and treble tone controls follow the input section, and they feed the volume-loudness control. The contour selector places a resistor network across each of two capacitors in the compensating network to adjust the amount of boost at the low frequencies. After the desired loudness level is set the volume control effectively serves to adjust level.

The "basic" part of the amplifier consists of a 12AT7 as voltage amplifier and direct-coupled phase splitter, a 12AU7 as a driver, and a pair of 6CM6's as the output stage. Feedback is taken from the secondary of the output transformer to the cathode of the first section of the 12AT7, and output impedances of 8 and 16 ohms are provided.

Heath Company, Benton Harbor, Michigan.

The success of this company's kits originally introduced to allow service technicians and experimenters to construct their own test equipment at a

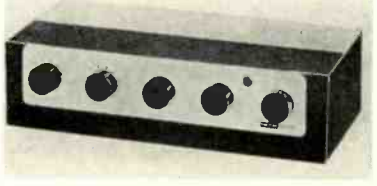
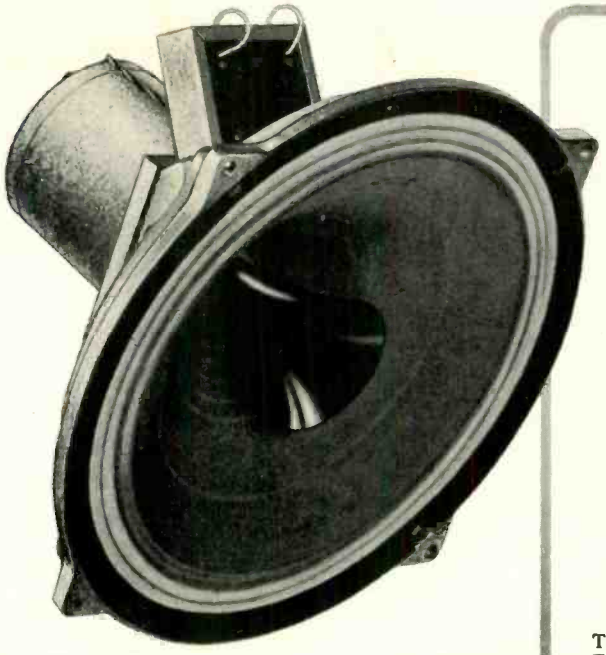


Fig. 35. Compact Harman-Kardon amplifier, model C100.

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Fig. 36. Heathkit Preamplifier—one that the user can build himself.

considerable saving over factory-built units led them into the amplifier field. The most popular amplifier so far has been the "Williamson Type" amplifier, which is available either with the output tubes serving as triodes or with the Ultra-Linear circuit. This amplifier is built in two parts—the amplifier proper and the power supply. Power is furnished to either of two types of preamplifiers, with the newest model, the WA-P2, providing complete control facilities. This unit, shown in *Fig.* 36, has separate turnover and rolloff controls—the former with LP, RIAA, AES, and EARLY 78 positions, and the latter with droops of 0, 8, 12, and 16 db at 10,000 cps. Together these provide adequate flexibility. Separate tone controls are provided, and the volume control is not compensated. The three high-level inputs have separate level-adjusting controls, and one flat position of the preamplifier provides for a low-level microphone.

The new W-5M power amplifier is built on a single chassis with the power supply, and is equipped with a protective cover. This unit employs two KT66's in an Ultra-Linear output stage, and the design gives improved performance for at least one octave lower in the bass range, and to a considerable extent at the high end. A new balance circuit is incorporated which makes it possible to balance the output with only a VTVM, instead of the usual milliammeter. The use of KT66's in the output stage gives somewhat greater power output, as would be expected, and lower intermodulation and harmonic distortion is afforded, with improved phase-shift characteristics at both ends of the spectrum.

The Heath line includes several other amplifier kits, including one which is labeled the economy model, with a 6-watt output.



Fig. 38. Leak model TL/10 amplifier with remote control preamplifier and master control unit.

Interelectronics Corporation, 2432 Grand Concourse, New York 58, N. Y.

The current models of Interelectronics' amplifiers include the 40-watt "Coronation 100," and "Coronation" preamplifier-equalizer consolette. The latter is shown in *Fig.* 37.

The power amplifier consists of two 6SN7's driving two KT66's, and a speaker damping control is a feature of this model. This permits adjustment of the output impedance from approximately one third of the nominal impedance of the output tap to slightly less than zero with complete stability. This is important, for with a total of nine feedback loops in the amplifier, some care must be taken to ensure stability. To accommodate electrostatic loudspeakers —which are probably imminent—this amplifier is equipped with an output jack with suitable connections.

The control consolette has separate rolloff and crossover controls, each with four positions, a source selector switch, a volume control with separately controllable loudness contour, and separate bass and treble controls. For extreme quiet in the preamplifier section, the Z729 is used, and low-noise resistors are used in critical circuits. All equalization—both for phono and for the tone controls —is done by judicious use of feedback.

H. J. Leak & Co, Ltd., (Distributed by British Industries Corporation, 164 Duane St., New York 13, N. Y.)

The Leak amplifier first introduced in this country in 1949 was, for that time, unusual in the extremely low distortion at rated output—the name "Point One" referred to 0.1 per cent harmonic distortion—and it is, in addition, a model of neat and efficient construction. The TL/10 differs from the earlier TL/12 primarily in power output, but the newer 10-watt model has equally low distortion. Needless to say, frequency response is flat over the audio spectrum, so distortion remains the important difference between amplifiers.

The TL/10 consists of two chassis, *Fig.* 38—the remote control preamplifier and the basic amplifier. The former consists of two stages, both using EF86's (which are equivalent to Z729's) with feedback around the first stage for phonograph compensation, while the second stage, triode connected, serves as the output tube. Four equalization curves are provided, with close adherence to the prescribed curves. The tone control is of a modified Baxendall type, and the volume control follows the second tube, thus reducing hum and noise from the preamplifier unit as volume is reduced. A tape recorder feed, appearing as a jack on the panel of the control unit, is connected to the output of the second stage just ahead of the volume control. Another panel-mounted jack provides for the input from a tape recorder—this arrangement making it simple for the user to connect a portable tape recorder to the amplifier when he wishes to use it, and equally simple to remove it from the circuit when it is not in use.



Fig. 37. Interelectronics "Coronation" consolette.

Both tuner and pickup inputs are fitted with level-adjusting controls, and a terminal strip on the rear of the unit permits connecting a load resistor to suit the particular pickup used. The input signal required at the phono jack for 10-watt output is 8 mv, while a signal of .05 volts at the tuner or tape recorder jacks will give the same output.

The power amplifier is noted for its neat construction, with cabled wiring, and most of the small components mounted on a resistor board. The tube lineup consists of an EF86 pentode as the first stage, a "long-tailed pair" consisting of the two sections of a 6SN7 for the phase splitter and driver, with a pair of KT61's—similar to 6V6's but with somewhat more linearity and considerably more power sensitivity—in an Ultra-Linear connection for the output stage. With four minor changes, KT66's may be substituted for the KT61's, and under these conditions the amplifier will function the same as with KT61's. These changes accommodate the lower power sensitivity of the KT66's by providing increased gain in the first stage of the amplifier.

The basic amplifier provides a power supply for an external tuner unit—a plate voltage of 330 at 20 ma current drain, and a heater supply of 6.3 volts at 1.5 amps. The two sections of the amplifier are connected by a six-wire cable, with the input lead being shielded. The external power supply is available on the control unit.

S. B. Marantz, 25 W. 43rd St., New York 36, N. Y.

The Marantz Audio Consolette has achieved considerable popularity since it was first introduced. It is a three-tube unit, requiring a separate power supply which is a small selenium-rectifier unit. Both are shown in *Fig.* 39.

The amplifier provides low-level inputs for microphone and two pickup out-

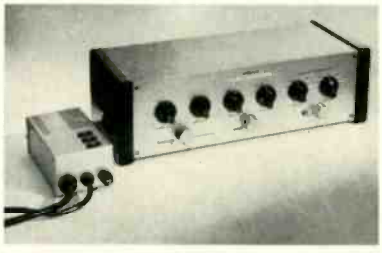


Fig. 39. Marantz Audio Consolette with separate power supply unit.

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puts, and four high-level inputs—all being chosen with one selector switch. Turnover and rolloff are separately adjustable, and the recorder feed is connected ahead of both tone and volume controls. A loudness compensator permits adjustment for listening level, and a four-position switch provides three positions of low-pass filter and one flat position. Output is from a cathode follower, with an output impedance of approximately 5000 ohms. Heaters are supplied with direct current, and the separate power supply unit removes all a.c. equipment from the amplifier proper, with the exception of the power switch.

The low-level phono input has sufficient gain to work with the 1- to 3-mv pickups and provide full output without the use of a transformer.

Mark Simpson Manufacturing Co. Inc., 32-28 49th St., Long Island City 3, N. Y.

The Masco line of amplifiers consists of two models—the 10-watt Custom Ten and the 8-watt CM-8. Both employ 6V6's in the output stage, but with several differences in the earlier stages.

The Custom 10, shown in *Fig.* 40, provides one phono input, with a switch to accommodate high- and low-level pickups, and three high-level inputs for tuner

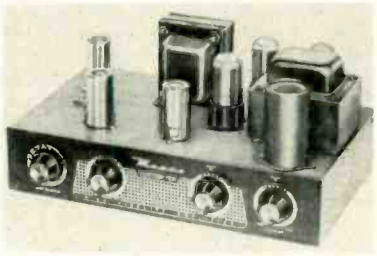


Fig. 40. Masco "Custom 10" amplifier.

and other sources. Feedback around the first two stages provides the equalization, with five positions being provided. The remaining circuit lineup consists of the compensated volume control, two voltage-amplifier stages with feedback around them, the tone control section, a voltage amplifier, a cathodyne phase splitter, and the output stage. A hum adjusting control is provided, and the recorder-feed output is located just ahead of the tone control network.

The CM-8 is a simpler unit, providing inputs for magnetic or crystal pickup and for one high-level input such as a tuner, with a fixed equalization network for phono. A 6SL7 serves as a voltage amplifier and phase splitter, with the bass tone control in the feedback network—the treble rolloff control being located in the grid circuit of the 6SL7.

McIntosh Laboratory, Inc., 324 Water St., Binghamton, N. Y.

With the introduction of the McIntosh circuit in 1950, a new era in high-power amplifiers was ushered in, for with only two 6L6's the first McIntosh model—50W-2—was capable of putting out a 50-watt signal with IM distortion less than 1 per cent. The basic difference



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Model W-3 consists of W-3M plus WA-P2 Preamplifier listed on this page. Shpg. Wt. 37 lbs., Express only $69.50

Heathkit
WILLIAMSON TYPE
(CHICAGO TRANSFORMER)



This hi-fi amplifier is constructed on a single chassis, thereby affecting a reduction in cost. Uses new Chicago high fidelity output transformer and provides the same high performance as Model W-3 listed above. An unbeatable dollar value. The lowest price ever quoted for a complete Williamson Type Amplifier circuit.
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Model W-4 consists of W-4M plus WA-P2 Preamplifier. Shpg. Wt. 35 lbs., Express only $59.50

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This latest and most advanced Heathkit hi-fi amplifier has all the extras so important to the super-critical listener. Featuring KT-66 tubes, special Peerless output transformer, and new circuit design, it offers brilliant performance by any standard.
Bass response is extended more than a full octave below other Heathkit Williamson circuits, along with higher power output, reduced intermodulation and harmonic distortion, better phase shift characteristics and extended high frequency response. A new type balancing circuit makes balancing easier, and at the same time permits a closer "dynamic" balance between tubes.
Aside from these outstanding engineering features, the W-5 manifests new physical design as well. A protective cover fits over all above-chassis components, forming a most attractive assembly—suitable for mounting in or out of a cabinet. All connectors are brought out to the front chassis apron for convenience of connection.
Model W-5M consists of main amplifier and power supply on single chassis with protective cover. Shpg. Wt. 31 lbs. Express only $59.75
Model W-5 consists of W-5M, plus WA-P2 Preamplifier shown on this page. Shpg. Wt. 38 lbs. Express only $79.50

Heathkit
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This particular 20 watt Amplifier combines high fidelity with economy. Single chassis construction provides preamplifier, main amplifier and power supply function. True hi-fi performance ±1 db, 20 cps to 20,000 cps. Preamplifier affords 4 switch-selected compensated inputs. Push-pull 6L6 tubes used for surprisingly clean output signal with excellent response characteristics and adequate power reserve. Full tone control action. Extremely low cost for real high fidelity performance. Shpg. Wt. 18 lbs. $35.50

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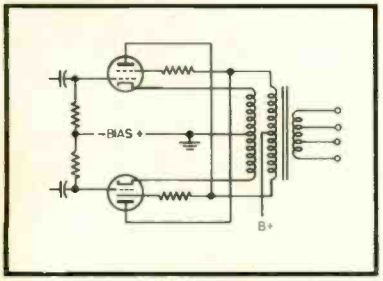


Fig. 41. Simplified schematic of the McIntosh output stage. Windings A and B are bifilar wound, with a 1:1 turns ratio.

between the McIntosh circuit and conventional amplifiers is in the output coupling system. The plates of the output stage are connected to opposite ends of a primary winding on the output transformer; the cathodes are connected to opposite ends of a second winding, as shown in *Fig.* 41. Both windings have the same number of turns, and they are wound bifilarly—with two turns of wire being fed onto the winding machine at the same time. Thus the plate of one output tube and the cathode of the other have the same signal potential. With pentodes, it is desirable to have the screen bypassed directly to the cathode, rather than to ground. By connecting each screen to the opposite plate—through a resistor to limit screen dissipation—it is at the same signal potential as the cathode, and at the same d.c. potential as the plate. Each output tube is thus operating with one half of its load in the plate circuit and one half in the cathode circuit. This gives excellent efficiency and power output and, since it represents approximately 100 per cent feedback in the output stage, reduces distortion greatly. This arrangement does require harder driving of the output grids, and in the 50W-2 the driver was coupled to the output stage by a transformer.

The newer Mc-30 amplifier, (*Fig* 42), rated at 30 watts, utilizes the same output connections, but employs cathode-follower drivers. While the power output is lower—30 watts—it is still adequate for any home requirement, and the distortion is held to an equally low minimum. The Mc-30 uses one half of a 12AX7 as the first stage, direct coupled to a 12AU7 as a "long-tailed pair" phase splitter followed by a 12BH7 push-pull voltage amplifier and another 12AX7 as the cathode-follower driver. The output tubes are 1614's, which have a high heater-to-cathode voltage rating. Fixed bias is used on the output stage.



Fig. 44. National Horizon 5 preamplifier and control unit, which plugs into either the Criterion tuner or the Horizon 20 power amplifier.



Fig. 42. McIntosh Mc-30 amplifier.

The output transformer has four windings—two are identical and are located in the plate and cathode circuits; a third winding serves as the "secondary" for feeding the voice-coil circuit outputs; and a fourth winding is employed only for voltage feedback to the cathode of the first tube. The unit is self contained, and furnishes power to a McIntosh preamplifier.

For those who want high power—and most particularly, for public address or hotel installations where many speakers are to be supplied, there is the K-107 series—available with 600/150 ohm output in K-107F, with constant-voltage feeds for multiple speaker installations in K-107G, and with 4-, 8-, and 16-ohm outputs, as well as 600 ohms, in K-107H. Each of these amplifiers is capable of putting out a 200-watt signal with less than 1 per cent harmonic distortion. The circuitry is similar, but larger output tubes are used—8005's—and power and driver requirements are all necessarily "king size."

Two preamplifiers are available—the Model C-104 which is fairly conventional, and some two years old, and Model C-8 which is comparatively recent. This model, shown in *Fig.* 43, provides extreme flexibility, since turnover frequencies are selected by switches and with five switches usable singly or in any combination desired, 29 different curves are available at the low end and 29 at the high end. This should be adequate for any possible curve now in existence or ever to be in the future. Separate bass and treble controls are provided, and an aural compensation switch adjusts loudness quality to suit the individual. Five inputs are available—two at high level, one unequalized at low level for microphones, and two equalized for phono pickups, one for high-output models and one for low-outputs. The latter incorporates a switch which may be opened to insert a series capacitor in the circuit for use with capacitance pickups, and a variable load resistor is provided so as to match any desired pickup. A five-position rumble switch introduces a one-, two-, three-, and four-section R-C network progressively as it is rotated, sharply reducing low-frequency response in the vicinity of 30 cps.

For those applications where the preamp is to be used with other than a McIntosh amplifier, the Model C-8P should



Fig. 43. Flexible control amplifier—McIntosh model C-8M.

be chosen, since it is self powered. The C-8 derives its power from the main amplifier.

National Company, Inc., 61 Sherman St., Malden, Mass.

This company is a relative newcomer to the hi-fi field, but its name has long been known for communications equipment. The line consists of a preamplifier-control unit, the Horizon 5, and two power amplifiers, the 10-watt Horizon 10 and the 20-watt Horizon 20.

The Horizon 5, *Fig.* 44, is designed to plug into the National Criterion tuner or the Horizon 20 amplifier, and it derives its power and all input and output connections through a 16-terminal plug, mounted at the rear. The unit employs some unusual circuitry (in addition to using printed wiring to a large extent), having, for example, a dual volume control which can serve as a binaural control, for which the tuner is equipped. Elaborate and well tailored tone controls are capable of giving a bass boost of 26 db at 20 cps and a cut of 19 db at the same frequency. At the high end, the boost is 11 db and the cut can be as high as 23 db at 10,000 cps. The unit employs but two tubes, both being 12AX7's, with feedback and losser equalization serving for the phono channel.

The Horizon 20 uses two 6L6G's in the output stage, the circuit being arranged to work one of the tubes with a plate load and the other with a cathode load. This is the single-ended push-pull configuration, and reduces the demands on the output transformer. Distortion is quite low, for the amplifier is rated at 20 watts yet has only 3 per cent IM distortion at slightly over 30 watts. The tube lineup consists of a 12AX7 with the first half operating as a voltage amplifier and the second half as a cathodyne phase splitter. Fixed bias is used on the output stage, and power is furnished to the Horizon 5 preamplifier



Fig. 45. National Horizon 20 power amplifier. When cover plate is removed, Horizon 5 amplifier may be plugged in making it a complete self-contained amplifier.

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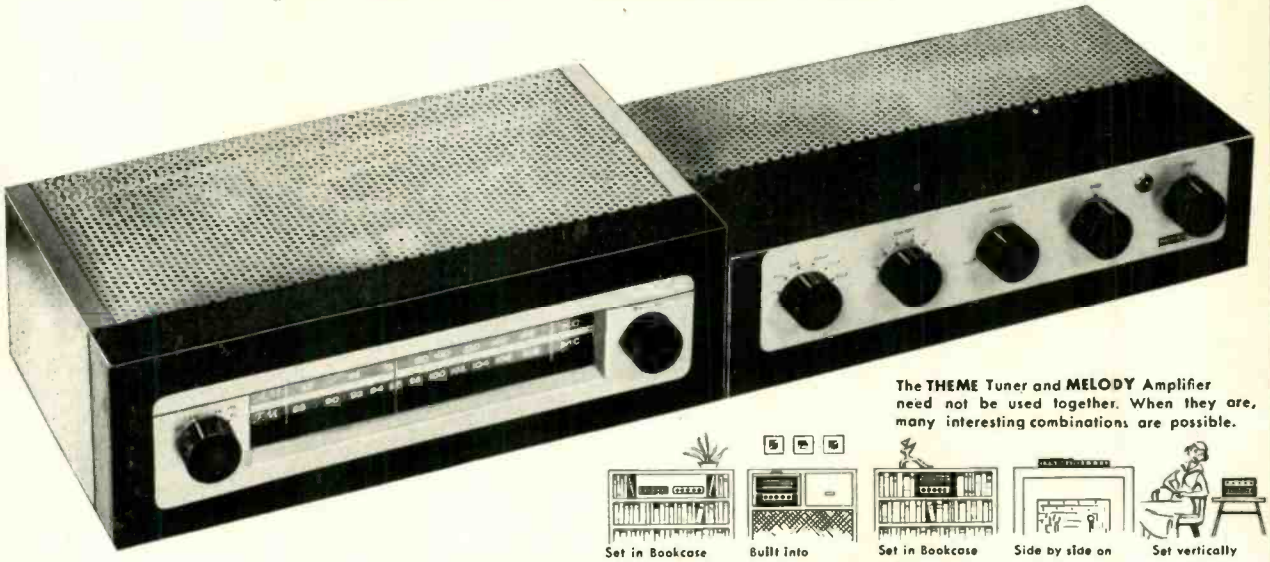
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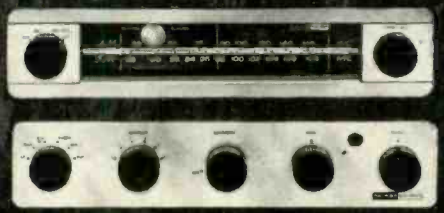
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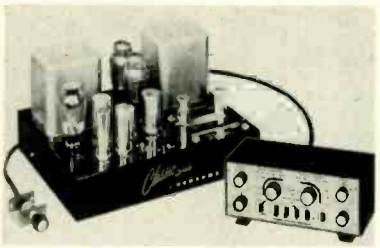


Fig. 46. Newcomb Classic 2500-R, with remote control unit.

unit which may be plugged in to occupy the space covered by the blank panel in *Fig.* 45. Input connections to the power amplifier itself, or to the Horizon 5 preamplifier are made on the rear apron, and a safety switch makes it necessary that either the preamp or the blank panel be in place in order to turn on the a.c. power.

The Horizon 10 is similar in appearance, but is equipped with a simpler type of preamplifier and control unit, which is an integral part of the amplifier and is not removable.

Newcomb Audio Products Co., 6824 Lexington Ave., Hollywood 38, California.

The Newcomb "Classic" line is quite complete, offering some eight conventional amplifiers—three with remote control units—a stereophonic model for two-channel reproduction, and two Compact models. The Classic 2500-R, shown in *Fig.* 46, is typical in appearance for the remotely controlled units, and the Compact 12, shown in *Fig.* 47, is typical of the smaller units.

There are two 25-watt models, one with and one without remote control; two 15-watt models, with and without remote control, a 12-watt unit with remote control, and a 10-watt unit; all in addition to the two Compacts, with 10 and 12 watts respectively. The R-7 Remote-Control Preamplifier permits remote operation with any amplifier, and consists of two units—the control unit and the power supply which also incorporates preamplifier tubes to feed signals from low-level inputs through the cable to the control unit.

Another interesting and useful feature of the Newcomb line is the Audi-Balance—an arrangement by which the user can adjust the two tubes of the output stage without the need for meters. Operation of a switch places a 60-cps a.c. potential of about 3 volts on both output-tube grids



Fig. 48. Pickering model 410 Audio Input System.

in phase. If the tubes are perfectly balanced, no hum will be heard in the loudspeaker because of the push-pull output stage which requires that the signal be fed to the grids 180 deg. out of phase. If hum is heard, the user adjusts the balancing control to reduce the hum to a minimum, then restores the switch to the normal position.

Constructionally, there are several fine features in the Newcomb units. Most of the small components—resistors and capacitors—are firmly mounted, with any larger than 1-watt resistors being supported by clips so as to avoid strain on the leads. Another feature which simplifies mounting in a cabinet is the Adjusta-Panel, which is a subpanel on which the controls are mounted, and which can be moved forward so as to permit the shafts to extend through panels up to ¾ in. thick.

Pickering & Co. Inc., 309 Woods Ave., Oceanside, N. Y.

Primarily a manufacturer of pickups, this company has one amplifier unit which serves as the control point for high-quality systems. The Model 410 Audio Input System provides one phono input and two high-level inputs, together with tone controls, equalization selector, and a volume control. It is self powered, and is designed on the lines of a professional unit. The equalization is meticulously correct for the positions provided, the bass tone control provides six positions (using a tap switch) of bass boost, the maximum being 12 db at 30 cps; the treble control, also a tap switch, provides one boost position of 4 db at 10,000 cps, a flat position, and four cut positions with a maximum droop of 14 db at 10,000 cps.

The unit, pictured in *Fig.* 48, is self powered, and employs a 6AU6 as the preamplifier, and three 6AB4's—two as voltage amplifiers and the third as a cathode follower. A 6X4 serves as a rectifier.

Pilot Radio Corporation, 37-06 36th St., Long Island City 1, N. Y.

Because of the completeness of this line, it would be impossible to describe all models. The most important, from the user's standpoint, appear to be the inexpensive Model AA-903; the basic 15-watt Model AA-410; and its big brother, the 30-watt AA-904; and the relatively new and compact AA-420.

The AA-903 is a single-chassis 10-watt amplifier providing inputs for magnetic pickups with four equalizer positions, and for three high-level inputs. Separate treble and bass tone controls are used, and a dual volume control helps keep hum to a minimum during low level reproduction. The output stage uses 6V6's, and feedback is applied over the last three stages.

The tone controls are of somewhat unique design in that they are completely flat at the center positions. The networks are fed from one half of a dual triode through circuits which introduce equal amounts of boost and cut when the controls are set at the center. When the

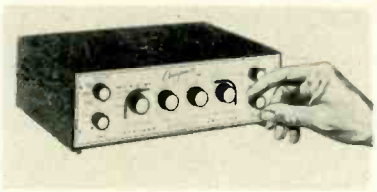


Fig. 47. Newcomb Compact 12.

slider moves toward BOOST, the cut is decreased while the boost remains constant, with the result that the level is boosted. The reverse action occurs when the slider is moved toward CUT. This arrangement gives curves of good listenability.

In all Pilot models, shielded heater leads are used where necessary to reduce hum to a minimum, and low-noise resistors are used in critical circuits.

The AA-410 is a basic amplifier using 5881's in the output stage. The circuit consists of two voltage-amplifier stages, a cathodyne phase splitter, and the output stage. This unit is designed to work with a separate preamplifier.

Model AA-904 is a deluxe basic amplifier, with KT66's in the output stage. It is a Williamson-type amplifier, using two 6SN7's with one as voltage amplifier and phase splitter, and the other as a push-pull driver. Dual phase-correcting networks are employed in the feedback network to achieve good stability. This model, shown in *Fig.* 49, is also designed to work with an external preamplifier or with a tuner which incorporates tone and equalization controls, such as the Model AF-860.

The AA-420 is a compact 15-watt amplifier using 5881's in the output section, and equipped with preamplifier, tone controls, and a compensated two-section volume control. While similar in function to many other compact units, as seen in *Fig.* 50, it is essentially an AA-903 on a small chassis turned on its side and combined with a preamplifier and control unit. It provides for a phono input, with a variable load resistor to suit the pickup used, and with a dual-concentric switch with separate sections for bass and treble equalization curves. Three high-level inputs, each with separate level-setting controls, are designed for radio, TV, or tape inputs. The tone control section is similar to the AA-903, but uses dual-concentric controls. Because of its small size, it is eminently suitable for use in bookcase



Fig. 49. Pilotone AA-904 amplifier.

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Fig. 50. Model AA-420 Pilotone amplifier.

installations, although it can be removed from the case and mounted in another cabinet if desired.

The Pilotrol, just announced this month, is a deluxe version of a preamplifier-control unit with a number of unusual features which should appeal to the critical listener who wants flexibility of control, and who indulges in recording — perhaps mixing locally originated material, such as voice, violin, or piano, with accompaniment from an orchestra from a phonograph record.

This unit, shown in *Fig.* 51, resembles a professional console in appearance, with the sloping panel, indicator lights, and push-button controls. It is equipped with a volume indicator and a switch that selects whether the meter indicates the recording output or the monitor output thus ensuring that the correct setting for the recording channel is maintained even though the user may change the monitor—the normal signal output—level.

The Pilotrol incorporates two preamplifiers—one equalized by proper settings of push-button controls for turnover and for rolloff, and the other flat for microphone—a push-button group for selecting the input source such as phono, radio, tape, and auxiliary, continuously variable bass and treble tone controls, a microphone control which permits mixing with any of the other input sources, volume and loudness controls, a meter-function switch, and a meter-range switch. Indicator lamps show which program source is connected. D. c. is used on the heaters of the preamplifier tubes for minimum hum, and a variable resistor permits adjusting the pickup load to match the magnetic pickup used. The unit is constructed so that it may be installed in a conventional cabinet, or it may simply be used in the sloping-front cabinet shown.

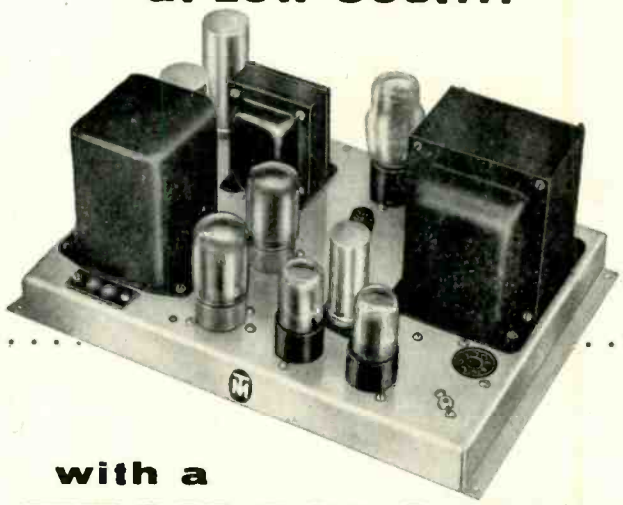


Fig. 51. The audiofan's delight—the new Pilotrol input unit.

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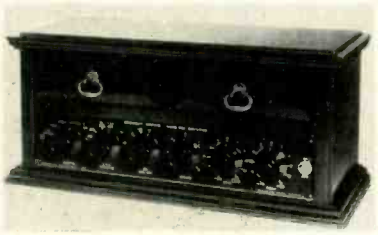


Fig. 52. Grommes Model 210PA preamplifier.

Normal output level is 1.0 volts, with rated harmonic and intermodulation distortions both less than 0.2 per cent at the 1-volt ouput. Input signal for normal output is 15 mv on the microphone channel, 10 and 45 mv respectively on the low- and high-level pickup inputs, and 150 mv on the radio, tape, and auxiliary inputs. Outputs on both monitor and recording channels are from cathode followers with an impedance of 500 ohms, and a rated hum level 90 db below 1 volt.

The experimenter will find another use for this instrument—with the high gain available in the metering circuits it would serve admirably as an a.f. vacuum-tube voltmeter, an accessory often longed for by the hobbyist.

Precision Electronics, Inc., 9101 King Ave., Franklin Park, Ill.

This company, manufacturer of the Grommes amplifiers, offers a wide range of models ranging from preamplifier-control units to 30-watt basic amplifiers. The most popular of the control units is the 210PA, shown in *Fig.* 52 installed in a mahogany housing. This unit uses two 6SJ7's in the preamplifier section, with feedback around both for equalization, and providing separate control of turnover and rolloff. One unequalized position is designed for use with a microphone input. Three high-level inputs feed the compensated volume control, a switch eliminating the compensation when desired. A third 6SJ7, serves as a voltage amplifier, feeding the first section of a 6SN7, and the tone-control switches operate to change feedback networks around these two tubes. The remaining section of the 6SN7 serves as a cathode-follower output stage. The tone controls are calibrated to the actual boost or cut at 50 and 10,000 cps. The tape recorder feed precedes all tone and volume controls, and the entire unit requires a separate plate and heater supply.

Models 216BA and 230BA are basic amplifiers with 30 and 60 watts output respectively. The 230BA, *Fig.* 53, employs four 6BG6G's in the output stage, with a selenium rectifier to provide the fixed-bias supply. This unit furnishes power for the preamplifier, and is furnished with two a.c. outlets. The stability if this amplifier is such that with the load removed, a .015 capacitor may be placed across the 16-ohm tap without ringing on a square wave—a critical test on any amplifier. Multiple feedback loops are used to obtain a total of 24 db of feedback, and the output impedance of the amplifier at the 16-ohm tap is 0.8 ohms.



Fig. 55. The input unit, model QC-1, for the QUAD II amplifier.

QUAD II (The Acoustical Manufacturing Co. Ltd., Huntingdon, England; distributed by Beam Instruments Corporation, 350 Fifth Ave., New York 1, N. Y.)

A number of attractive features appear in the Quad II amplifier, which consists of a compact basic amplifier and a separate control unit, shown in *Figs.* 54 and 55 respectively. The basic amplifier employs two EF86's in as pentodes in a self-balancing phase-splitter stage driving two KT66's operating as tetrodes in a circuit with part of the load in the cathode circuit and part in the plate circuit. This is somewhat similar to the McIntosh circuit shown in *Fig.* 41, but in the latter the two windings are equal, whereas in the Quad II the cathode section is less than the plate section. This amplifier provides a power output of 30 watts at an IM distortion of 1.45 per cent, although the amplifier is rated by the manufacturer as a 15-watt unit.

The advantages of cathode loading, with the attendant feedback into the grid circuit, is evident from the performance characteristics of this amplifier. At 12 watts output, the total third and higher order harmonic distortion is less than 0.1 per cent; 25 per cent tube mismatch does not cause distortion greater than 0.18 per cent, and total distortion at 25 cps does not exceed 0.2 per cent. The power amplifier requires a signal of 1.4 volts for 15-watt output, and impedances of 7 and 15 ohms are available.

The QC-II control unit is even more unusual in construction, operation, and performance. The phono input circuit employs a plug-in network which is designed for different pickup load and level requirements by varying feedback around the first stage. Six types of plug-in units are available, accommodating pickups with sensitivities ranging from 3 to 100 mv, and matching impedances from 2000 ohms to 100,000 ohms. Moving-coil pickups, with outputs of the order of 3 mv, can be accommodated without an input transformer, which eliminates a source of hum pickup. Six other plug-in units give the same characteristics to the phono section, but change one of the high-level inputs to an unequalized low-level input to accommodate a microphone.

Four equalization positions are provided, and two or more buttons may be depressed at the same time to give other characteristics, as desired.

The tone control circuits are unusual, particularly since they are coupled with the low-pass filter section. The filter requires two knobs—the two at the right in *Fig.* 55. One has a CANCEL position, and three other positions labeled 10K, 7K, and 5K, representing the cutoff frequencies of 10,000, 7000, and 5000 cps. When this control is in the CANCEL position all tone controls are out of the circuit, and the amplifier is flat (except for the preamplifier, of course), regardless of the settings of the control knobs. When this knob is turned to any of the other three positions, the tone controls are in the circuit, and affect the response. In addition, a low-pass filter action is evident, with a 20,000-cps cutoff frequency and the frequency of maximum loss at about 35,000 cps. This eliminates any spurious frequencies above audibility. The second control from the right is marked with the word LEVEL and a series of figures from 1 to 50. When in the LEVEL position, the filter is effectively at 20,000 cps, with response flat to about 10,000 cps. As the control is rotated, the slope of the curve becomes sharper, the figures representing the number of db per octave of the cutoff. This provides a wide variety of curves, and all under the selection of the user, yet with instant return to "flat" simply by turning the filter switch to CANCEL.

The unit is somewhat unusual in construction, with its die-cast front plate and recessed control knobs. It is convenient to use, however, and permits instant comparsion of quality with different curves. Mounting of the unit is accomplished by fitting the panel section through an opening of the proper size and drawing the cover up tightly against the panel, using the mounting screws at the rear of the unit.

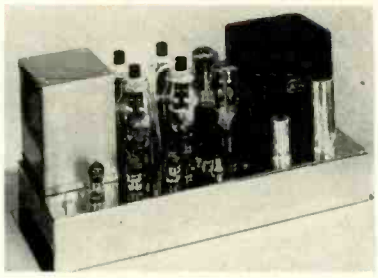


Fig. 53. Grommes Model 230-BA power amplifier—a 30-watt unit.

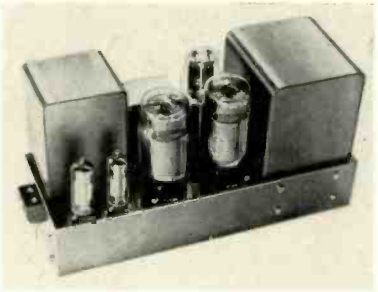


Fig. 54. QUAD II power amplifier, an extremely compact unit rated at 15 watts, but capable of a 30-watt output at an IM distortion of 1.45 per cent.

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Fig. 56. The Rauland "Libretto"—the backbone of the "book" hinges open to give access to the controls.

Rauland-Borg Corporation, 3515 West Addison St., Chicago 18, Ill.

The Rauland 1826 amplifier is one of unique design, consisting of a basic amplifier with a preamplifier and a cathode follower to feed a cable leading to the remote unit, which resembles an attractive leather-bound book, as shown in *Fig.* 56. The remote unit contains the bass and treble tone controls, as well as equalization controls for phono reproduction. Thus the user can employ phono-bass-boosting to a radio signal, if he wishes. Selection of the input signal is made at the main unit. This could be considered a disadvantage, but it would be necessary for the user to go to the tuner or to a turntable to inaugurate a particular program, or even to turn on the main amplifier, so it does not appear to be unnecessarily complicated in operation.

A more recent amplifier, the 1811, is a self-contained 6V6 amplifier with an output of 10 watts. This unit has three equalization curves, and uses separate bass and treble controls, as well as a compensated volume control. A switch permits removal of the compensation if desired.

Regency Division, I.D.E.A., Inc., 7900 Pendleton Pike, Indianapolis 26, Ind.

While Regency introduced a $1000 amplifier a year or so ago, it has other amplifiers in its line that are more popular. Among them are the HF-350P preamplifier, and the HF-350A basic amplifier, which are designed to work together.

The HF-350P, shown in *Fig.* 57, is a self contained unit accommodating two phono inputs a microphone, and four high-level inputs, each with its own level adjusting potentiometer. Seven equalizing positions are provided on a switch, and the unit incorporates separate bass and treble tone controls, and both volume and loudness controls. The power supply furnishes d.c. to the heaters of all four of the tubes. Cathode followers provide low-impedance outputs, to feed the power amplifier and a tape recorder, the latter input being ahead of the volume controls, but following the tone controls.

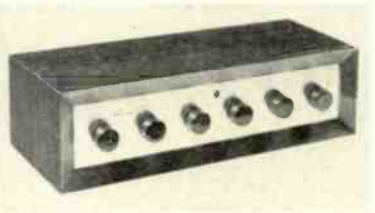


Fig. 57. Regency HF-350P preamplifier and control unit.

The 30-watt basic amplifier, *Fig.* 58, employs a pair of 5881's driven by cathode followers, and with three stages preceding those. It uses a well filtered power supply, and has fixed bias on the output stage.

Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass.

Designed with a view toward optimum performance in the user's home, the Scott line consists of two equalizer-preamplifiers, models 120-CP and 121-A; two compact table-model units, models 99 with 12-watt output and 210-C with 23-watt output; and two laboratory power amplifiers, the 32-watt 232-A and the 70-watt 265-A. Model 121-A, shown in *Fig.* 59, is equipped with the Dynaural noise-suppressor circuit, as is the 210-C, while models 120-CP and 99 are provided with sockets into which an external Dynaural unit, model 114-A, may be plugged. Model 265-A is shown in *Fig.* 60.

The 121-A equalizer-preamplifier employs continuously variable turnover and rolloff controls, a volume-loudness control, input selector, bass and treble controls, and the Dynaural controls. This latter circuit provides a sharp rumble filter, at the selection of the user, together with a signal-controlled low-pass filter action to limit noise and distortion. The variable turnover control is arranged to provide an 800-cps turnover when set at its mid position. As the control is turned clockwise, the turnover decreases uniformly to 250 cps, providing an exact constant-amplitude response at all intermediate points. When the control is turned counterclockwise from the center position, the turnover decreases rapidly to 500 cps and then remains fixed. Further counterclockwise rotation varies the bass rolloff to provide an exact match for NARTB, RIAA, old NAB, London, Columbia, BBC, and other curves. For rolloff a special tapered resistor is required to spread the range evenly around the control. A switch on this same control removes all rolloff for flat treble response.

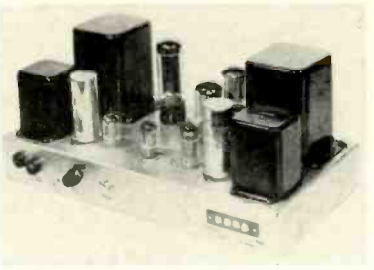


Fig. 58. Regency HF-350A amplifier.

The Dynamic Power Monitor incorporated in the 265-A power amplifier was designed to prevent damage to loudspeakers in case the user turns the volume up too high or inadvertently pulls out an input plug. The 70-watt power output is sufficient to ruin a speaker if the input signal becomes too high. The Monitor reduces the long-term power handling capacity of the amplifier to as low as 10 watts, if desired, without sacrificing short-time power handling ability, which is unaffected for the first 250 milliseconds after a strong signal is applied. Beyond that time, the power output is reduced to a point which normally represents the maximum safe continuous power for the loudspeaker system.

The circuit, shown in simplified form in *Fig.* 61, functions as follows: When a strong signal is applied to the amplifier, the diode V_3 puts a positive voltage on the grid of V_1, which in turn controls a series voltage-regulator tube, V_2. This reduces the maximum power output by reducing the plate supply voltage, rather than simply by gain reduction—which would be ineffective in case of an extremely large input signal. R_1 sets the bias on V_1, which is controllable by the user to set the maximum permissible power output, with C_1R_2 representing the time-delay which permits instantaneous peaks to pass without any limiting.

Figure 62 is a simplified schematic of the Scott variable-output-impedance



Fig. 59. Scott model 121 Dynaural Equalizer Preamplifier.



Fig. 60. 70-watt Scott model 265-A power amplifier.

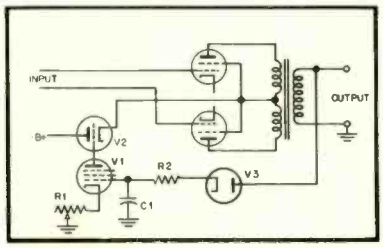


Fig. 61. Simplified circuit of the Scott Dynamic Power Monitor circuit in the 265-A power amplifier.

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control circuit. Potentiometer R_1 provides a variable voltage feedback, and potentiometer R_2 provides a variable current feedback. These two potentiometers are coupled together, and serve to maintain a constant amount of feedback, while varying the output impedance to suit the particular speaker being used.

All of the Scott amplifiers are designed to have clean symmetrical clipping of both halves of the input signal upon reaching the overload point, since uniform overload of both halves of the signal is considerably less objectionable to the human ear than unsymmetrical overload, which introduces unpleasant distortion. This result is achieved by using conservative amounts of feedback,

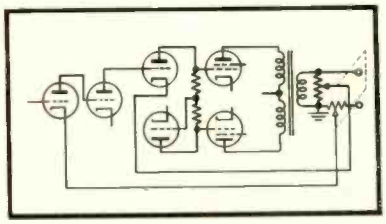


Fig. 62. Variable damping control used in the Scott 265-A amplifier.

with sharp cutoff filters at both ends of the frequency pass band to eliminate the possibility of oscillations arising from the clipping.

To maintain low hum and noise levels, a common grounding point is used rather than conventional chassis grounds which are likely to cause ground loops. The use of aluminum instead of steel for the chassis contributes further to the low hum level, since aluminum is non-magnetic and therefore not susceptible to eddy currents.

Sonex, Inc., 245 Sansom Street, Upper Darby, Pa.

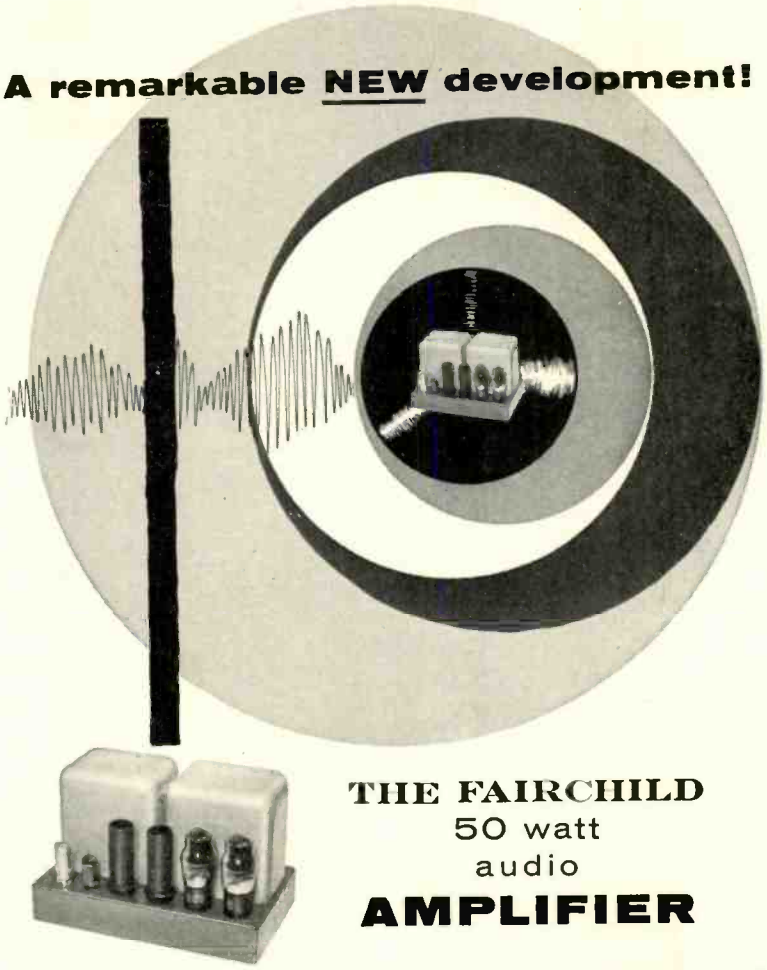
This line consists of a preamplifier-control unit and two power amplifiers—the 25-watt model 251 and the 60-watt model 601.

The preamplifier provides two phono inputs, one with correct termination for most available magnetic pickups, both high and low level, with the other only for low-level pickups; two high-level inputs are provided for tuner and tape or TV. A recorder feed is provided, with connection being made ahead of both tone and volume controls. The output of the unit feeds a power amplifier, with a cathode follower being used to maintain a low source impedance.

The two power amplifiers follow closely the Williamson-modified-to-Ultra-Linear output stage; the 25-watt model uses two KT66's, while the 60-watt model uses four. Both models supply power to the preamplifier.

Stephens Manufacturing Corporation, 8538 Warner Drive, Culver City, California.

The one amplifier offered by Stephens is designed to work with the same company's 500-ohm speaker systems, and is the only unit on the market which does not employ an output transformer. The



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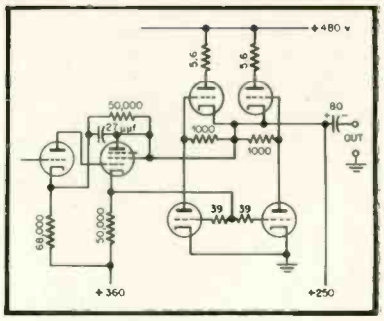


Fig. 63. Output stage of the Stephens "Citadel" output-transformerless amplifier shown in Fig. 1.

output stage consists of four 2A3's in a series-parallel arrangement, as shown in *Fig.* 63. The signal is fed to the two lower grids from a cathode follower, and the output is taken from the filaments of the upper tubes—through an 80-μf capacitor, since this point is at a +250-volt d.c. potential above ground. The amplifier, shown in *Fig.* 1, features very low phase shift, and employs selenium rectifiers throughout for plate supply. Since no other manufacturer offers any 500-ohm voice coils, this amplifier has not yet achieved the popularity it deserves.

Stromberg-Carlson Company, 1225 Clifford Ave., Rochester 21, N. Y.

Three amplifiers comprise the Stromberg-Carlson line—the 10-watt AR-410, the 25-watt AR-420, and the 25-watt remote control model AR-425. The AR-410 is a small self-contained unit employing a 12AU7 as a preamplifier, the two sections of a 12AX7 as voltage amplifier stages, a 12AT7 as a phase splitter, with 6F6's in the output stage. The circuit of the power section is fairly conventional, although feedback from the output transformer is taken from a tertiary winding, which is wound to have less leakage inductance than usual low-impedance secondaries.

The AR-420 shown in *Fig.* 64, incorporates continuously variable turnover and rolloff controls, together with bass and treble controls, and a volume-loudness control with a switch to remove the loudness compensation. It accommodates high- and low-level magnetic pickups, high- and low-level radio tuner input, as well as two auxiliary high-level inputs. The output stage consists of a pair of 6L6G's, and feedback again comes from a tertiary winding.



Fig. 64. Stromberg Carlson model AR-420 amplifier, with continuously variable turnover and rolloff controls.

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The AR-425 amplifier has a separate control unit which derives all operating voltages from the basic chassis which is similar to the AR-420 in circuit. The remote unit accommodates low- and high-level magnetic pickups and a microphone, as well as a low- and high-level tuner input and a high-level auxiliary input. Three equalization curves are provided, and a three-section volume control gives loudness compensation. A BRILLIANCE control introduces a low-pass L-C filter into the circuit with cutoffs at 3, 5. 9, and 20 kc. The output is a cathode follower, permitting operation up to 31 feet from the power amplifier section.

Tech-Master Products Company, 75 Front St., Brooklyn 1, N. Y.

Tech-Master has long been the leader in television kits, with suitably simplified construction data so that anyone can assemble a TV set and make it work—usually better than many commercial units. It was only natural that this company would enter the audio-amplifier market with a kit.

The amplifier consists of model TM-15A, a combined amplifier and power supply on one chassis using 5881's in



Fig. 65. Tech-Master kit-type preamplifier.

an Ultra-Linear output stage, and model TM-15P, the remote control preamplifier-equalizer. The former is a Williamson-type unit of conventional design, but engineered to make it possible for the home constructor to make it work properly. The preamplifier, shown in *Fig.* 65, employs a 12AX7 as a feedback-equalized preamplifier, and a 12AU7 with the tone controls between the two sections. Three equalization curves are provided for magnetic pickups, and three high-level inputs will accommodate tuner, tape, TV, or crystal or ceramic phono pickups.

United Transformer Company, 150 Varick St., New York 13, N. Y.

Primarily a transformer manufacturer, this company is currently offering a 25-watt power amplifier, model MLF—for Multiple Loop Feedback—in a semi-kit form, shown finished in *Fig.* 66. Most of the amplifier construction is completed when the user buys the kit, since the sub-chassis is a printed-circuit unit incorporating all of the resistors and capacitors correctly connected. All the user has to do is to connect the power and output transformer leads to the sub-chassis, install the power switch and pilot light, insert the tubes and he can be playing the amplifier. As to performance, this model has eliminated most

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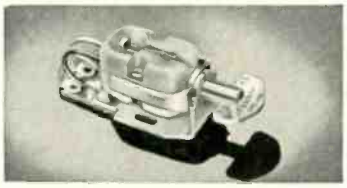
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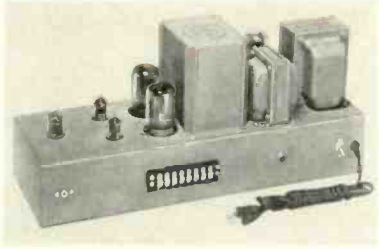


Fig. 66. UTC amplifier—a "semi-kit" unit employing a printed wiring panel which comes with the small components already in place.

of the troubles encountered by the home builder who assembles a Williamson-type amplifier, and performance at extremely low frequencies—less than 10 cps, for example—and at frequencies above 50 kc has been improved because of the multiple feedback loops. The circuit of this amplifier—originally published in the June issue with one or two minor (?) errors in it, is reproduced correctly in *Fig. 67*.

The use of the printed-wiring panel ensures that the "dress" of the wiring will be identical in every amplifier of a given design, simplifies the location of any of the components in case of failure, and—in the case of the MLF amplifier—makes it a very simple unit for the home constructor to finish, since he is required to connect only 17 wires leading from the filter choke and the power and output transformers to the printed-wiring subpanel, insert the tubes, and the unit is completed and ready to play. In the case of a circuit which employs several feedback loops, this is a very desirable feature, because minor changes in wiring and in parts placement could easily make a considerable difference in the performance of the finished amplifier.

Conclusion

There are other amplifiers on the market—some undoubtedly on a par with those mentioned—and the omission of the products of any particular manufacturer does not mean that those products are not considered suitable for a high-quality home music system. Such omissions have been the result of a lack of information from the manufacturer or the necessity of shortening some of the material because of the large number of amplifiers available.

Selection of an amplifier for each individual's own particular applications should not be particularly difficult, even though the various units may appear to be somewhat complicated. It is not necessary that the user be thoroughly familiar with what happens throughout the circuit of a modern amplifier to enjoy the entertainment which a good music system can give. Even the lowest priced high-fidelity amplifier is so far superior to the average music reproducing system sold as a radio-phonograph combination that almost anyone would notice the difference immediately. True, there are grades of amplifiers, just as there are grades of speakers, tuners, tape recorders, automobiles, or even such a commonplace product as a loaf of bread. No one can say, without risk of being challenged, that any one

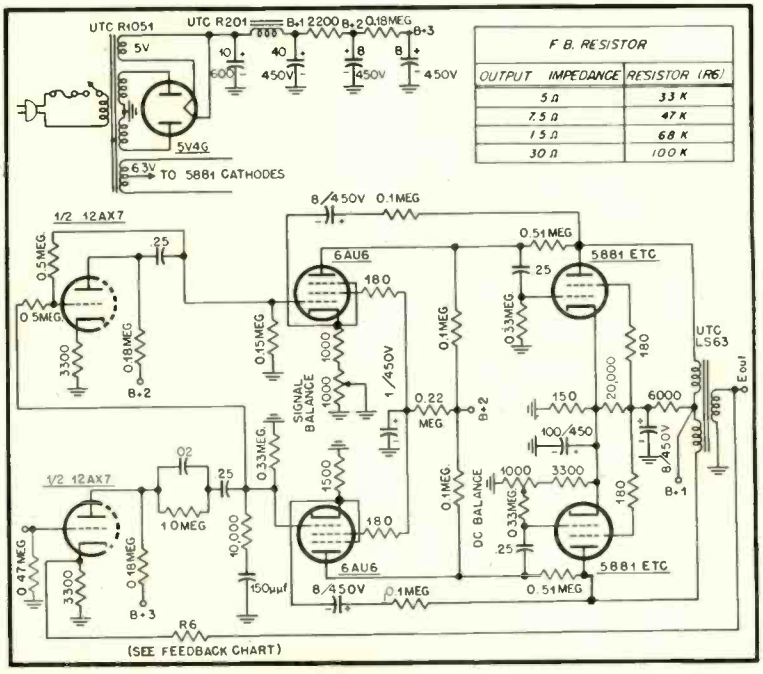


Fig. 67. Corrected schematic of the UTC MLF amplifier. This circuit was published in the June, 1954, issue in a form that wouldn't work.

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amplifier is "the finest on the market," for there are so many excellent ones on the market that a person could almost telephone his distributor and say, "Send me an amplifier costing about *x* dollars." There are differences in features, of course—some use tetrodes, some use triodes, some use the Ultra-Linear circuit. Some amplifiers provide as few as three equalization controls for phono reproduction, others are so flexible that they can accommodate as many as 25 or 30 curves. Some are designed for only one or two inputs, while others have provision for five or six in addition to feeding a tape recorder.

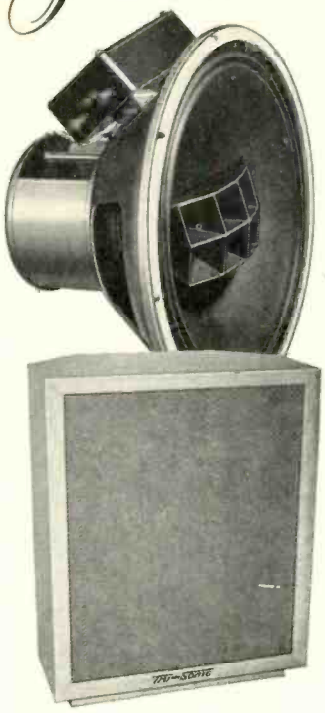
The final choice should be based on two questions: "How much money can I afford to spend for an amplifier?" and "How am I going to use this amplifier in my home?"

Obviously, you are likely to get more features, higher output power, greater flexibility, and—possibly—lower distortion at the normal listening level with an expensive amplifier than with the units in the lowest price bracket. But you must ask yourself if—for your own requirements—these particular features are important. If you have a small apartment and expect to feed only one speaker with radio programs, for example, you do not need the 100-watt Super-Roarer with 40 phono equalization curves, dual tone controls for both bass and treble, and three separate channels so you can listen to a stereophonic program while you record another monaural program at the same time. You should be able to get along with a fairly simple unit without any phono preamp at all.

If, on the other hand, you have an enormous record collection extending back to the days before electrical recording, with representative discs from a dozen foreign countries and some two hundred domestic recording companies, you will do well to select your amplifier from those which do give you sufficient flexibility to match any recording curve ever used and four others that haven't even been thought of.

By all means, make sure that you select the best amplifier your budget will allow—skimp a little on some of the other components at first, if you must, but be sure that the amplifier is of top quality. Amplifiers are not like automobiles—they do not have to be traded in every year or so (unless you simply have to keep up with your friend who *does* have the Super-Roarer). Transformers last practically forever, resistors and capacitors are almost invariably used well below their ratings, and tubes can be replaced. The writer is still using a power supply built to go with the Residence Radio System built in 1948 (the amplifier has been modernized a number of times since then, but it hasn't been touched in over two years); and the first 6AS7G amplifier described in these pages in May, 1948, is still working an average of eight hours a day—*and it has never had a single failure since it was built.* Tubes have been changed, to be sure,

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Once the potential purchaser is convinced of the reliability of high-grade modern amplifiers, he can go about the serious business of making his final choice. Not all amplifiers will sound the same, even with the same program sources and the same loudspeaker system. While we can measure frequency response, distortion, transient response, output impedance, and most of the other characteristics of an amplifier with a high degree of accuracy, there still remain some characteristics which we do not know how to measure—if we assume that we know what those characteristics are. For any audio engineer will tell you that it is possible to run a series of tests on two amplifiers and find them to have practically identical frequency response, distortion under one per cent, the same output impedence and damping factor, yet when subjected to a listening test these two amplifiers may not sound alike at all. We can guess at what causes the difference but we may not be able to measure any perceptible difference in the two units. Therefore, even if the specifications measure up to what you want in an amplifier, do not fail to listen to it, preferably in direct comparison to one or two others, and if at all possible, with the same loudspeaker and enclosure that you intend to use. It is well to select as subject material a record with which you are thoroughly familiar, because you should not introduce more than variable at a time. Listen to the same music on two or more amplifiers—change nothing but the amplifiers as you switch back and forth—under no condition should you listen to two separate *systems* if you are attempting to pick only an amplifier. The same advice would apply if you were choosing a speaker—try a number of speakers in direct comparison, always using the same amplifier, phono pickup, and source material.

Even the source material is important, for you won't always be listening to a symphony orchestra, a string quartet, or a jazz combo. Get some variety into your source material. Remember too that you may listen to the radio sometimes, and that the human voice will have to be reproduced. This is an important test, too, because certain tone controls may introduce too much "chestiness"—the term applied to the range between 100 and 200 cps which makes the voice sound barrel-like.

And finally, while you may ask advice on what *quality* differences there may be in different amplifiers, you should not ask anyone to tell you which amplifier sounds best. You are the person that is going to listen to it, and you are the one who will have to be satisfied—you and your family, perhaps, but certainly no one else. So if you are sure of the integrity of the manufacturer—and you may well be in the case of any of the high-quality audio components—base your selection on how the unit sounds to your own ear. Then buy it, take it home and put it to work, and . . .

Happy Listening.



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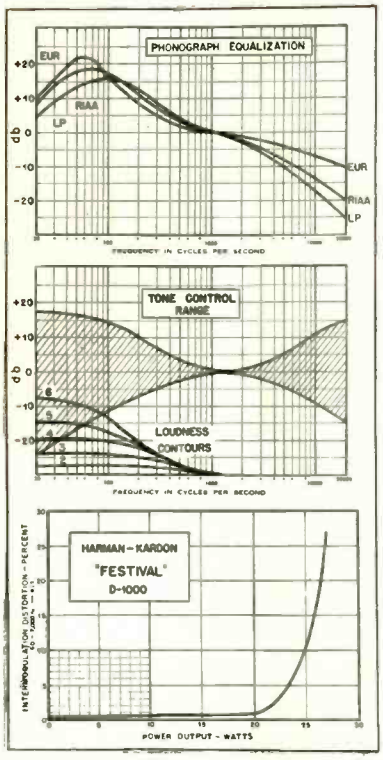


Fig. 1 (above). Performance curves for the Harman-Kardon Festival. Fig. 2 (below). Schematic of the audio portion.

Equipment Report

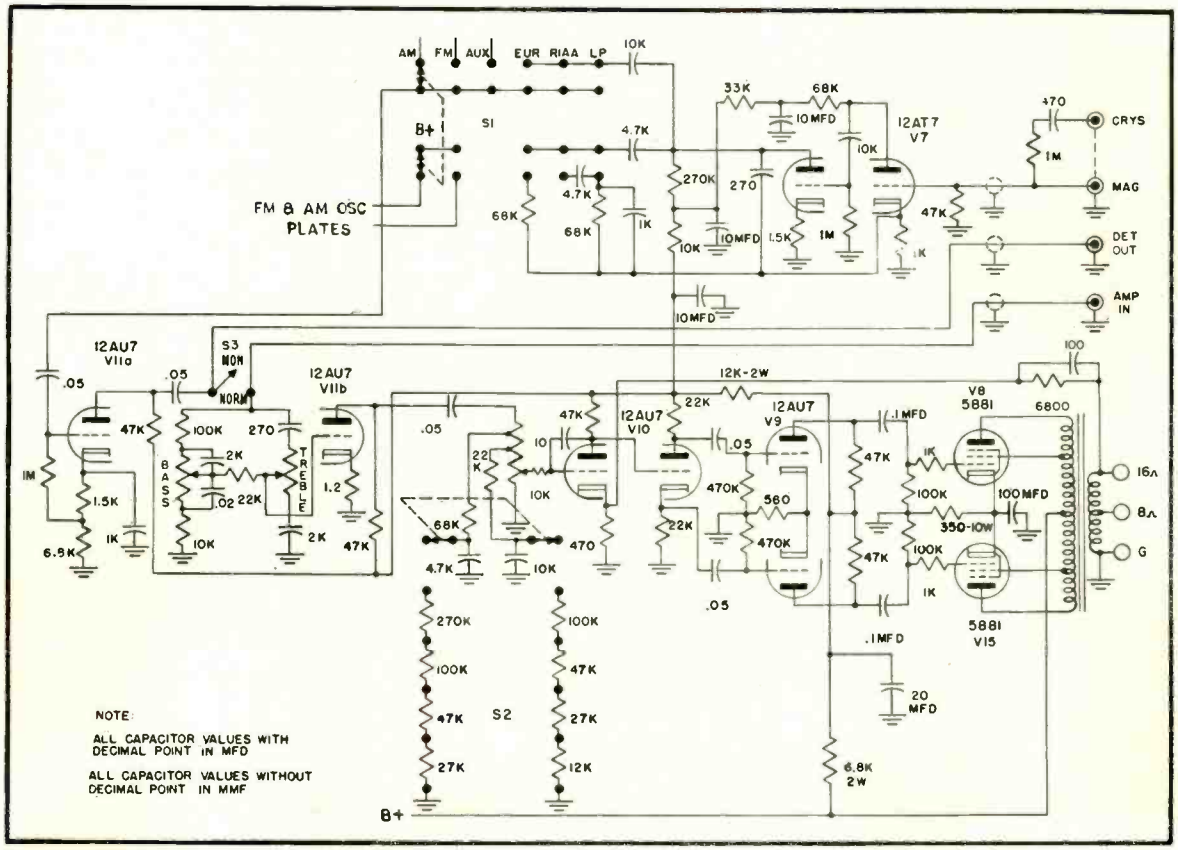
Harman-Kardon "Festival" Tuner and Amplifier, Model D-1000

COMBINING in one chassis a sensitive AM-FM tuner, complete with preamplifier for magnetic or crystal pickups, tone controls, and a 20-watt power amplifier, the Festival—newest and most complete of the Harman-Kardon line—provides in one unit all the elements necessary for a home music system, excepting, of course, the loudspeaker and its enclosure. From the measurements, it appears that nothing has been sacrificed by the combination, for the curves compare favorably with separate units and distortion in the Ultra-Linear output stage is under one per cent up to the 20-watt point, reaching 2 per cent at about 22 watts. As with most properly designed feedback amplifiers, the break point is well defined, and distortion increases rapidly at higher outputs.

The tuner section consists of separate front ends for the AM and FM sections, with ferrite-cored built-in antenna for AM and provision for external antennas for both AM and FM. When the Festival is used with a grille cover, the built in antenna is removed and mounted on the rear, with a jack on the rear apron into which the leads are plugged. The FM sensitivity is estimated to be better than 5 μv for 30-db limiting, and on AM all local stations (up to 30 miles) were received with the loop.

The audio portion of the Festival has some interesting features, one of which makes it easy for the tape-recording enthusiast to connect to the tuner circuits or the phono preamp. Many modern recorders are provided with a switch which shorts the input and output leads when the recorder is not in use, thus permitting the recorder to be connected permanently between the signal sources and the audio-amplifier section of the system. This is particularly useful with a three-head recorder, for the user can feed a radio (or in this case, a radio or phono) signal into the recorder, and monitor direct or from the tape, at will. This is a comparatively simple operation when separate units are used, but this is the first combination tuner-amplifier that has been observed so far to have this feature. The output from the selector switch —through one stage of amplification—is fed to a DET OUT jack, and can thus be connected to the input to the tape recorder. The output from the tape recorder is fed to the AMP IN jack. In case the tape recorder is not provided with the necessary switching facilities, a switch is provided on the rear apron which

(*Continued on page 70*)



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EDWARD TATNALL CANBY*

Albums-Plus

BY FAR THE MOST significant development in records these last few months is not disc hi-fi, which (advertising aside) is moving forward in more or less established channels, but a new merchandising stunt which has already had far more than mere sales effect—the introduction of more and more spectacular "audio-visual" albums, adding the appeal of eye-material of an astoundingly wide variety to the existing ear-appeal of the record itself.

Eye-appeal isn't new, of course. It began after the war, when the formerly sedate and plain albums for ye olde 78-rpm discs blossomed out in colors. Cover art was born and has, on the whole, prospered ever since. It has, indeed, become a serious art-form in spite of itself, under the fierce goad of competition—involving some of our biggest artists of the day and of the past. At first, the brightest colors sold the most albums but very soon the eye-splitting glare of every conceivable garish color lay-out took the sales appeal clean out of mere color—and so, ART crept in, necessarily! Not necessarily good art or bad art but the principle of Art itself—the use of shapes, forms, designs, to appeal to the eye. That is how art has always operated; and in most centuries, remember, art has been just as practical, just as competitive as in the era of record covers.

And now—the insides of the albums go visual, to much more spectacular lengths. Not only art, but documentary photography and, most of all, words—text. The old "album liner" is now expanded to 40- or 50-page books of information and inspiration.

In fact, things have already gone so far (see below) that in a good many cases I, for one, find the visual material a good deal more interesting than the audible! Maybe some of these new albums-plus should be offered alternatively at a lower price minus the records (or the lone, single record that many of them boast).

But don't let me give the impression that this move is to be taken lightly or without due appreciation. The good and the bad are, and will be intermixed as always; but the potentialities for good, the possibilities in the way of a wholly new form of product midway between the poles, art, literature and music, are fascinating. For a good many years there have been sporadic attempts to coordinate books and records, or art and records, but these new albums-plus mark the first really successful formula for the combination. We haven't begun to explore the possibilities as yet.

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

Ballet

"Hommage à Diaghilev." Including music from "Parade" (Satie), "Spectre de la Rose" (Weber), "Afternoon of a Faun" (Debussy), "Daphnis and Chloe" (Ravel), "Swan Lake" (Tchaikowsky), "Les Sylphides" (Chopin), "Good Humored Ladies" (Scarlatti-Tommasini), "Three-Cornered Hat" (De Falla), "Pas D'Acier" (Prokofieff), "Kikimora" (Liadov), "Petrouchka" (Stravinsky); 35-page booklet, color prints, drawings, photos, information. Philharmonia Orchestra, Markevitch.

Angel 3518C (3)

The plain difficulty in listing this album, as above, is testimony to its revolutionary character. The records, fine as they are, constitute merely one part of a beautifully organized "exhibit" of sight and sound; the music is conducted by a member of the Diaghilev "circle," Igor Markevitch; the illustrations are virtually all by famous names in the same great inter-art group—Picasso, Cocteau and the like—and even the written commentary stems from the same unified source, as do the extremely interesting informal snap-shot-type photographs—Stravinsky and Debussy in the latter's apartment taken by Satie; Prokofieff, Stravinsky, Ansermet, and Diaghilev in a London street (1921) and many others.

. . . If these names mean little to you, the album, granted a curiosity on your part, will still prove of great interest; for the brilliant group of assorted artistic creators in various fields that collected about the massive Diaghilev (a kind of elevated Barnum and Billy Rose combined) was surely one of the most productive assemblages of hi-IQ art-makers since the Italian Renaissance, and it was the sparkling impetus of Diaghilev, the great entrepreneur, who made it all go.

Our latter-day Greenwich Village bohemians look pretty sad beside these titans of eccentricity! They were that—but they delivered the goods and their stuff, as anybody can see and hear in this album, has had an enormous influence on every artistic field—and many commercial fields—to this very day.

The best virtue of this album is that its at first seemingly helter-skelter assemblage of an astounding quantity of drawings, photos, color reproductions, testimonials, quips, epigrams—and music—actually is, *in toto*, a perfectly splendid indirect reflection of the whole feeling and purpose of the great Russian-French movement, in art, in music and in dance, of those years 1908 to 1929, Diaghilev's artistic reign. This is a genuine modern documentary, radio-TV style applied in the very best sense to this new record-album-plus medium.

And so I find I simply cannot review it merely as a recording. Indeed, I come last of all to the music, which is in part ultra-familiar (the more credit to Diaghilev and associates . . .) in part strange, and all rather beautifully played and superbly recorded. Markevitch was a youth in the Great Days but he took up the feeling and the sense of those artistic times and one senses here a decided authority in the interpretations, an ease, a fluency, that comes from good musicianship plus direct, first-hand experience of the original performances. A great tradition, passed on directly.

The music in most cases is not complete—but this album is not a recording of ballet scores as such. A few, the less well known, are given *in toto*—Prokofieff's unfamiliar "Pas D'Acier" (Dance of Steel)—a machine-age ballet from the hard-bitten Twenties that I found surprisingly uninteresting, for this usually warm and human composer—and Satie's surprisingly jazzy "Parade." The "Afternoon" and other familiar scores are played with gorgeous musicality if in a few cases the experts may question tempi and the like.

This is no child's ballet album; it's not recommended for starry-eyed youthful balletomanes whose urge is hero-worship! But for any adult with an eye for line, for color, a mind for interesting documentary history and an ear for ballet music—this is it.

And don't tell me this review is long. It ought to be twice as long. So also with many another item of this sort. Just stop for a moment and think of the combined talent and time that went into (a) the original productions of these many works—dance, staging, music—and (b) the recording of eleven utterly unlike musical scores, and (c) the extraordinary job that must have been done to assemble and arrange the text and unique art work in this album itself. Years!

The Ballet. "Les Patineurs" (Meyerbeer); "The Incredible Flutist" (Piston); "Fire Bird" Suite (Stravinsky); "Daphnis and Chloe" Suite #2 (Ravel); "Invitation to the Dance" (Spectre de la Rose) (Weber); "Sylvia," "Coppelia" (Delibes); "La Valse" (Ravel); Bacchus et Ariane" Suite #2 (Roussel). Boston Pops, Boston Symphony, NBC Symphony, Stokowsky Symphony, assorted conductors. 18-page booklet, full-page photos.

RCA Victor LM 6113 (3)

Here is RCA's counterpart and, were it not for the superbly high standard set by the above Diaghilev album, this would surely rate very high. In a sense it is a budget job, since the recordings are not newly made but constitute a collection of handily available RCA playings—note that several are not the ballets themselves but the concert suites derived from the original scores for symphonic performance. No objection, except that there is a divergency of style, interpretation and recording acoustics (and quality) that is mildly disturbing.

The booklet is handsomely bound-in with a good looking plastic ring binding, decorative and functional; the full-page ballet photos, borderless and tinted in misty cool and warm shades, are superb of their sort. The long text by Robert Lawrence, in three divisions—"Ballet with Accent on Music," "Some Words on Listening," and a brief comment on each ballet, are useful and easy to read.

This is the album to give to the budding balletomanes! The pictures will enchant, the comment is not difficult (nor unusually profound), the whole approach is in the tradition of ballet and opera glamor that has such a wide appeal. The musical selections, be it noted, are nicely comple-

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mentary to those of the Diaghilev album, with only one duplication and an overlap (parts of "Daphnis"). In both good and bad respects a more conventional album than the Angel opus.

A Midsummer Night's Dream. Old Vic 1954 Production; B.B.C. Symphony, Sargent. **LM 6115(3)**

This is the now-standard quick release on records of an important "Broadway" production, a technique that is applied gratifyingly to every thing from new musicals to grand opera and straight drama. The much-heralded all-over British production of Shakespeare and Mendelssohn, here recorded, combined in one show music, speech, acting, ballet and general spectacle.

As far as the actual show was concerned most opinion here felt that it was an anticlimax, somewhat of a hodge-podge, undigested, over-long, inconsistently styled. The recorded version, of course, merits its own separate judgement and, actually, is altogether different in effect. The whole of Mendelssohn's score is here, but in a scrambled order with some rather odd tempi (evidently to fit the stage doings-of-the moment) and clearly not as originally intended by Mendelssohn —if that matters. The speaking-acting is strictly in the expected Shakespearian manner, which will satisfy most listeners and annoy some.

I'd suggest that, even with an excellent explanatory booklet to put it together, this production falls between the stools; too much music for the Shakespeare people, too much dialog for the music-lovers. Musical plays in the time of Schubert, Mendelssohn, Beethoven, were clearly far removed from any conceivable music-speech combination familiar to us today and it is bound to be as difficult for us to recapture the unity of that theatre style as it might be for us to enjoy the then concert style—involving three or four hours of heavy music at a stretch! Times have changed.

SEVERAL B'S

Bach: Brandenburg Concertos #1 thru #6. Chamber Orch. Vienna State Opera, Prohaska. **Bach Guild 540/1/2**

Here is a wonderful study in tone colors, and perhaps the closest approach to the originally intended sound of these six varied concertos so far put on records. Each work is in itself a study in tone color, an exercise in virtuoso tonal orchestration with the widest variety of instruments of the period. It has been clear for a long time that the restoration of the original instruments, without "modern improvements," leads to far greater listenability in these works—for any listener, trained or no. But the Bach instruments are not easy to find and to play, the fabulous techniques of Bach's day have been largely lost and are only gradually being recovered.

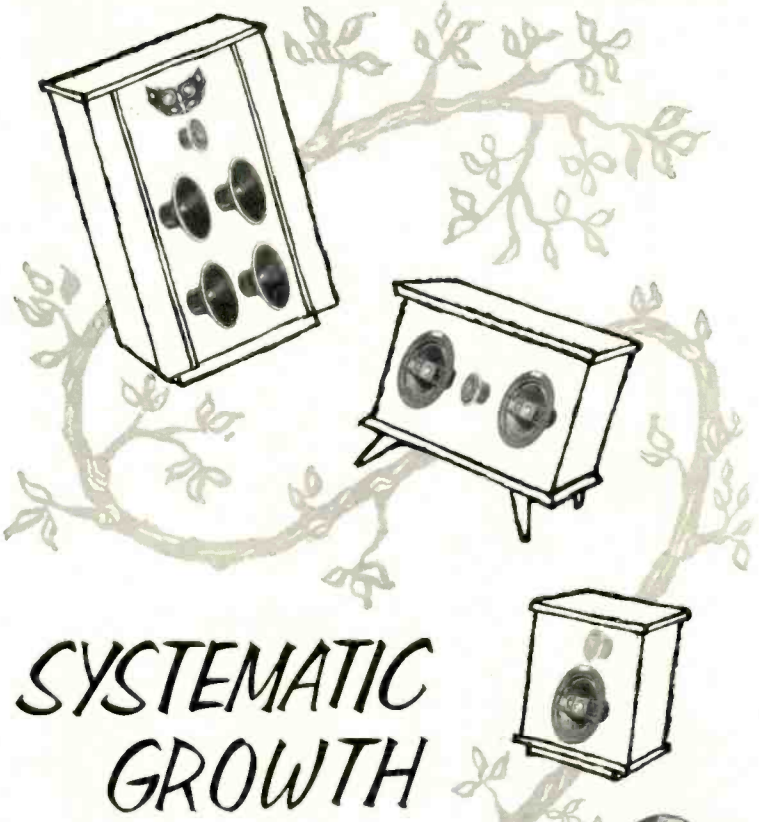
Prohaska's carefully painstaking versions of the Brandenburgs are superbly recorded with utmost instrumental clarity, from the standpoint of tone-color. The rich play of color-contrast from one concerto to the next is wonderfully evident, from the sharp, thin sound of the baby *violino piccolo*—"little violin," and the ploppy high-pitched horns, in the First Concerto through the turtle-dove chortles of the pair of recorders in the Fourth, the edgy dark string tones of the Sixth, the multiple overlapping string choirs of the Third.

The chief glory of the set is in the famed "Bach trumpet" of the Second Concerto, here played by Helmut Wobisch, one of the men who have restudied the lost trumpet techniques of the 18th century to cope with this extraordinary kind of trumpet music. The *clarino*, the small valveless trumpet of Bach's day, was, it seems, relatively light in tone rather than loud and piercing as are most modern small trumpets, which explains the odd combinations that Bach uses—in this concerto, a trumpet, a recorder and a violin as the solo group. Most earlier high-trumpet recordings have featured loud trumpets; this is the first in which the *clarino* part is correctly balanced against the other instruments, its tone relatively light, though still climbing those dizzy heights of pitch which take it up into the highest flute range. (The part used to be played an octave lower by an ordinary modern trumpet, a very sad sound!)

Prohaska's Bach is earnest, sincere, a bit on the inflexible side, but these concertos seem to me more fluently played than the earlier Prohaska performance of the four Bach Suites (also in "restored" versions) on Vanguard.

Another new recording of the Brandenburgs, from Vox, will be reviewed later.

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Bach: Art of the Fugue. Gustav Leonhardt, harpsichord. **Bach Guild BG 532/33 (3)**
Bach: Goldberg Variations. Gustav Leonhardt, harps. **Bach Guild BG 529**

The Art of the Fugue, Bach's last work, is not easy to explain to those who haven't "fallen" for Bach by dint of sheer musical enjoyment. To those who do feel sense in Bach's music—whether they are trained musicians is beside the point—the Art of Fugue speaks for itself and many an ignoramus has found its music thrilling, fugues or no.

The difficulty lies in two aspects. First, it is a treatise on the art of writing fugally, and as such it is archaic in style even for Bach's day, harking back to a long tradition of musical "mathematics"—it treats a single very short theme to every trick of counterpoint, imaginable, including mirror fugues, fugues that play backward, combination of three and four subjects, plus a vast array of sheer "development" illustrating the maximum that can be done with an extremely simple and elementary idea. All of which is pedantic, dull in a way, and yet being Bach is at the same time tremendously powerful and imaginative—if you can hear it.

And the entire work, secondly was written for no specified instrument at all, but was merely set out in open score (four separate lines) as pure pitch and rhythm.

Now this is no puzzle at all to anyone who has had even the most elementary training in composition. But it has continued to baffle music listeners used to music written "for" some direct medium. And so theories continue to pop up, new mediums are tried—string quartet, two pianos, string orchestra, organ, full orchestra, and finally, in this version, the harpsichord.

My ear says no—but I suspect that part of the trouble is in a certain rigidity in the Leonhardt playing that, especially in a supremely difficult and vast musical edifice such as this enormous piece, quickly sends the ear to sleep. I've tried; I can't take more than a side or less of this version without running to turn it off. Sorry. And I've known the "Art" for a long time, too.

The Goldberg Variations, a far more informal, brilliant, idiomatic piece very specifically written for harpsichord virtuosity, confirms the point. The Landowska version on RCA Victor, faint, tinny and from 78's, is marvellously more pliant and alive, though one cannot directly criticize Leonhardt for the slightest clumsiness, bad registration or other obvious fault. Another recording by this player, on the organ, "17th Century Organ Music," (Vanguard VRS 452) shows once more the same strangely rigid, dogmatic playing, outwardly impeccable but strangely deadening to the senses. It would seem to be a matter of musical personality.

How many times a not-too-confident listener must have thought, in listening to performances of this sort—*"something must be wrong with me."*! I'm an enternal optimist in these matters. I am sure that any listener, no matter how untrained, will get to enjoy a really *good* performance, even of old man Bach himself, given a little time.

A non-communicative playing will register just as low a reading on the untrained ear as on the trained—but the beginner, not knowing any better, blames himself; the informed listener says "bad performance" and feels smug and virtuous, knowing how right he is! But both ears are right.

Orchestral Music of Brahms. New York Philharmonic, Bruno Walter.
Columbia SL 200 (4)

A conservatively styled album-plus, but one of the finest to hit the market this season nevertheless, this offers all four of the Brahms Symphonies in such beautiful readings as you will rarely hear again; also included are major separate works for orchestra.

Yes—others can conduct Brahms, but there is scarcely a man alive now who can give such a wholly natural, moving, convincing, intuitive playing of this fast-aging music. Not our younger conductors, by and large; the " feel" for Romantic music of this kind is disappearing and no amount of instrumental virtuosity will bring it back. I did a recent detailed comparison of one of these recordings with the same music as conducted by Leonard Bernstein for Decca—the same players, too—and the differences were startling, for any listener.

If you are, again, one of those not-too-confident listeners to the classical, this is the album for you. For this music will talk directly to you and convince you in its own terms, and it won't need advertising and publicity to help it, either. You can't miss.

The album is most tastefully bound in a handsome Victorian-style gold and black fabric and there are 13 pages of full-size pictures and commentary as well.

Berlioz: The Damnation of Faust. Soloists, Harvard Glee Club, Radcliffe Choral Soc., Boston Symphony, Munch.
RCA Victor LM 6114 (3)

The wave of interest in Berlioz may well bring you to consideration of this giant work. This is a heartfelt performance with much excellent work in it, notably from the choral singers (no slight intended upon the solos and orchestra but choruses are so often lackadaisical and uninspired) but there is, necessarily, a rather distracting mixture of styles here—a kind of international performance, like the French opera at the Met and the New York City Center. This is not good, in the long run, for the highly stylized drama of Berlioz; it is inevitably better in a wholly French performance, especially in the singing department.

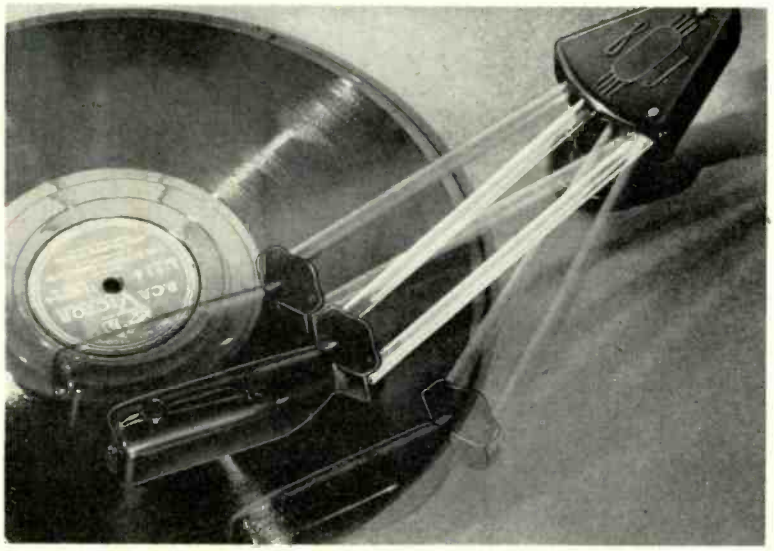
This is exciting and well worthwhile, (though you'll find it a pretty long pull), but you'll discover a really better performance in the old recording from France, Columbia SL 110 (3). Sample it, if you can, before you commit yourself to this one. RCA Victor wins by a mile as to hi-fi.

Menotti: Amelia al Ballo (Amelia at the Ball). La Scala, Milan, Production. With booklets. **Angel 35140 (1)**

If you have ever enjoyed Menotti's English operas, notably the light-hearted "The Telephone" and the spooky "The Medium," this early opera will please you equally, though it is sung in Italian. It is a farce, in one act, preposterous and

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amusing; the complete text in Italian and English in the accompanying booklet (another booklet describes La Scala and its history) makes following the story pleasant and easy, and the music is skillful, tuneful and unpretentious, persuasively performed under the composer's supervision. Superior recorded sound, too.

Virtuosi di Roma. (Corelli: Concerto Grosso in D, Opus 6, #4; Vivaldi: Concerto in F; Clementi: Symphony in D, Opus 18, #2. HMV LHMV 2

One of a new series of HMV albums-plus, (His Master's Voice, pressed and packaged by RCA Victor), this lovely recording features the well known Roman group in two of the now-familiar type of early 18th century concerto and a symphony of the early 19th century, rediscovered only recently, by a man whom every piano student knows for his piano works, big and little, Muzio Clementi. This last is the prize on the record, though the other items are excellent material. Clementi's symphony, a first hearing for virtually everybody, is of the Beethoven period but in a conservative vein as of that time; there is much of Mozart and Haydn in it, but tempered with a Romantic lushness that is not far from Mendelssohn.

The new HMV series is boxed with a fancy removable color print in a window in each album, this one being a beautiful Madonna and Child by Crivelli done in tempera colors. "Suitable for framing."

Mozart: The Complete Works for Piano Solo. Walter Gieseking. **Angel 35188 (11)**

The killer-diller to date—eleven LP records and one of the top pianists of our time. The review copy problem was a dilly here, and Angel solved it by making up a special sample album for us folks. It has the blue moiré silk cover, genuine, and the 24 pages of excellent notes, but only one record. That one is a bit erratic; some of the sampled Mozart is superb, some is not quite as successful as it might be, which is perhaps an indication of the nature of the other ten discs.

Gieseking's Mozart, of a very high order, nevertheless is just a bit on the cool side; it lacks the enormous vitality of his incomparable Debussy. I can't help feeling that the much younger Badura-Skoda can do a few things with Mozart that not even this great pianist can match. All of which doesn't much lessen the value of this collection as a unique complete survey. Pianists who think Mozart is easy (and probably play him badly for that reason) can learn a vast amount about good pianism and musicianship here. Listeners can revel for years in it. Go to it—if you have $75 handy.

The Confederacy. Essays by Bruce Catton, Clifford Dowdy; extensive photographs, facsimiles Lee's Farewell to the Army of Northern Virginia; Music by Richard Bales based on music of the South, 1861-65. Soloists, Nat. Gallery Orch., Cantata Choir, Luth. Ch. of Reformation, Bales.
Columbia SL 220 (1)

This album marks the ultimate in the opposite direction—all the above material, 32 pages of booklet and only one record! I list the contents in order of interest (for my ear and eye, anyhow) and solemnly state that I would be glad to purchase this album without any record in it at all; for the material presented in the large bound-in book at the beginning is absolutely fascinating, on a par with that in the "Diaghilev" album reviewed earlier and an equally thorough job of amassing information, creating a sense of the time and of history. The lavish pictures are profuse and extremely interesting, as is the comment.

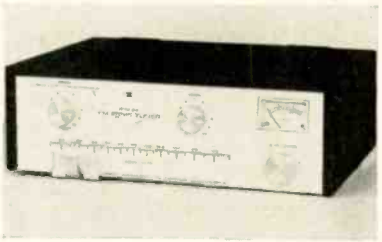
As for the record—well, after all, what is there to *hear* about the Confederacy! Precious little. Mr. Bales has collected a batch of sentimental ditties, mostly on the order of "Johnny Get your Gun" of another time, or "Silver Threads Among the Gold," and has dolled them up for orchestra, with solo singers of considerable pretentiousness. General Lee's Farewell, read by a cousin named Lee, is convincingly Southern-accented, but, withal, very short and mainly appropriate platitudes. It is no Gettysburg Address. Even the record's handsome special label, with a Confederate stars and bars in place of Columbia's usual blue, doesn't help much.

In short, this is a record album to be seen and not heard—and well worth the cash, too! Who'd a'thought we'd come to this.

(*Continued on page 78*)

Leonard Radio "*Audio Mart*"

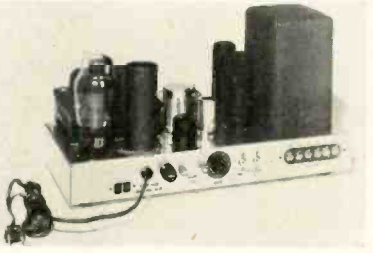
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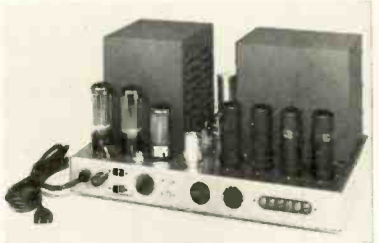


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THREE-CHANNEL PREAMP-MIXER

(*from page 15*)

this condition the input line is terminated by a 390-ohm resistor. The signal voltage from the microphone is fed to the grid of the first stage through an .01 μf capacitor by way of the second half of the selector switch. Polarizing voltage is provided for the carbon microphone by the resistive voltage divider across the output of the power supply rectifier. Sufficient rectifier filtering is acquired due to the 20,000-ohm resistor and 50 μf capacitor included in the voltage-divider network.

As shown in *Fig. 2*, the component parts are assembled on a 7 × 17 × 3 inch chassis. The front panel is of the standard 19-inch relay rack size and measures 8¾ inches high; it is shown in *Fig. 3*. Although the unit is constructed for rack mounting, it can be mounted conveniently in a carrying case and used as portable equipment because of its light weight and small size.

Frequency response of the equipment

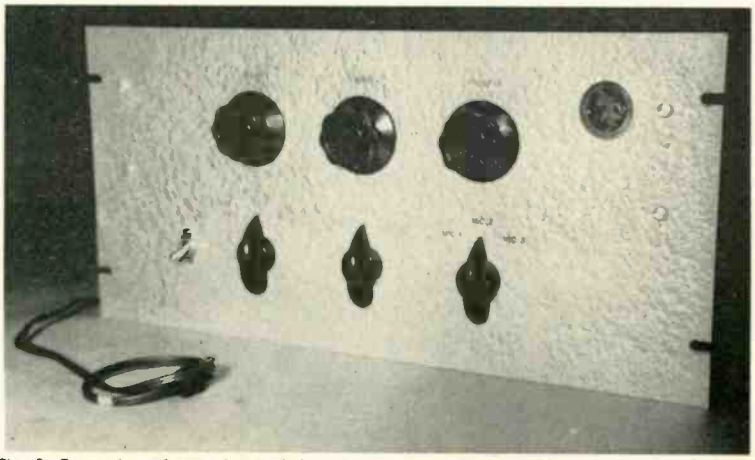


Fig. 3. Front view of unit designed for rack mounting. For portable use, the size could be reduced considerably.

Channel 1 includes ½ of a 6SL7 tube designated in the schematic as V_{1A}. Channels 2 and 3, shown as V_{2A} and V_{2B}, each use ½ of a 6SL7 in the same envelope. Each channel feeds into its individual gain control, these potentiometers then feeding the grid of a voltage-amplifier stage through 0.22-meg isolating resistors. This voltage-amplifier stage is the second half of the 6SL7 tube used for channel 1 and is designated V_{1B}. A single section of a 6SN7 is employed as the output stage, working into transformer T_1. A suitable single triode instead of the 6SN7 twin triode could just as well be used in the output position.

The power supply, a symmetrical or full-wave selenium rectifier type, is conventional except for the voltage divider to supply polarizing voltage for carbon button microphone operation.

is flat within plus or minus 1½ db in the range from 30 to 15,000 cps. Distortion is 0.7 per cent at 1000 cps and the noise measurement is 60 db or more below normal output into 500 ohms. At normal microphone output levels the output of the amplifier into a 500/600 ohm line is approximately 1.90 volts (zero db), with the gain controls set to about midway position.

Operation of the unit can be understood from the block diagram given in *Fig. 4*. Here the equipment is shown as used in one of many applications—that is, in connection with recording on tape. Because of its flexibility and because it is completely self-contained and self-powered, this equipment may be utilized in numerous applications.

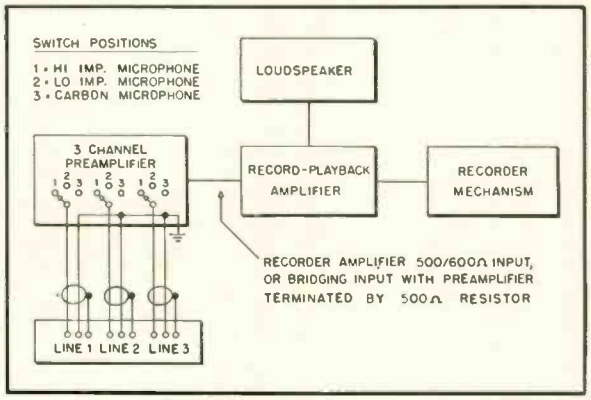


Fig. 4. Block diagram of connection when used in a typical tape-recording setup.

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ABOUT MUSIC

(*from page 10*)

nitely not the way to go about it, unless you have an independent income and can remain glued to your phonograph night and day for months or even years. A good beginning would be the *Brandenburg* Concertos, some of which, by the way, turn up consistently on "Favorite Compositions" polls conducted by WQXR among its audience. The reason for their popularity seems to be that these half dozen "concertos" Bach wrote for "His Royal Highness, Monseigneur Christian Ludwig, Margrave of Brandenburg" are closest in spirit and content to orchestral music as we know it today than any other works of the period. You might investigate the Münchinger set on London ffrr for a buoyant and kinetic approach to the music. Karl Münchinger and his Stuttgart Chamber Orchestra have been criticized for "rhythmic inflexibility." There is drive and propulsion here, but no rigidity to these ears. With a steady pulse, Münchinger achieves remarkable dynamic effects, linear texture, and a fine sense of tonal balance.

For those of you accustomed to the soaring tones of a typical cathedral organ, the sound of a Baroque organ may come as something of a surprise. At first, the reedy quality of the upper register will strike you as "tinny," the volume too inadequate, and the general tone devoid of lushness. But once you've become acclimated, so to speak, you'll begin to notice other things about this type of organ, most important of all, its extraordinary lucidity—a quality so essential to the music of Bach. Each line can be followed like (to use an analogy appropriate to this publication) lines on a schematic. Decca's recordings of the blind German organist, Helmut Walcha, are models of acoustical clarity.

There are now over half a hundred Bach cantatas in the LP catalogue. That's approximately a fourth of all Bach's works in this form available in print. As a beginner, try Cantata No. 4 *"Christ Lag in Todesbanden,"* No. 140 *"Wachet Auf,"* or No. 82 *"Ich habe genug."* The Bach Guild Chorus and Orchestra have recorded the first two of these. Their interpretations, under the baton of Felix Prohaska, are well conceived. The tempo of the opening of No. 140, majestic and promising, immediately sets the mood for the entire work.

And speaking of sure rhythmic impulses, no musician is more gifted in this respect than the seventy-five-year-old wizard of the harpsichord, Wanda Landowska. There is nothing tentative about her playing, her attacks are clean, her phrasing unerring, and her love of Bach and his times shows itself in everything she interprets. Mme. Landowska has recently completed her "last will and testament"; that is how she describes her monumental recording of the complete *Well-Tempered Clavier* for RCA Victor. She has been heard to say: "Bach and I, we understand each other; we make a happy couple." With the help of recordings such as these, you too may find "living with Bach" a happy and rewarding experience.

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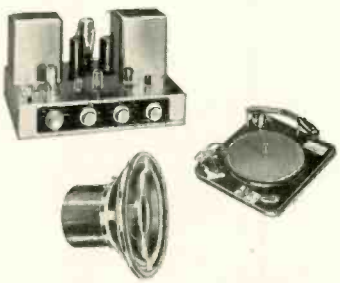


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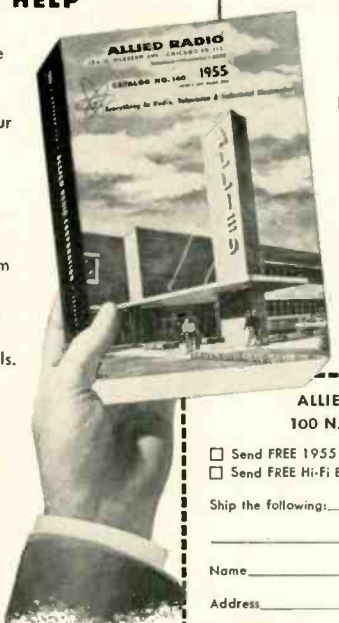
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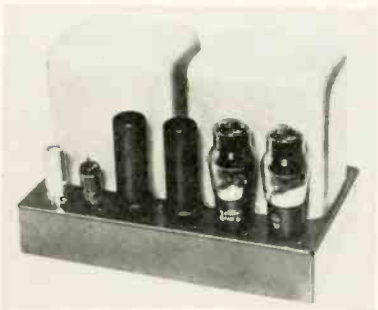
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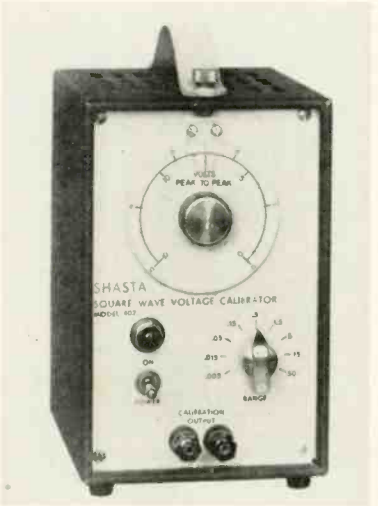
NEW PRODUCTS

• **Fairchild Amplifier.** The Fairchild 50-watt hi-fi power amplifier is the smallest 50-watt chassis now on the market, measuring only 12"w x 7"d x 7¼"h. It has exceedingly low intermodulation and harmonic distortion, excellent signal-to-noise ratio, and is guaranteed not to ring at any level regardless of load power factor. A unique balance control permits adjust-



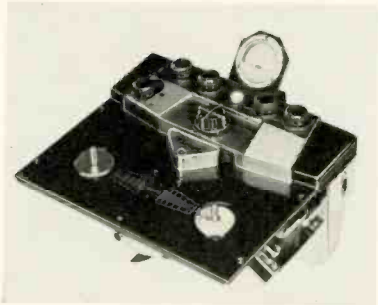
ment for minimum distortion, proper phase inversion, and dynamic balance of the output tubes to be made aurally, without test equipment of any type. The amplifier is exceptional in its stability under varying load conditions. Further data may be obtained by writing Fairchild Recording Equipment Company, 154th St. and 7th Ave., Whitestone, N. Y.

• **Square Wave Voltage Generator.** This instrument permits calibration of an oscilloscope so that voltages may be read directly from the face of the CR tube. In operation it generates a square wave with a constant frequency of 1 kc/sec. and an amplitude which can be varied continously from 0 to 50 volts. A display of this signal on a 'scope appears as two parallel horizontal lines. The distance between the two lines is equal to the desired voltage. The



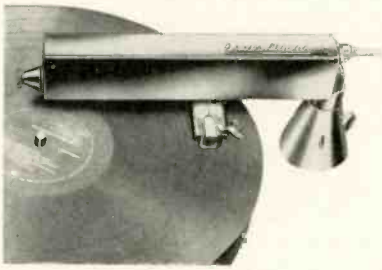
amplitude of any other signal then displayed may be read directly in volts by comparison with the calibrator signal. Signals of unknown amplitude may be measured by comparison with the calibrator dial. The range of the instrument is covered in nine steps from .005 to 50 volts full scale. Manufactured by Shasta Division, Beckman Instruments, Inc., P.O. Box 296, Station A, Richmond, Calif. Requests for information should specify Model 402.

• **Tape-Recorder Mechanism.** Designed for custom installation, the new Ekotape Model 212 Symphotone tape recorder mechanism reproduces and records at 3¾ and 7½ ips with a twin-track recording head. Frequency response is 40 to 13,000 cps. A single control selects tape direction, fast forward, standard forward, rewind, and stop. Other controls govern playing speed,



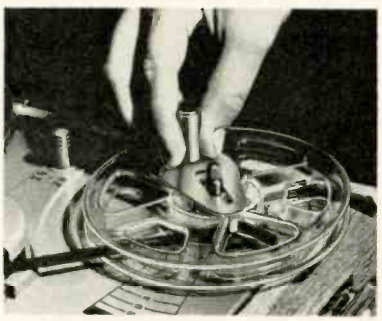
record/playback, and volume. The unit incorporates two high-impedance inputs—a jack for microphone, and a terminal strip for phonograph pickup or tuner. For playback the 212 must be fed into an external amplifier. Write Webster Electric Company, 1900 Clark St., Racine, Wis., for Bulletin R8A1.

• **Trans-Linear Tone Arm.** Distortion due to tracking error is practically eliminated by the new Trans-Linear tone arm which is now being manufactured by Karl Products, 1704 Walnut St., Philadelphia, Pa. The arm performs in a manner similar to that of professional record cutting equipment, the stylus traveling across the surface as the record is played. The angle at which the stylus touches the record is unchanged as the playing progresses from



outside to center. Pin-point indexing, which greatly facilitates cueing, is afforded by means of a calibrated adhesive-backed index strip which is supplied with the arm. Two models of the Trans-Linear arm are available, one for 12- and one for 16-in. turntables. Folder on request.

• **Tape Threader.** The chore of threading tape on a blank spool is eased by this device which is manufactured by The Flahan Company, 7517 Pelham Drive, Cleveland, Ohio. It is a sturdy metal unit which holds the tape to the reel for the



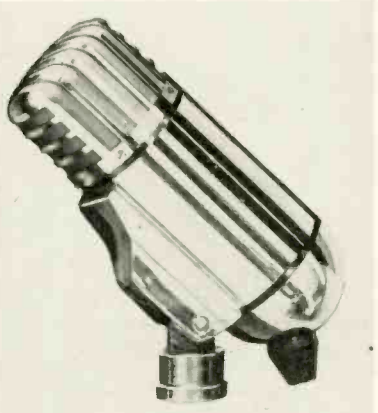
first few turns, then can either be slipped off or left in position to serve as a crank. The threader can be used on any size spool up to 7 ins. and fits all makes and models of recorders which are equipped with standard spindles. It can also be used on any standard 8-mm motion picture reel.

• **Deluxe Table Phonograph.** Built throughout of high-fidelity components, the new deluxe "Encore" highlights the Pilot line of table-model phonographs. It features a push-pull 8-watt amplifier with less than 1 per cent distortion, a Garrard RC-80 automatic record changer with GE variable reluctance cartridge, and 3-step equalization control for all types of recordings. The two-way speaker system consists of an 8-in. woofer and a 6-in. tweeter enclosed in an acoustic chamber.



The mahogany finished cabinet is smartly styled with the new "Solareed" grille treatment. The Encore may be adapted to chairside use by means of easily mounted wrought-iron hairpin legs which are available as an accessory. Pilot Radio Corporation, 37-06 36th St., Long Island City 1, N. Y.

• **Dynamic Studio Microphone.** The latest addition to the Capps line of high-quality microphones is a dynamic unit designed primarily for reproducing large sound bodies such as orchestras, choirs, and organs. Designated Model DM-2050, the microphone has a frequency response of 50 to 15,000 cps. Impedance is 50 ohms. Extremely compact, it measures only 1⅝ in. in diameter and is but 4½ ins. long.



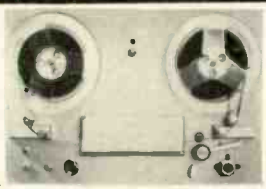
It is available in either high gloss finish for broadcast application, or matte finish for television. Each microphone is supplied with an individual calibration chart. Further information will be supplied by Frank L. Capps & Co., Inc., 20 Addison Place, Valley Stream, N. Y.

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A single knob controls Start, Stop, Reverse, Record and Play. Tape travels in same direction as knob is deflected. At high speeds (skip and rewind) tape lifts automatically from heads establishing contact only at intermediate speeds for locating or editing. Tape can be hand-cued by merely turning one reel in either direction. Automatic motor shut-off with lost tension eliminates 'spills' and 'breaks.' Dual speed hysteresis synchronous motor. Change of speed automatically changes equalization. Simple single-line threading. Has separate heads for erase, record and playback-monitoring with provision for mounting up to six heads.

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Employs the famous Weathers FM pickup cartridge and tone control. Frequency response extends from 20 to 20,000 cycles. Player is mounted on an attractive Formica base finished in either blond or mahogany.

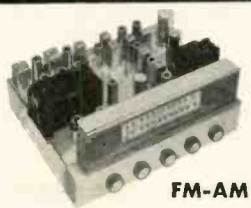
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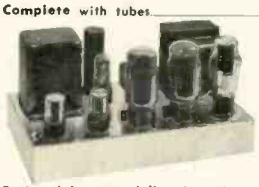
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Four equalization positions cover most recording characteristic requirements. Separate bass and treble controls permit up to 15 db boost or attenuation at 50 and 10,000 cycles respectively. Two cathode-follower outputs are provided: one for feeding main amplifier, and the other, bypassing the tone-control circuit, for tape recording. Frequency response: FM—20 to 20,000 cycles ± ½ db, and AM—20 to 5000 cycles ± ½ db.

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Designed for critical listening, the new C550 delivers 30 watts of audio power with only 1/10 of 1% harmonic and ½ of 1% intermodulation distortion. Frequency response extends from 20 to 20,000 cycles ± .1 db, and from 5 to 100,000 cycles ± 2 db. Effective gain permits amplifier to be driven to full output with only 1.5 volts input.

A special thermal delay circuit protects power supply and other components by insuring proper warm-up before high voltage is applied. Damping factor is 30:1, and internal output impedance, .57 ohms at 16-ohm tap. Output taps are provided for 8 and 16-ohm speakers. Employs KT-66 output tubes in push-pull.

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PREAMPLIFIER EQUALIZER

Model C350

An extremely flexible control system designed for use with highest quality audio components. Has 4 inputs for magnetic phono pickups, tuner, TV and tape recorder, each with independent level control. Seven positions are provided for phono equalization covering the entire range of record characteristics. Separate controls permit boost and attenuation of bass up to 15 db, and treble, + 13 db and —15 db. These controls operate a hinged circuit with fixed turnover points, thus eliminating distortions due to sharp 'shelving'.

Two cathode follower outputs are provided: one for main amplifier, and the other, bypassing the tone-control circuit, for tape recording. A loudness control with disabling switch permits setting for desired listening quality at all levels. Power supply is built in.

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Audio Fair—Los Angeles

Annual West Coast event readying for capacity attendance at the Alexandria Hotel, with first six floors devoted to the activities of the Fair and the Audio Engineering Society.

FEATURING the first Annual Western Banquet of the Audio Engineering Society as the opening activity, the third Audio Fair—Los Angeles gets under way on Wednesday evening, February 9. The technical sessions start the next day in the Grand Ballroom on the mezzanine floor and continue through Friday and Saturday.

The Fair itself opens Thursday evening, with "Trade Night." Since it is nearly impossible to separate qualified "resellers" from persons who are affiliated with the trade, the Advisory Committee decided that it would admit anyone who had read about the Fair in the trade magazines, whether engineer, audiofan, or dealer. The official opening announced to the general public—not those in the know about audio—is 2:00 p.m. on Friday, February 11. The show continues until Sunday evening, so many who could not otherwise attend will be able to come in on their day off.

Representing a change from previous audio shows throughout the country, this year's Audio Fair—Los Angeles is open only to the manufacturers of *audio components*—and not to packaged "high-fidelity" radio sets and phonographs. This is a step in the right direction, for entirely too many manufacturers of packaged equipment have entered the high fidelity market simply by applying the name "high-fidelity" to their products, without any apparent real effort to produce equipment which came up to the as-yet-unspecified standards which are well known by anyone in the audio components business and by audiofans who are acquainted with high-quality products, but which have never been reduced to a complete and reliable set of standards which could be used to evaluate equipment on a "go—no go" basis. With the restriction placed on exhibits, the public is sure to get an honest picture of what is truly "high fidelity," and need not go away with the feeling that a complete home music system can be had for "49.50, including ten records of your own choice," which is the trend in the fringes of the industry.

The list of exhibitors who will show at this year's Audio Fair—Los Angeles includes most of the big names in the audio industry, as would be expected. The preliminary list follows:

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Ampex Corporation
Audio Devices, Inc.
Audiogersh Corporation
AUDIO Magazine
Ralph Auf der Heide
Bell Sound Systems, Inc.
David Bogen Co., Inc.
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The Tetrad Company, Inc.
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Tung-Sol Electric, Inc.
University Loudspeakers, Inc.
Webster Chicago Corporation
Westminster Recording Co., Inc.

EQUIPMENT REPORT

(*from page 61*)

shorts these two jacks together, giving a normal circuit arrangement.

Phonograph equalization is provided for the three most useful curves, as shown in the top section of *Fig.* 1. A built-in high-pass action reduces extreme low-frequency response to eliminate rumble. Connection of a crystal or ceramic pickup is made through a small capacitor and a series resistor to the input of the preamplifier, and equalization is then correct as indicated on the selector switch.

The loudness contour switch places less and less shunting resistance across the compensating capacitors of a conventional two-tap compensated volume control. As the resistance is increased, the amount of compensation increases, as shown in the center section of *Fig.* 1, along with the tone-control range. This arrangement affects the maximum amount of correction available, and permits the user to set the control for the average reproduction level, then controlling the volume in the normal manner.

The lower section of *Fig.* 1 shows the distortion of the power amplifier. Note that distortion is less than 1 per cent at the rated 20-watt output. Two rectifier circuits are used—the output stage, together with the entire audio amplifier obtain plate supply from the high-voltage winding on the power transformer, using a 5U4GA rectifier, while the tuner section derives its plate supply from a lower-voltage section of the transformer and a 6X4 rectifier. Separate filtering circuits ensure a minimum of hum and of interaction between the two sections of the unit. *Figure* 2 is the schematic of the audio portion of the Festival.

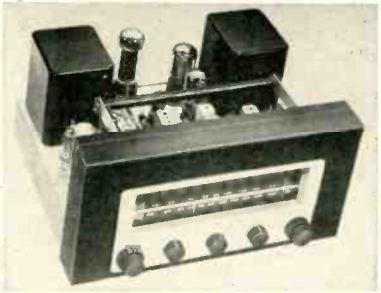


Fig. 3. The Harman-Kardon Festival, Model D-1000.

The a.f.c. action of the FM tuner section is remarkably effective, holding the station in tune over a dial spread of about one-quarter of an inch, and with a minimum of quality change throughout the deviation. The a.f.c. circuit is defeated by pressing inward on the tuning knob, which is a logical location.

Sensitivity of the audio circuits is such that an output of 1 watt is obtained from an input of 0.15 volts at the AUX jack, and only 3 mv from the phono jack. The AMP IN jack requires a signal of 0.4 volts for the 1-watt output, and the same magnitude of signal is available at the DET OUT jack to feed the tape recorder.

With the volume control at maximum, the hum and noise output is 53 db below 1 watt, but this is not a true figure in practice because the operating position of the control is about 30 db below maximum. With the volume control at minimum, the hum and noise output is 78 db below 1 watt, which is practically inaudible.

For the user who has a minimum of space and who still wants high-quality reproduction, the Festival might be the answer, for there does not seem to be any evidence of compromise to achieve compactness. The simplicity of the controls would appear to the non-technical user, and especially to those whose interest is solely in good reproduction without any desire for gadgetry.

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AUDIO ETC.

Edward Tatnall Canby

Voice of the People Department

UNDER THIS HEAD, let me quote some pieces of mail, excerpted, as recently received by this department. Sometimes a phrase or two in a letter can bring out a point of general interest better than a whole article. Two, in this letter:

Dear Mr. Canby,

". . . I have a technical problem . . . the best means of reproducing the very low bass from let's say 20 to 200 cps. My specific question concerns the value of the "air coupler" . . . All the technical publications have given ample space to the virtues of the exponential horn and its variations; for instance, I believe I could build the Jensen horn in the October (1954) AUDIO without much difficulty. But (few publications) have written on the air coupler, either for or against. Is it as good as (they say) below 60 cps? Is it any good at all?

"In my case I could better house an 8-foot air coupler than I could a Jensen horn, but which would be better for that bottom octave? I'm quite a lover of the pipe organ so I want to reproduce 32 cps and Cook's 16 cps is a new challenge."

That's a slightly doctored version, but it represents the writer's questions pretty well. Here's an excerpt from my answer—on two points:

"As far as I'm concerned, the air coupler died a peaceful death some years ago and I really didn't expect to hear from it again. Though I'm not a technical expert on such matters, common sense tells me that the idea of a resonating column is not good, and unnecessary today, and a lot of . . . engineering opinion that I have heard seems pretty well to bear this out.

". . . I would suggest, however, that the excitement of hearing a 16-cps note is not very profound. It's not music and it's not much of anything else but a slow vibration. Even the 32-cps pitch is practically non-existent in music, and though it is certainly desirable to have a solid musical bass, the strictly musical importance of the very low fundamentals is slight indeed."

"All of which doesn't mean that you should give up your search for low bass; but don't take it too seriously. There are other much more interesting tones to listen for, in the long run."

Next, a representative of the old school of thought that prefers the good old-fashioned phonograph to these new fancy hi-fi noise-makers. It seems to me that the trouble in arguments like the following is simply a misplaced emphasis, a faulty train of reasoning, based on right feelings. Most people who think this way are good listeners, often with highly musical ears, who not only can interpret musical sense with ease from the sounds of the older machines but who—quite rightly—deplore the ugly sounds they have heard coming from equipment that is technically top-notch. They are very, very right in their basic hurt! But their conclusions are not valid.

"Mr. Canby:

". . . I write concerning your opinions of commercially built "hi-fi phonographs, especially as you have regarded them in the July 1954 issue of this magazine. Frankly I don't think you're being fair. I own and use extensively a ——— affair which completely satisfies me.

"My cousin was happy with oil lamps and a woodburning stove—until he came to the city. But, at one time, I owned a [complete and expensive hi-fi system]; it was stolen in toto, diamond and all, and in the meantime I rented a demonstrator ———. The superbly *balanced* sound and the complete lack of fussing with solder and knobscrews quickly led me to pay in full for the machine, my entire $150 plus $16.75 for a diamond stylus, its only lack.

"I admit that I am primarily interested in music, but isn't that the case with nine tenths of all record purchasers? Do we need the remarkable qualities of modern sound equipment when we can have pleasant music so easily and cheaply?

". . . Please do not misunderstand me; I own a very large and quite varied all-LP library, in very fine condition. All of my Olympians [Mercury] and a few other isolated records, such as Gieseking-Debussy-Angel [Piano works of Debussy] actually sound quite startling. I'm a happy man."

My answer in part was as follows:

"The trouble with good phonograph equipment is that the better it is the more tricky it is to use and the more easily can it be misused to make hideous rather than good sound. I think that is the problem as far as you are concerned.

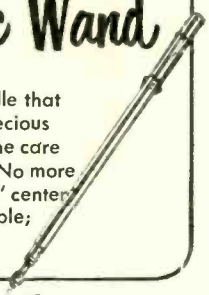
"The more expensive equipment, after all, does reproduce more closely the original sound as picked up by the microphones.

"I admit immediately that recorded music is a sound unto itself and that one can't exactly reproduce a concert hall, in any case. Nevertheless, the better equipment is capable of bringing out more of the musical values in a recording, and so I still feel that it is the thing to have—even for a music lover."

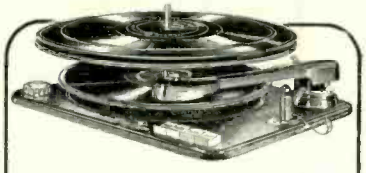
There's no doubt about it, we need a lot more education on how to use hi-fi equipment for best effect. Tin-ear or no, there are ways to get the best out of records—even recorded railroad trains and steam calliopes! As noted here last month in con-

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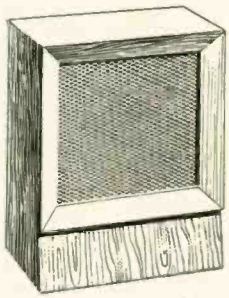
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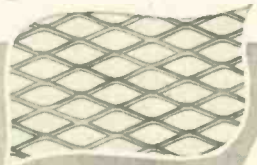
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nection with the Audio Fair, some of our professionals could learn a bit too, along with the customers.

Finally, a letter from an overseas serviceman and Audio subscriber who, after asking about a mail-order portable phonograph marked "best" in a well known catalogue that features a single point for all records (my answer will, of course be—stay away from all "all-groove" points, "best" or otherwise, if you want to treat your records fairly, with the single possible exception of the Weathers cartridge), goes on to describe record collecting in France as a tough proposition. (It's even tougher for Frenchmen, who must pay what is for them fabulously high prices for records and equipment.)

"I suppose there are some really fine hi-fi German and maybe even French records that we should be adding to our collections here, but no one seems to know just which companies in Europe do dependable work. As listening booths and pre-trials are unheard-of in the smaller towns where we are stationed, the problem of knowing which records are good is difficult indeed. . . . It is a shame that the "Stars and Stripes," our official overseas newspaper, has never gotten around to running columns on records or music in general. Cameras are discussed in full, you can find out the HP of every new European vehicle on the road, but here in the home of so much great music it is impossible to find a single worthwhile critical article on instruments, records, orchestras, etc. Even tourist books ignore the subject in favor of best brands of perfume, gloves, etc. to carry home. For that reason many of us can thank you for helping us through the maze of new recordings and reissues which we never even have a chance to hear or read about."

I wish someone would help *me* through the maze. But be that as it may, I can only remark as I did after the summer of 1953 when I was in Europe, that the place to buy European recordings is in the U.S.A.

Though our own musical activity has been picking up as far as records go, there is still a vast quantity of European-played music issued here on LP records, or shipped here in special editions for the U.S.A., as with Angel and London records. Most American companies now have European affiliates and vice-versa. Records are far cheaper to buy here and, I suppose, cheaper to make. Quality in many cases—not all—tends to be better as far as the record plastic material is concerned, English discs being the outstanding exception.

True, many new European recordings are issued on both American and European labels and so are available in Europe. But the high cost of recorded music over there often means economies in the making, such as close grooving; some items that are 12-inch LP's here are crammed onto 10-inch discs in Europe. But the clincher, for American servicemen, at least, is the price. Records shipped from America are I would guess bound to be far less expensive than the local product. (The European citizenry, of course, would have to pay a steep import tax that would remove the profit entirely.)

As for music criticism and information, I suggest that perhaps if this soldier were stationed in one of our own small country towns he might find himself in the same box. Useful and informed criticism of records and music, up-to-date information and understanding concerning hi-fi equipment, are matters for the big cities, here as in Europe.

I'll never forget trying, a few years ago, to buy a GE replacement stylus on that highly civilized vacation spot, Cape Cod.

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Long distance calls to every town within thirty miles produced nothing; they'd never heard of the thing. Finally a local GE toaster-gadgetry outlet sold me a complete cartridge at full list price. He didn't aim to carry any damfool things like extra needles and if I wanted one I could have the cartridge. I took it. No alternative, short of New York or Boston.

Records for Overseas

The best bet for overseas servicemen is as follows. (1) Study record reviews, to taste, sent on from the U.S.A. or in European journals. (2) Acquire a late issue of the monthly *Schwann Long Playing Record Catalogue,* from a record dealer in the U.S.; or the *Long Player,* also monthly. (For information, write Schwann at 131 Clarendon St., Boston 16, Mass., The Long Player at Box 346, New York 19, N.Y. Year's subscription to the *Long Player,* overseas, $4.). Both carry monthly listings of manufacturers' suggested prices (i.e. list prices, minus discount). (3) Order from local U.S. dealer or from one of the larger big-city dealers, most of whom now given discounts up to 30 percent from the list price. Almost any dealer will ship overseas.

These two cumulative catalogues between them list just about every LP available in the U.S., marking the newest releases for quick identification; heavy advertising by the various record companies gives an added label-by-label cross section of new material. They are invaluable as an adjunct to reviews.

For those who are stationed in Latin American countries, note that a Spanish-language Mexican monthly on LP and Hi-fi, *"LP"* ("La mejor musica del mundo Para discotecas selectas") gives quite remarkable coverage to most major U.S. LP issues and to most of the current hi-fi equipment as well. Brief reviews, in Spanish, big ads for new records and equipment. A separate section is called "Alta Fidelidad" which in the last issue I received included a glossary of hi-fi terms in Spanish, with English equivalents in parenthesis. Might come in very handy. Subscription, $3 U.S., for foreign mailing. Address: Editor, Otto Mayer-Serra, Apartado postal 8688, Mexico, D.F.

Gadgetizing: 1. Micro-Poise

I'm as intrigued by an ingenious gadget as the next man is—even by what one might call a *hopeful* gadget; that is, one that is on the right track even if it doesn't work out too well. There are lots of hopeful gadgets in hi-fi and I'll admit that I've praised a number of them in the past, even though in the long run I have put some of them aside as not really very practical.

One of the most fruitful areas for well-intentioned devices in audio has been the stylus-weighing department. Everybody wants to know how much his or her stylus point "weighs," but in the past nobody has been able to decide for sure, thanks to those complexities of pickup geometry, the arcs of travel, the side-pull and what-not, that make readings in grams singularly inaccurate on most devices.

I mentioned the Weathers weighing gadget some time back—and noted at the time that its ingenious suspension principle at least got around the difficulty of the point's vertical arc of travel; but the arrangement of detachable levers on this little springless weigher, as then noted, was perfectly designed for quick misplacement. In no time at all I had lost essential parts of the device (behind the radiator or up the vacuum cleaner hose) and that settled that. Moreover, I had already come to feel that, even though the elimination of springs was a big step towards practicality, there were still friction problems which might make the Weathers scale something less than accurate, at best.

Now the indefatigable Maximilian Weil has come up with another stylus weigher which, at long last, really works. I don't think anybody will improve on it. The Micro-Poise goes straight back to the most ancient and the simplest principle of all, the balance, see-saw style. Put the pickup on one side of the see-saw or teeter-totter, put a small brass weight on the other and see what happens. A collection of small weights of varying sizes will allow you to figure stylus pressure by process of elimination.

Of course this device is somewhat trickier than a teeter-totter. The ingeniously machined central pivot is a pleasure to see, the product of a lot of experiment and some very sharp old-fashioned know-how. The inscribed "record groove" on the pickup side of the balance, into which you slide the stylus, is another tricky idea, and much better than the cups and depressions in some other devices. The small brass weights that fit over a pin complete the arrangement—two of them in convenient sizes. Rest your pickup stylus in the groove, put on a likely weight, and the device immediately tells you, with only a quarter-inch or so of motion, whether you are heavier, lighter, or the same as the given weight.

What seems to me good about this gadget is, first, the good geometry, which makes for the best possible positioning of the stylus, in the normal playing location, and, better, requires but an extremely small arc of motion to give a "reading," thereby reducing a major source of error; and second, the absolute minimum of friction inherent in this see-saw balance approach. This is one gadget I expect to keep on using.

The Micro-Poise isn't cheap—none of the point-pressure gauges is cheap—but a bit of close inspection will convince you that the machining and calibration of weights is of a high order here, and worth a bit of cash.

2. Static Eliminators

Another area of perennial hopefulness in the record gadget field is static removal. It was one of the first, after the introduction of the plastic record, and many a reader will remember the excitement over the radioactive polonium activated static brushes which a lot of nervous people immediately decided were by-products of the atomic bomb and at least as dangerous. (They wern't).

Static still has to be removed via gadgetry, the static-free plastic record being still a rarity. Some of it goes away via the residue of one or another of the wipe-on or spray-on fluids. Some gets wiped off clumsily via a damp cloth.

Some still goes via ionization of the adjacent air, as with the polonium static brush, but there are much more practical ways of doing it now. The newer radioactive gadgets last a large number of lifetimes, instead of losing 50 per cent of their efficiency in a year or so.

I reported, back awhile, on the Mercury Disc Charger, a tiny bit of radioactive material embedded in plastic that clips onto one side of your pickup and "scans" the record as it plays, removing static ahead of the stylus. Since then another and very similar device has appeared, the Eby Stati-Mute, and I have had this one inconspicuously attached to my playing arm for some months. I must report that it works, and this goes, too, for the Disc-Charger. (That is an un-

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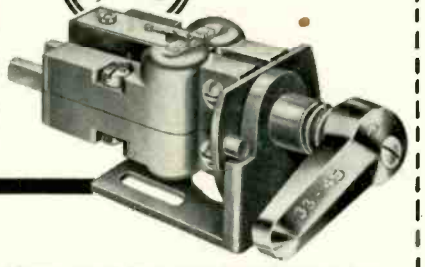
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the 2nd audio anthology continues from where the first left off and contains reprints of articles from January 1950 through July 1952. In both books the articles were brought up to date, corrected where necessary, and assembled by subject. **the 2nd a a** may still be had with board cover.

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fortunate name, I'd suggest! One would almost think it charged the disc up, instead of discharging it.)

The main criticism I've heard suggested concerning these static-removers is that they merely loosen, but do not remove the dirt and grime which is held to a plastic disc by the bonds of the static charge. In practice this is not, it seems to me, a serious criticism.

It is true that if you play a very dirty record under the static "scanner," much of the lint and dirt will ball up under the stylus and some grinding of the groove may occur, I suppose. But obviously the thing to do with such a dirty record is to clean it first; then on subsequent playings it will remain static-free under the scanner and pick up a minimum of new dirt. Clean records, new records, fare very well under the scanning beam, as I have good reason to know. And so I recommend both of these, the Disc-Charger and the Stati-Mute as a painless and automatic means of keeping discs free of static. Nothing in the way, nothing to use up. (And if you want to reset your stylus pressure to compensate for the slight additional weight, pull out your Micro-Poise, above.)

3. GE "Baton" Arm.

General Electric's pickup arm has reached me a trifle late, a couple of years or so, but I still have some comments on it that are of current application, since the arm is still very much on the market.

The "Baton" arm (two sizes, 12-inch and 16-inch) is a handsome twin-tubular affair with a counterweighted section up front, somewhat like that in the Pickering arms. But unlike Pickering, GE has a balance scale built into a visible counterweight shaft that extends back from the cartridge shell. Because everything is visible about this front-end assembly, I find that there is much less danger that an unknowing or absent-minded user will grab the main arm and drag the cartridge point across the record than there is in the nicely streamlined Pickering models, where the vertical-moving head assembly is concealed under the end of the main arm, which moves only sidewise.

The GE arms are clearly intended for the GE cartridge and that is that. The scale is calibrated to match the weight of that cartridge, for one thing. More important, the slide-in cartridge holders are intended basically for the GE and are not very well adapted to most other makes, mainly because the two contacts in the rear of the receptacle, reached through a snap-in kind of spring arrangement, are not too easy to hit.

Don't worry, if you have other cartridges in mind: I've got an E-V Ultra-Linear ceramic in my GE arm now. Most adaptations can be made with a bit of ingenuity. But I should think that, as a general principle, a regular "shell" with its own contacts into the arm, as in many changers, would be a useful adjunct to this and other arms for those who want to be able to use a wide variety of cartridges, or who use two separate cartridges for one-mil and three-mil playing.

Cartridge Mounting

An increasing difficulty, incidentally, in cartridge standardization as to size and mounting is the rapid drift away from the once-universal horizontal pin connections at the cartridge rear. Numerous cartridges still have them, but many newer ones have vertically placed contacts, one above the other, and the distance between the pins, vertical or horizontal, gets less and less as

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cartridges get smaller and smaller. A universal arm to match all present types of cartridge contacts in plug-in fashion is no longer possible. The Clarkstan arm for example, which a few years ago would take just about any cartridge on the market with a quick twist of its set-screw clamp, now will not accept many new cartridges. (It has two horizontal spring-loaded contacts against which you push the rear of the cartridge.) The shell arrangement, with loose slip-on wire connections inside, to slip over any cartridge's pins, plus its own external prongs, is now the best answer to universality, for any arm or player.

Which brings up another question of minor but intriguing importance. What of the half-inch mounting holes, now standard (with varying screw sizes) for American use? As cartridges have grown smaller, the once universal pair of screw holes at this distance (RCA's and a few others were slightly different) and the familiar large-size head or shell become daily more anachronistic. Most new cartridges are so small that the mounting gear is in the form of "wings," spread out from either side of the tiny cartridge itself, clearly a makeshift adaptation of a small unit to an overlarge space.

The miniature cartridge first hit the popular market in a relatively large way with the original Philco-Columbia LP player and its small crystal "sugar-lump" cartridge, with special small arm to match. This department then hailed it as a coming and presumably standard size; but the idea didn't go over widely, though Astatic's model U crystals and their special arms are still extant today as an outgrowth of the old LP player. The large cartridge receptacles and the wide-spaced mounting centers, half-inch, continued standard for the United States.

We now still use the large heads, big enough to fit the biggest and clumsiest of old-style cartridges, though the plain fact is that a large proportion of the newer cartridges are miniature in size and more miniatures appear every month. Recent major recruits are the tiny Pickering magnetics (mounted on relatively huge and clumsy adapters for the big shells), the Sonotone, Astatic, and Shure ceramics, and the Dutch Ronette crystals. All of these are now equipped with wings or other devices to fill the empty spaces in the standard cartridge head.

But in a few years, we can guess, the large shell will have to go. Then the miniatures will move, properly, into miniature heads in new slim arms, like those long used for the Zenith "Cobra" pickups, or the special Ronette tubular arm now available in this country. (You take off the Ronette wings; the small cartridge just fills the head.) Fine—we can use smaller, lighter, less bulky arms. But what will the new "standard" mounting arrangement be, I ask?

So far I haven't seen the slightest indication of any forthcoming agreement. Has anybody given the matter a thought? True, it's not exactly a basic matter and I can see how most manufacturers, thinking purely of their own product would never give it their attention. They should. For as usual, the poor goat—the consumer—will in the end be the one to suffer if, in abandoning the present semi-universal U.S. standards for cartridge mounting, we move into an area of simple chaos, where every cartridge requires its own special adapter and every arm, changer or non-changer, likewise, and an audio parts dealer in order to match all the leading cartridges to all the leading arms will need a vast carload of adapter fittings! Could happen, and it probably will.

Isn't it time to investigate a practical new miniature cartridge standard right now? Maybe it's already too late—for present designs are radically unlike in the essential respects. It's not too late to try. What is needed is a compromise smaller adapter shape, to which the present small cartridges could practically be adjusted, as they now are to the large-size standard mounting. It would take ingenuity, but we have plenty of that around, if only the cartridge designers would get together in a Standards Committee—as the tape equalization people finally have done.

Ronette

Following this continuing stream of thought, herewith some words on the above-mentioned Dutch-import Ronette crystal cartridge. I got a sample load of these units, plus the Ronette arm, last winter from Holland. (The separate cartridges were, of course, equipped with standard half-inch mounting wings as per above.) I did not then know that these cartridges were to be widely used on coming U.S. equipment, notably the 1955 Columbia phonograph line and several others. Thanks to this, and to their general availability, the Ronette line is now of considerable importance in the United States.

These are plain "old fashioned" crystals, and many will turn up noses. But don't do so until you investigate the kind of performance these units give. There are some very interesting points to note. And among them the most interesting to me is the audible effect of extreme high compliance, as widely claimed in Ronette literature; for this reminds me of an old battle in these pages, *Circa* 1948, when, unaccountably, the new Columbia-Astatic crystal LP cartridges played new LP records without "buzz" in the loud parts, where many existing expensive magnetics made nasty noises at every loud passage. The magnetics were flatter in response, but the high-compliance crystal sounded better.

Our magnetics have long since overcome this trouble and the newest magnetics are outstandingly good as compared to earlier models. The point I have to make is slightly different, for today.

The Ronette, as sold in the U.S., comes in two models, the OV or "standard" grade, very cheap, and the P or professional cartridge, outwardly the same in looks but with higher standards of response, a different curve. (More of that in a moment.) I've been trying both, and my interest went immediately to the cheaper cartridge, the OV, since that one is to be used in many a low-priced "hi-fi" phonograph. It appears, for instance, in the new Columbia 3-speed player attachment, which sells for about $17 and is thus the cheapest player available with minimum quality requirements, including two sapphire needles. (No "all-groove" points, no precious metal.)

It may seem crazy, but when I connected the two Ronettes straight into a high-level amplifier input, unequalized (as one does with the new ceramics) it was the cheaper OV that sounded the best—and indeed, though its response is relatively limited, with a practical top of under 10,000 cps, it reproduces hi-fi recordings with far better sound than it has any "right" to, according to its description.

I can give you two interesting reasons why. First—compliance. The outstandingly good compliance of this unit gives it a tone quality that is smooth and natural to the ear with a minimum of metallic "crystal" sound and a particularly nice clarity in the loud passages. Even with a slightly restricted frequency range—remember that

"THE PLAY'S THE THING"
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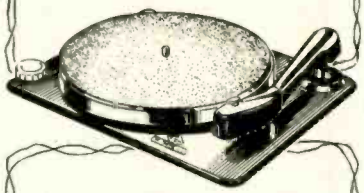
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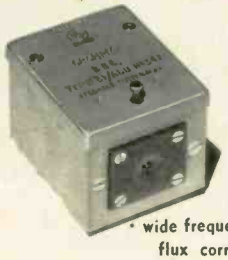


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the upper highs are mathematically very close, 8000 cps to 16,000 cps being only one octave—the basic sound of this unit is excellent. It reproduces, let's say, 99 per cent of the significant musical material on a record.

But there's another reason. Why did it sound better than the professional model P Ronette, under the same conditions? Because of equalization.

Few crystals are really anywhere near flat in response, even to the theoretical constant-amplitude curve that is normal for them. They have peaks and they fall off above or below some peak frequency. The Ronette OV model has a curve of response that is decidedly not flat. But its general shape, nevertheless, follows the constant amplitude curve as to tonal balance, high and low. Therefore, as played into a flat amplifier (with proper termination), unequalized, it matches pretty closely the now semi-standard record playback curve, highs boosted and lows rolled off.

This has been and still is the principle of operation for all the newer wide-range quality crystals (including ceramics) in the U.S. The E-V Ultra-Linear is advertised as adhering to the RIAA-New-Orthophonic curve within close tolerances; the CAC cartridge was designed to match the old LP curve without equalization.

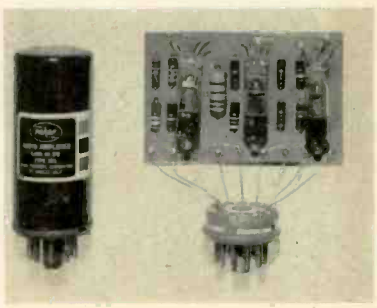
But the professional Ronette P cartridge has a special curve. It has, with proper termination, a *constant velocity* response over most of its range. (See EQUIPMENT REPORT, Dec. 1954.) Over this area of its response, then, it acts like a magnetic cartridge. Too strong highs, unequalized—it reproduces the recorded high boost without the built-in compensating roll-off of other crystals. As far as I can figure it (and I admit that I am not entirely out of the underbrush of confusion in these matters) the lower end of the Ronette P model still boosts the bass more or less normally according to the constant amplitude curve when working into a high load resistance, 1 meg. or more. Anybody with a little know-how and some basic curiosity can equalize the P for good results, and I managed it quite handily. But not most unknowing listeners especially if they are not warned in advance.

Common sense tells me that unless the clear difference in *type* of response curve is made very, very plain in Ronette literature, many people—and plenty of service men too—are going to find themselves dismally confused. I'm getting a headache already, thinking about it.

NEW PRODUCTS

(from page 68)

• **Packaged Circuits Utilizing Etched Circuitry.** Of particular interest to engineers and designers is a new departure in packaged multi-component units which use circuits etched on impregnated Teflon.



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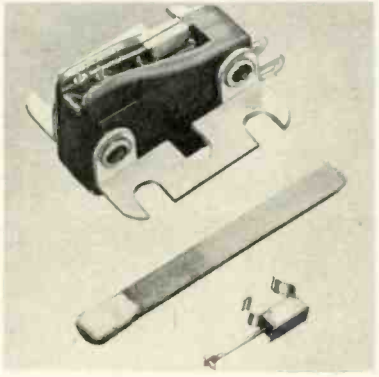
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Manufactured by Audio Products Corporation, 2265 Westwood Blvd., Los Angeles 64, Calif., and sold under the trade name "Pakaps," the new line is offered in three series having many applications in computer and airborne instrumentation, laboratory equipment, and high-fidelity audio amplification. Standard series 100 and miniature Series 200 units perform such functions as low-, medium-, and high-speed binary scalers, cathode followers, multivibrators, pulse formers, pulse shapers, ring counters, and gates. Series 300 Pakaps are multistage amplifiers available in three ranges of amplification: 20, 40, and 60 db, flat from 20 cps to 40 kc. Overall size is 3½" high x 1¼" diameter.

• **Sonotone Ceramic Cartridge.** Exceptionally fine performance characteristics are inherent in a new single-stylus high-fidelity ceramic cartridge recently announced by Sonotone Corporation, Elmsford, N. Y. Known as the 1P, the cartridge features high compliance and extended



frequency response. It does not require an equalizer or preamplifier, making it an ideal unit for improving older phono installations. Output is one volt from microgroove records. Because of its small size it will fit into an unusually large number of tone arms. The unique replacement stylus snaps into place and is available with either diamond or sapphire tip.

• **Collaro Record Changer.** Many improvements which add considerably to the user's convenience have been incorporated in the new Collaro Model RC-54 three-speed changer. Automatic intermix permits stacking of 7-, 10-, and 12-in. records in any order of play without any adjustment or pre-setting, provided they are of the same speed. The complete changing cycle of the RC-54 requires only six seconds, regardless of the speed at which records

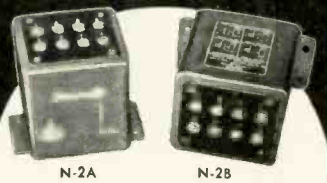


are being played. Mechanical features include: A powerful 4-pole motor with dynamically-balanced rotor; a weighted steel turntable which runs on a cushioned ball thrust for rumble-free operation; automatic idler disengagement when the changer switches to "off"; automatic switch-off when last record has been played, and automatic muting switch which shorts out the pickup during the change cycle. The new RC-54 is considerably smaller than its predecessor, measuring only 12 x 13½ in. Further information may be obtained by writing The Collaro Division of Rockbar Corporation, 215 E. 37th St., New York 16, N. Y.

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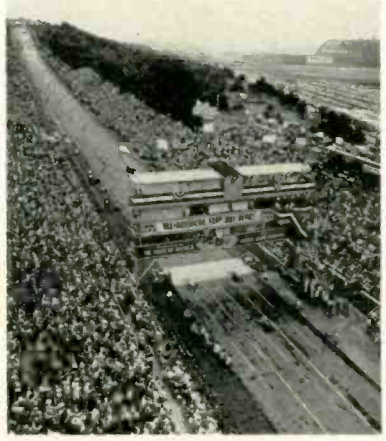
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(from page 20)

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(from page 65)

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Industry People...

Irving Greene has resigned as vice-president of New York's Asco Sound Corporation to become advertising and sales promotion and sales manager of University Loudspeakers, Inc. His place as Asco sales manager will be filled by **Ozzie Reiter** . . . **Jack Karns,** executive vice-president of Recoton Corporation, vacationed in Florida during the Christmas holidays . . . **Jane Froman** is the latest show business celebrity to be bitten by the hi-fi bug—her new music system incorporates a two-way Lansing speaker, a Marantz preamplifier and a McIntosh 30-watt amplifier . . . University Loudspeakers, Inc., sales executive **Larry Epstein** vacationed in Mexico after illness . . . A bout with a bug bedded **Victor Brociner** of Brociner Electronics Laboratory . . . **George C. Daleo** has resigned as chief cabinet engineer for CBS Columbia—after a short vacation he will open shop as a manufacturers' representative in New York . . . Recent additions to sales division of Electro-Voice, Inc. announced by **Lawrence L. LeKashman,** vice-president in charge of sales, include **Cullen Macpherson** as assistant manager of the reproducing components division, **George R. Riley** as assistant manager of the distributor sales division, **Lloyd W. Loring** as sales engineer, and **Everett E. Leedom** as advertising manager . . . **Charles A. Hansen,** having completed his assignment to build a distributor sales organization for Gramer-Halldorson Transformer Corporation, has returned to California to conduct his own manufacturers' representative firm . . . **Dr. Jerrold R. Zacharias,** professor of physics and director of the laboratory for nuclear science at Massachusetts Institute of Technology, has been elected to the board of directors of National Company, Inc. . . . **John E. Hogg** has been named manager of field sales for the instrumentation division of Ampex Corporation.

Industry Notes...

Purdue University has installed 27 Magnecord record-playback machines for use in its foreign language laboratory, according to Carroll W. Hoshour, products manager for **Magnecord, Inc.** It has been found that regular use of tape recorders in the teaching of foreign languages is from two to five times faster than other methods. The machines are installed in sound-proof booths in which a student hears, through headphones, instruction material emanating from another machine which serves as the master unit. The master tape has frequent intervals of silence, during which the student speaks into a microphone and attempts to duplicate the sounds he has just heard. The student's recorder records both what he has heard and said. In this manner the student and his instructor are enabled to compare the instruction pronunciation with the student's own. The Purdue language laboratory was established in 1950 and is under the direction of Dr. Elton Hocking.

To publicize the opening of its new sound laboratory at Pittsfield, Mass., the **General Electric Company's** power transformer department is using a "talking" ad —an advertisment that is both a recording and a regular printed ad. Contrasted on the recording are sounds recorded inside and outside of the laboratory's anechoic chamber. A reader can hear these sounds by merely punching out the paper record and playing it on home phonograph equipment. The ad is produced by Sound 'N' Sound Enterprises, Inc., of New York.

Shure Brothers, Inc., manufacturers of microphones and acoustic devices, has announced plans to begin construction of a modern one-story plant in Evanston, Illinois, a suburb of Chicago. The new building will provide 80,000 sq. ft., with room for expansion on the industrial property covering 220,000 sq. ft. The plant, which is expected to be completed in the Spring of 1956, will serve as the new home for the entire Shure organization. A new engineering laboratory for the development of electronic fire-control systems for military aircraft will be established next month in Waltham, Massachusetts, by **Radio Corporation of America.** A portion of the Waltham Watch Company plant, 225 Crescent Street, was leased to house the new operation, which will be equipped with the latest in research test equipment and scientific computing devices.

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ORGAN RECORD

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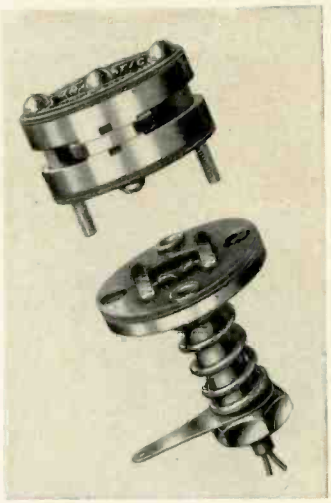
FAIRCHILD RECORDING EQUIPMENT

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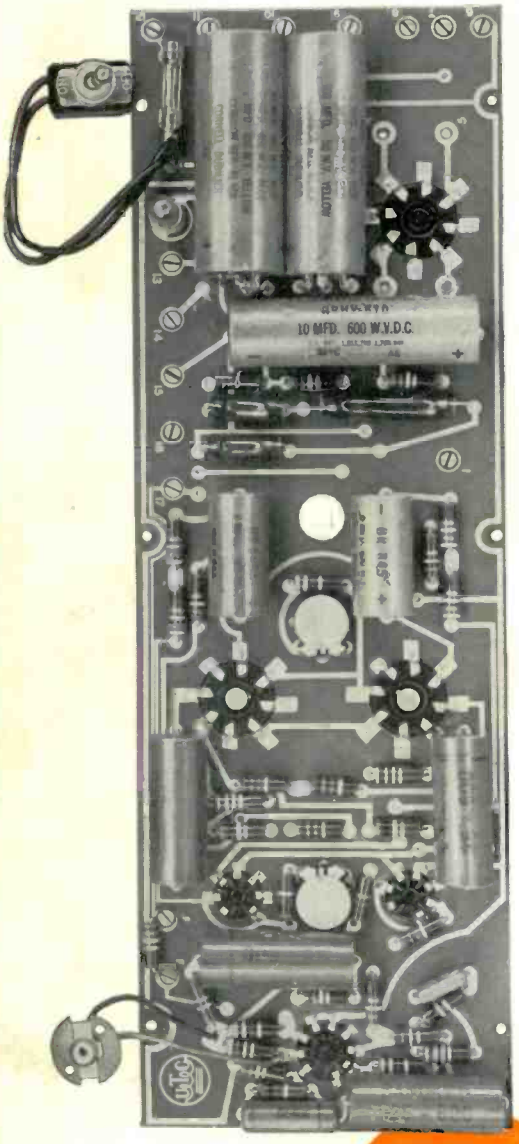
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